Code-Switching Cyberbullying Detection and Communication System in Malaysia (CSCDCSM)

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Abstract

Social media for decades has always been a mechanism that brought the entire community together, yet for decades it has also always been a malevolent platform that has extinguish the existence of our loved ones where not a hint of sympathy is due. The main culprit for such vile actions is none other than, cyberbullying. The repercussions from cyberbullying are undeniably vomit-inducing and must be avoided at all costs. With that being said, the cyberbullying cases in Malaysia has become more prevalent than ever despite the current strategies established. Apart from that, domain research delved into has unveiled the severity of cyberbullying cases wherein many victims as well as the bystanders refrained from reporting the incidents. Having said that, the cyberbullying occurrences in social media are immensely difficult to identify manually due to the excessive data flow, prime example in which as much as 3.15 million Malaysians uses Twitter currently. Furthermore, Malaysia is a multilingualism country whereby Bahasa Rojak, or more commonly known as code-switching is practiced amongst the citizens wherein monolingual cyberbullying detection systems are much less effective. Not to mention, the research survey and interview conducted have solidified the presence of the aforementioned problems and the idea of code-switching cyberbullying detection and communication system are well-received by the respondents. Therefore, this project has aimed to develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government agencies and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets generated on Twitter, thus allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia. After an exhaustive process of system development, the system was successfully developed with fully functional features and satisfactory quality attributes that were highly concerned by the target users, validated and verified through unit testing and user acceptance testing, thus triumphantly achieved the aim of the project.

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Chapter 1: Introduction to the Study

1.1 Background to the Project

Cyberbullying, unlike traditional bullying, is regarded as the exploitation of electronic means, predominantly social media platform to harass others deliberately with more secrecy and time flexibility (Olweus, 2012, Wright, 2017 cited in Rosa *et al*., 2019; Zhao, Zhou and Mao, 2016). The aftermath of the individual especially the young ones getting cyberbullied cannot be overlooked nor viewed lightly. These traumatic experiences may range from having low self-confidence to something much worse that is irrevocable (Foong and Oussalah, 2017). The more devastating part about cyberbullying is the fact that no countries are insusceptible to the issue of cyberbullying, not even Malaysia, a country with diverse ethnicities living together. According to a large-scale survey with 20793 respondents conducted by Ipsos in 2018, it was revealed that Malaysia is ranked top 10 amongst the other 28 countries in terms of the most cyberbullying cases reported by the parents of the victims of cyberbullying (Cook, 2020). Despite Malaysia's early effort in assembling an institution known as MCMC (Malaysian Communications and Multimedia Commission) that regulates online content through resolving complaints reported to its platform as well as and an agency, CyberSecurity Malaysia with a programme called CyberSAFE (Cyber Security Awareness For Everyone), dedicated to raise public consciousness on safety and threats in cyberspace (CyberSecurity Malaysia, 2021a), as well as a team known as MyCERT (Malaysia Computer Emergency Response Team) that provides a reporting platform called Cyber999 on issues encountered on the internet including cyberbullying (CyberSecurity Malaysia, 2021b), the ranking was evident enough to prove that the current strategies employed to mitigate cyberbullying cases is simply not effective. A better approach would be having these agencies including the non-governmental organisations (NGO) across Malaysia to proactively identify these cyberbullying incidents across social media platform and warn the individuals before taking any consequential action. Moreover, these parties can employ such approach to provide counselling service to the victims of cyberbullying if needed, therefore preventing any unfortunate events from happening. However, cyberbullying in social media is extremely hard to identify manually due to one of the reasons being the overwhelming flow of data being pumped every single day. To illustrate, it is revealed that there are approximately 500 million of tweets being posted on Twitter every single day (Mention, 2018). And surprisingly, there are around 3.15 million of Malaysians who uses

Twitter as of current (Clement, 2020). Another reason of why cyberbullying is hard to detect particularly in Malaysia is because Malaysia is a multilingualism country whereby Bahasa Rojak, or more commonly known as code-switching is practiced amongst the citizens. Code-switching is a phenomenon that happens during a discourse in which two or more languages, not excluding dialects are involved concurrently (Esen, 2019). According to the study by Tan, Shahidatul Maslina Mat So'od and Bahiyah Abdul Hamid (2019), they unveiled that Malaysians uses code-switching which is switching from English to Malay and vice versa to insult other people on Twitter.

Therefore, it was concluded that some form of automation is needed. Sentiment analysis or specifically machine learning (ML) and natural language processing (NLP), is the answer to that. ML is a branch of Artificial Intelligence (AI) that learns and ameliorates all by itself through the data that it was fed into without being explicitly programmed, with the goal of predicting specific outcomes (IBM Cloud Education, 2020a). On the other hand, NLP is also a subset of AI whereby it aids the computers in comprehending, deciphering and manipulating the language we speak (SAS, 2020). By applying sentiment analysis to identify positive or negative sentiment encapsulated within a message (MonkeyLearn, 2020), detecting cyberbullying message across social media platform is viable. Thence, in an effort to mitigate the severity of cyberbullying incidents in Malaysia, this paper will delve deeper towards the idea of implementing a code-switching cyberbullying detection and communication system for government agencies and NGOs to detect Malaysia-based cyberbullying tweets on Twitter through incorporating sentiment analysis.

1.2 Problem Context

Prevalence of cyberbullying cases in Malaysia despite the current approaches and strategies established, is the main problem that inspires the proposal of this project. As mentioned earlier, Malaysia was ranked top 10 in a large-scale survey conducted in 2018 as the most cyberbullying cases reported by the victim's parents. Apart from that, another poll initiated by the United Nations Children's Fund (UNICEF) in 2019 have addressed that 3 in 10 youths have experienced getting cyberbullied (Athira Nortajuddin, 2020). To further solidifies the severity of this issue, based on the statistics reported, there are more than two times the amount of cyberbullying incidents happened in 2020 as compared to 2019 (CyberSecurity Malaysia, 2021c, CyberSecurity Malaysia, 2021d), and those are only the ones who were aware of its service and proactively reported them,

there could be much more victims being cyberbullied out there who did not report and stuck in the state of agony. Even though MCMC was established in 1998 and MyCERT was already initiated since 1997 meanwhile CyberSAFE was introduced in 2010, yet the issue of cyberbullying is still relevant to the public's ears, it is fair to say that Malaysia as of current has not found the definite solution to mitigate cyberbullying cases in spite of the initiation of the reporting platform and the awareness programmes.

As of today, there are quite a few helpline services for victims of cyberbullying in Malaysia, such as Befrienders Malaysia along with Protect and Save the Children (R.AGE, 2016). However, the **ineffectiveness of these helpline services** became obvious as it was reported that 63% out of the approximate 5000 Malaysian respondents were not acquainted with these services (Bernama, 2019). These data imply that there could be victims of cyberbullying out there being on the edge of the precipice, just one step away from leaving their loved ones yet was unaware to the helping hand extended to them.

Effectiveness aside, the perception of these victims towards the consequences of reporting their experiences from being cyberbullied can said to be the greatest factor in determining whether these cyberbullying cases will be unveiled and combated. Victims with low self-esteem are **reluctant to report their incidents of getting cyberbullied** as they perceive it will only worsen the situation or just flat out futile. Heartbreakingly to say, some may even think they deserve such treatment (Gordon, 2020), hence would rather not seek for help. Moreover, it was discovered in the literature review that there are **bystanders who do not report witnessed cyberbullying incidents** as well. As long as no parties have found the definite way to mitigate these occurrences, sooner or later the unexpected will arrive.

Apart from that, the **flow of data** within social media platforms are purely **too overwhelming**. As discussed previously, the messages generated in Twitter are enormous. Van Hee *et al*. (2018) claims that these overwhelming data are too many for the moderators to even remotely monitor manually and subsequently agreed that a system that automatically detects these negative sentiment messages is inevitable.

Based on the literature review conducted, almost every research focused on cyberbullying detection system in one language. However as established earlier, Malaysia citizens practices

code-switching, whereby the meaning of a sentence expressed can drastically differs when other languages are involved. For example, the phrase *'you so cantik'* and *'you so hodoh'* has totally different implications. Thence, **monolingual cyberbullying detection system will not be as effective when applied in Malaysia context**.

1.3 Rationale

To resolve the issues stated above, a code-switching cyberbullying detection and communication system using sentiment analysis based in Malaysia is more than essential to be implemented, so as an endeavour to lessen cyberbullying incidents from occurring. From developing this system, government agencies and NGOs are able to monitor Malaysia-based cyberbullying activities occurred throughout the platform Twitter. Everything is automatised, beautifully summarised and displayed in a graphical view for the users. Moreover, with the help of the system, these system users can warn any individuals for their cyberbullying behaviour before taking any severe measures to make them realise the consequences of cyberbullying others. Apart from that, some victims of cyberbullying may not be aware of any available helpline services in Malaysia or are afraid from seeking any counselling help at all. Instead of waiting them to reach out for support, the government agencies and NGOs can be the ones to take the initiative and enquire them on whether they need any form of assistances. Through such approach, victims of cyberbullying will be less likely to suffer from mental illness, or even worse, resulting to committing suicide. Additionally, the system will be built to detect code-switching cyberbullying tweets on Twitter particularly English and Bahasa Malaysia or Malay to mitigate cyberbullying cases from remain undetected.

1.4 Potential Benefits

1.4.1 Tangible Benefits

- Ensure comprehensive coverage and detection of cyberbullying tweets happening in Malaysia.
- Allow quick detection of cyberbullying cases in Malaysia.

1.4.2 Intangible Benefits

- Reduce the number of cyberbullying cases in Malaysia.

- Reduce human resources and workload required to monitor cyberbullying activities.
- Reduce the likeliness of victims of cyberbullying suffering from mental illness.
- Influence people to be more thoughtful when relaying opinionated messages towards the target reader in social media.
- Create a healthier and a friendlier social media environment for the younglings.
- Relieve parents' worries on their children usage of social media.
- Improve public perception towards Malaysia through the reduction of cyberbullying cases.

1.5 Target Users

The target users this system is specifically designed for include the cyberbullying-prioritised government agencies and the NGOs that prioritises in providing counselling session for victims of cyberbullying. Both parties will be equipped with similar functionalities built into the system to deal with the cyberbullies and the respective victims.

1.6 Scope and Objectives

1.6.1 Aims

To develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government agencies and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets (Text-based only) generated on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia.

1.6.2 Objectives

1. To perform a study on topics including cyberbullying and sentiment analysis to acquire in-depth knowledge and insights towards them.
2. To conduct research in terms of collecting and analysing data from the relevant population to obtain thorough perception towards the system.
3. To determine the most effective sentiment analysis algorithm to detect code-switching cyberbullying tweets.

4. To devise and design comprehensive UML diagrams to define the system architecture and ease system development.

1.6.3 Initially Proposed Deliverables (Before Chapter 6)

The proposed system eases the government agencies and the NGOs' effort in identifying code-switching cyberbullying tweets generated on Twitter in real-time as well as allows authorities and NGOs to warn cyberbullies and to offer counselling help to the victims of cyberbullying if required. The list below shows the initially proposed system features and functionalities that will be developed for each user:

System

- Able to automatically gather Malaysia-based tweets (Text-based only) from Twitter in real-time and detect whether any code-switching (English & Malay) cyberbullying tweets are being posted. (Machine Learning Model)
- Able to generate a graphical view of the statistics of cyberbullying cases in charts.
- Able to alert system users whenever a cyberbullying tweet is detected.
- Able to display toxicity levels (Low, medium and high) of cyberbullies based on the number of cyberbullying tweets posted over the past month.

All Users

- Able to login to the system.
- Able to monitor the statistics of the cyberbullying cases and filter based on time.
- Able to send Direct Message (DM) to Twitter accounts with pre-written messages to warn cyberbullies or offer counselling support by giving contact numbers to victims of cyberbullying.
- Able to reply tweets with pre-written messages to warn cyberbullies or offer counselling support by giving contact numbers to victims of cyberbullying.
- Able to modify pre-written messages.
- Able to view all the Twitter accounts that have send or received cyberbullying tweets.
- Able to view all the cyberbullying messages detected.
- Able to remove misclassified tweets.

- Able to log out of the system.

Government Agencies

- Able to register a new user as government agency admin or NGO member into the system.

Considered

Considered features are features that will be implemented into the system only if there is sufficient time.

- Able to communicate with the cyberbullies or cybervictims through a chatroom (Two-way communication).
- Able to generate graphical statistics in map-view.
- Able to search cyberbullying tweets based on the input given such as username, date or location.

1.6.4 Refined Deliverables (After Chapter 6)

The list below shows the precise system features and functionalities that will be developed for each user. The deliverables below are decisively determined after gathering the opinion from the general public as well as the perception and requirements from the target users.

System

- Able to automatically gather Malaysia-based tweets (Text-based only) from Twitter in real-time and detect whether any code-switching (English & Malay) cyberbullying tweets are being posted. (Machine Learning Model)
- Able to generate a graphical view of the statistics of cyberbullying cases in charts.
- Able to alert system users whenever cyberbullying tweets are detected.
- Able to display toxicity levels (Low, medium and high) of cyberbullies based on the number of cyberbullying tweets posted over the past month.
- Able to display a reminder to the system users that notifies them to formulate support messages to be as caring and less offensive as possible.

All Users

- Able to login to the system.

- Able to monitor the statistics of the cyberbullying cases and filter based on time.
- Able to send Direct Message (DM) to Twitter accounts with pre-written messages to warn cyberbullies or offer counselling support by giving contact numbers to cyberbullies and victims of cyberbullying.
- Able to reply tweets with pre-written messages to warn cyberbullies or offer counselling support by giving contact numbers to cyberbullies and victims of cyberbullying.
- Able to modify pre-written messages.
- Able to view all the Twitter accounts that have send or received cyberbullying tweets.
- Able to view all the cyberbullying messages detected.
- Able to remove misclassified tweets.
- Able to log out of the system.

Government Agencies

- Able to register new government agency or NGO to access the system.

Considered

Considered features are features that will be implemented into the system only if there is sufficient time.

- Able to create tweets that prevents other accounts from replying except for the tagged accounts in order to warn cyberbullies or offer counselling support by giving contact numbers to cyberbullies and victims of cyberbullying.
- Able to generate a 24-hour report regarding the cyberbullying incidents occurred.
- Able to communicate with the cyberbullies or cybervictims through a chatroom (Two-way communication).
- Able to generate graphical statistics in map-view.
- Able to search cyberbullying tweets based on the input given such as username, date or location.

1.6.5 Nature of Challenges

The proposed system implements machine learning and natural language processing, wherein these two technologies are foreign to the developer in terms of both concepts and tools to be

applied, thus will prove to be a difficult challenge as the developer is essentially learning new technology from scratch with zero experience. Such challenge can be resolved through studying online from sentiment analysis experts as well as receiving insights and advices from FYP supervisor.

Apart from these two technologies, the system also needs constant flow of tweets from Twitter to not only for training the machine learning model but also for predicting cyberbullying tweets occurred in Malaysia. In order to achieve such feat, the understanding of the usage of Twitter API is important, which will be another challenge for the developer.

Since there are quite a few technologies the developer has to research on and learn, one of the biggest challenges the developer will face in this project is time management. Not to mention of the fact that the developer has to deal with assignments and exams from various modules in the meantime. To handle such immense challenge, proper planning must be conducted including the design of project plan as well as prioritising tasks according to its urgency.

Another foreseeable challenge that will be confronted during this project is the process of gathering data from government agencies and NGOs, which can be troublesome to get in contact with. To counteract said hassle, the developer will consult with the FYP supervisor to obtain insights on how to communicate with them.

1.7 Overview of Investigation Report

The investigation report in general discuss what the project is about and how the project will be approached in different perspective. The report has seven individual chapters with each chapter tackles the specifics of a subject matter relevant to the project.

The first chapter provides an overview of the project, including the project background, the problems that inspires the project as well as the rationale behind the proposed project. The chapter also delineates the potential benefits, both tangible and intangible from the execution of the project, the target users who the system is designed for as well as the scope and objectives of the project which can be determined through the project aims, objectives and deliverables. Additionally, the chapter discusses the nature of challenges the project will encounter. The chapter then ends with a

depiction of the project plan to describe how the investigation report is completed throughout the designated timeline.

The second chapter provides a literature review on other reliable sources that converses similar domain problem from different aspects, which is incredibly important to provide a comprehensive and precise understanding of the concerning issues and solutions designed as well as to ascertain credibility towards the project. The chapter also delve into similar systems and discusses them in detail to unveil essential features the current system should have together with the improvements that can be added.

The third chapter dives deep into technical research, investigating and selecting the most appropriate technical elements for implementing the system in this particular project including programming language, integrated development environment (IDE), libraries and tools, database management system, operating system, web server as well as the web browser.

The fourth chapter discuss the methodology that will be employed into developing the system. Two different methodologies will be thoroughly explained, compared and the most suitable ones will be selected with proper justification. The chapter also provide a brief overview of how the project will approached using the chosen methodology.

The fifth chapter first introduces the necessity of conducting research despite multiple studies on similar topic has already been done. The chapter later discuss the selection of the most suitable data gathering techniques based on the project environment. The chapter concludes with the design of the chosen data gathering technique.

The sixth chapter takes the data gathered from the samples and analyse them in-depth to establish whether the project deliverables composed earlier should be maintained, modified or be entirely removed.

The last chapter summarises the work completed throughout the investigation report and reflects on any areas where should be further explored to ensure definite success in the project as well as what can be improved as an individual from the developer’s perspective.

Aside from the chapters, a dedicated section to lists all the sources referred is constituted to give credit to the original authors and allow the readers to learn more about the matter discussed through

locating the specific source. Appendices are also provided to list all the materials relevant in completing the project including log sheets, project proposal form (PPF), project specification form (PSF), ethics form and Gantt chart.

1.8 Project Plan

Table 1: Project Plan

Final Year Project Plan - Semester 1				
Task Name	**Duration**	**Start Date**	**Finish Date**	**Status**
Project Proposal Form (PPF)	10 days	18/11/2020	27/11/2020	Done
Project Specification Form (PSF)	40 days	28/11/2020	06/01/2021	Done
Supervisory Meeting #1	30 mins	14/12/2020	14/12/2020	Done
Investigation Report (IR)				
Chapter 1: Introduction to the Study	3 days	07/01/2021	09/01/2021	Done
1.1 Background to the Project	½ day	07/01/2021	07/01/2021	Done
1.2 Problem Statement	½ day	07/01/2021	07/01/2021	Done
1.3 Rationale	½ day	08/01/2021	08/01/2021	Done
1.4 Potential Benefits	3 hours	08/01/2021	08/01/2021	Done
1.5 Target Users	1 hour	08/01/2021	08/01/2021	Done
1.6 Scope and Objectives	½ day	09/01/2021	09/01/2021	Done
1.7 Overview of the Investigation Report	2 hours	09/01/2021	09/01/2021	Done
1.8 Project Plan	2 hours	09/01/2021	09/01/2021	Done
Chapter 2: Literature Review	7 days	10/01/2021	16/01/2021	Done
2.1 Introduction	½ days	10/01/2021	10/01/2021	Done
2.2 Domain Research	3 ½ days	10/01/2021	13/01/2021	Done
Supervisory Meeting #2	30 mins	12/01/2021	12/01/2021	Done
2.3 Similar Systems	3 days	13/01/2021	15/01/2021	Done
2.4 Summary	½ day	16/01/2021	16/01/2021	Done
Chapter 3: Technical Research	7 days	17/01/2021	23/01/2021	Done
3.1 Programming Language Chosen	2 days	17/01/2021	18/01/2021	Done

3.2 IDE (Integrated Development Environment) Chosen	½ day	19/01/2021	19/01/2021	Done
3.3 Libraries/Tools Chosen	1 ½ days	19/01/2021	20/01/2021	Done
3.4 Database Management System Chosen	½ day	21/01/2021	21/01/2021	Done
3.5 Operating System Chosen	½ day	21/01/2021	21/01/2021	Done
3.6 Web Server Chosen	1 day	22/01/2021	22/01/2021	Done
3.7 Web Browser Chosen	½ day	23/01/2021	23/01/2021	Done
3.8 Summary	½ day	23/01/2021	23/01/2021	Done
Chapter 4: System Development Methodology	2 days	24/01/2021	25/01/2021	Done
4.1 Introduction	2 hours	24/01/2021	24/01/2021	Done
4.2 Comparison of Methodologies	½ day	24/01/2021	24/01/2021	Done
4.3 Justification of Chosen Methodology	2 hours	25/01/2021	25/01/2021	Done
4.4 Rapid Application Development	½ day	25/01/2021	25/01/2021	Done
4.5 Implementation of Chosen Methodology	2 hours	25/01/2021	25/01/2021	Done
Chapter 5: Research Methods	8 days	26/01/2021	02/02/2021	Done
5.1 Introduction	2 days	26/01/2021	27/01/2021	Done
5.2 Design	5 ½ days	28/01/2021	02/02/2021	Done
5.3 Summary	½ days	02/02/2021	02/02/2021	Done
Supervisory Meeting #3	20 mins	02/02/2021	02/02/2021	Done
Conduct Survey and Interview	18 days	03/02/2021	20/02/2021	Done
Chapter 6: Requirement Validation	7 days	21/02/2021	28/02/2021	Done
6.1 Analysis of Data	6 ½ days	21/02/2021	28/02/2021	Done
Supervisory Meeting #4	20 mins	25/02/2021	02/02/2021	Done
6.2 Summary	½ day	28/02/2021	28/02/2021	Done
Chapter 7: Conclusion and Reflections	3 days	01/03/2021	03/03/2021	Done

Chapter 2: Literature Review

2.1 Introduction

This chapter delves deeper amongst a multitude of scholar articles to investigate further on various aspects regarding cyberbullying, proposed technology along with multiple research on similar area. These in-depth research will help the researcher not only in understanding the severity of cyberbullying, the categories of cyberbullying, the concepts, approach and application of the technologies in different fields, but also in comprehending the techniques employed during implementation on tackling similar area. Apart from that, several similar systems that deals with similar subject matter will be selected and compared to identify the essential features as well as the improvements that can be implemented on the proposed system. After conducting these investigations, the research gap that can be addressed in this paper and system will be discussed.

2.2 Domain Research

2.2.1 Severity of Cyberbullying

Cyberbullying, the act of such distasteful behaviour that takes form in either text, image, audio or video must never be taken lightly (Chelmis, Zois and Yao, 2017). According to several past research (Campbell *et al.*, 2012, Mitchell, Ybarra and Finkelhor, 2007, Chang *et al.*, 2013 cited in Campbell and Bauman, 2018; Tokunaga, 2010, Patchin and Hinduja, 2010, Moreno, 2014, Hinduja and Patchin, 2014, Donnerstein, 2012, Olenik-Shemesh, Heiman and Eden, 2012, Hinduja, 2010 cited in Hutson, 2016), those who have been cyberbullied may diagnosed with affective disorders, also known as mood disorders (Ellis, 2020), which includes depression, low self-esteem, substance abuse, social anxiety, loneliness, hopelessness, suicide ideation and even suicide attempts. The statement above was supported in the study conducted by Farhangpour, Maluleke and Mutshaeni (2019) amongst 80 South African students who were victims of cyberbullying, whereby 21% of them were identified to have low self-confidence, 35% had depression meanwhile as much as 23% have had the idea of committing suicide. Meanwhile, Vimala Balakrishnan's (2018) paper also concluded with results conforming to the inference made by past research. In this paper, 216 amongst 1158 Malaysian participants were identified to be cyberbullied for the past one year. Out of all these victims, majority of them were affected in one way or another; Angry (73.6%), sad (85%), depressed (69.5%), lonely (60.7%), self-blame (53.2%) and even suicidal thoughts (39.9%).

Aside from the emotional factors, it was discovered in the same study by Farhangpour, Maluleke and Mutshaeni (2019) that there is a correlation between cyberbullying and poor academic performance in terms of grades, motivation to learn, and commitment to academy, which aligns with the results obtained in the study by Peled (2019), except for the fact that this study highlighted that the correlation is significant only for victims who were cyberbullied through email instead of social media, which was speculated because the usage of email is prevalent amongst the Israeli undergraduate students that were chosen as samples. Additionally, this study contributes to the findings of cybervictims[1] experiencing interpersonal problem as well as family problems. It is crystal clear from these studies that cyberbullying is truly severe and terrifying, with consequences comes in all shapes and forms yet brutal, disregarding the time and place, affecting the vulnerable victims equally.

Interestingly, the study conducted by Vimala Balakrishnan (2018) also unveiled the pattern where as much as 43.1% of the 216 Malaysian victims did not take action after being cyberbullied, not even report to adults nor authorities. This occurrence is not one of a kind either, similar observations were acquired in the article by Kowalski *et al.* (2020), wherein 35.8% of White and 37.3% of Black/African American victims did not do anything with regards to resolving the cyberbullying incidents. There are several studies that have deducted the mindset behind such action, and the inference was found to be varied based on the characteristics of the victims as well as the environment they are under. For starters, Vimala Balakrishnan (2018) has relates the reasons of such findings to previous studies by Crosslin and Golman (2014), Gan *et al.* (2014), Francisco *et al.* (2015) and Schenk and Fremouw (2012) which includes: not given necessary attention, be independent enough to deal with own problems and being ashamed as victims are afraid of being viewed as weak individuals. There is also an article that has correlated that lower self-esteem leads to lower tendencies to report cyberbullying incidents, as the victims dread that such doings will worsen the situation (Vimala Balakrishnan and Fernandez, 2018). In the meantime, another study was focused on students in between 12 to 17 years old, where it was deducted that most students are afraid to report the incidents to their parents because they scared that their parents would cease their access to the Internet (Baldry, Sorrentino and Farrington, 2016). Additionally, it was reported by Safaria (2016) that the parenting style of Javanese parents has notable influence towards the

[1] Victims of cyberbullying.

reluctancy of victims informing cyberbullying incidents. Evidently, there are various explanations and interpretations to the unwillingness of cybervictims in voicing out their cyberbullying experience.

In actuality, victims are not the only ones that can reach for help, bystanders too can request for assistance on their behalf by reporting the witnessed cyberbullying to the authorities or even to the victim's parents if the bystander is acquainted with the victim. Unfortunately, Vimala Balakrishnan (2018) has yet again observed another melancholic result wherein as much as 40.1% of 675 bystanders, which amount to 262 Malaysians who yet again did nothing towards the witnessed cyberbullying incident due to fear of harm with regards to their personal safety or exposure of their identity, meanwhile 30.8% of bystanders take no action because they deemed such incidents as not their concerns. Moreover, there are as much as 110 bystanders that add fuel to the fire by backing up the cyberbullies for their malicious actions. The fact that not only the victims but also the bystanders who witnessed the cyberbullying themselves did not report these cases and some even tried to ignite these incidents even further are concrete proof of why cyberbullying is still a concerning issue, with countless studies still fixated on the discussed topic. Even countries like Malaysia are part of the victim of such occurrences. Such observations indicate that there are possibly vulnerable victims out there suffering in silence, waiting for salvation, while the cyberbullies are out there harming more innocent individuals with no repercussions whatsoever. Therefore, rather than waiting for them to call for help, adults especially the authorities can and should be the ones to take initiative in helping the victims as well as mitigating such occurrences through alerting and punishing these cyberbullies.

2.2.2 Categories of Cyberbullying

Comprehending the very nature of cyberbullying in terms of what can be considered as cyberbullying and how else cyberbullying can be viewed can be eminently favourable to construct a well-rounded system in precisely identifying cyberbullying incidents. Watts *et al.* (2017 cited in Peled, 2019) has unveiled that there is a total of seven categories of cyberbullying: flaming, harassment, cyberstalking, denigration, trickery and outing, masquerading, exclusion. Several studies as well supports the categorisation of cyberbullying above with two new additions; trolling and fraping (Haidar *et al*., 2016, Zainudin *et al*., 2016, Romsaiyud *et al*., 2017, Moncur *el al*., 2016 cited in Mahlangu, Tu and Owolawi, 2018). Although this type of compartmentalisation of

cyberbullying can assist the system in pinpointing cyberbullying precisely, some type of cyberbullying can be quite the challenge to detect accurately. For example, masquerading, where one snatches another identity and fool others by forging their profile. This kind of situation can be surprisingly tricky as it is near to impossible to identify which profiles are the real ones unless specified by the actual person. However, the article by Van Hee *et al*. (2018) has categorised cyberbullying in an even more comprehensive and discernible manner wherein it comprises of threat/blackmail, insult, curse/exclusion, defamation, sexual talk, defense and encouragement to the harasser. Although these classifications are not as specific as the previous articles, it is certainly providing more coverage of cyberbullying as it does not restrict the perspective of looking at cyberbullying from the cyberbully itself but also from the victim and even the bystander as well. This information helps the researcher in better identifying potential cyberbullying messages when creating the dataset to train the machine learning model. Ultimately, making the system much more competent in detecting cyberbullying incidents than ever before.

2.2.3 Sentiment Analysis

Extracting opinions to make decisions has been part of people's daily routine, whether it is from friends, families or colleagues to decide a variety of matters. With the incessant flow of data throughout the Internet, companies, big and small around the globe has started to find methods in exploiting these data in order to understand the opinions of mass population and further assist business decision-making process. As this global phenomenon occurs over time, the term 'sentiment analysis' has begun to sneak into even public conversations too. According to Beigi *et al.* (2016), sentiment analysis, or opinion mining refers to the application of different techniques and strategies such as information retrieval, computational linguistics, natural language processing (NLP) and machine learning (ML) which encompasses deep learning (DL) as well for the purpose of dissecting valuable information from the sentiments expressed by the relevant entities. In addition to machine learning approach, Shahid Shayaa *et al.* (2018) has suggested that keyword-based and lexicon-based methods are considered under sentiment analysis approaches as well, albeit both approaches have quite the flaws. For example, keyword-based approach analyses the sentences or documents according to the existence of either positive or negative polarity words. Problems may arise when sentence such as "I am not happy with you." appears, the system classifies the sentence as positive sentence because the word 'happy', a positive word is inside the

sentence, even though in human understanding, the sentence clearly conveys negative sentiment. Meanwhile, lexicon-based approach composes an enumeration of words with polarity scored assigned manually, then the sentiment of a sentence is evaluated and classified according to the cumulative score calculated on the sentence based on the lexicon. Although such approach surpasses keyword-based approach, this approach can prove ineffective when occurrences such as abbreviation emerge. The selection between lexicon-based approach and machine learning-based approach can be circumstantial, with comprehensive lexicons, lexicons-based approach can perform well. However, when the prediction of sentiments focuses on data pulled from social media, machine learning-based approach tends to work better due to the versatility of data presented in social media.

In terms of machine learning-based approach, the procedures of constructing sentiment classifiers using machine learning approach are typically as follows:

1. Accumulate data from identified sources such as social media. However, for implementing the sentiment classifier, some may pre-select the data from available datasets from website such as Kaggle.com, as long as the data is identified to be relevant to the use case. The data may be labelled or unlabelled depending on the machine learning algorithm chosen or the data scientist's motives.
2. Pre-process data including remove missing data, tokenization, eliminate stop words, normalization and stemming or lemmatization.
3. Split data into two; One for training and another one for testing.
4. Extract features through Bag-of-Words, TF-IDF or other methods. This step is particularly important because it determines the preciseness of the classification.
5. Train the model/classifier based on the algorithm chosen. The algorithms mentioned here could be machine learning algorithm or specifically deep learning algorithm. Since deep learning is a subset of machine learning that works with artificial neural networks, hence the word 'specifically' is used above. The widely known and applied algorithms include:
    a. Support Vector Machine (SVM)
    b. Naïve Bayes (NB)
    c. K-Nearest Neighbour (KNN)
    d. Decision Tree (DT)
    e. Random Forest (RF)

f. Convolutional Neural Network (CNN)
g. Recurrent Neural Network (RNN)

6. Assess the performance of the classifier and further improve the accuracy by tuning the hyperparameters (Shahid Shayaa *et al.*, 2018).

The power of sentiment analysis in the aspects of its applications cannot be underestimated. Throughout the years, there have been tons of research regarding sentiment analysis with machine learning-based approach on different fields with different purposes. The table below demonstrates a small portion of sentiment analysis applications.

Table 2: Applications of Sentiment Analysis on Different Fields

Field	Authors	Purpose
Health Care	Korkontzelos *et al.* (2016)	Unearth adverse drug reaction (ADR) mentions from Twitter and DailyStrength forum whereby could be useful for pharmacovigilance exercise in time ahead.
	Rodrigues *et al.* (2016)	Unveil the emotional state of cancer patients.
Politics	Ceron *et al.* (2014)	Scrutinise political preferences of Italian civilians.
Transportation	Alomari, Mehmood and Katib (2020)	Analyse Saudi dialect tweets to draw information regarding traffic congestion based on the driver's feelings and opinions.
Marketing and Sales	Liang *et al.* (2015)	Investigate the reason of how sentiments expressed in online reviews concerning different subjects influences the sales of mobile application.
	Stavrianou and Brun (2013)	Analyse opinions and suggestions provided in the product's reviews. For the overall goal of developing an expert product recommendation system.
Media	Aqil Azmi and Samah Mohammad Alzanin (2014)	Extract comments posted by readers on online Saudi newspaper to examine opinion polarity.

Construction	Jiang, Lin and Qiang (2015)	Scrutinise the opinions expressed by the public in Weibo.com regarding the hydro project.

2.2.4 Research on Similar Area

This section encompasses the research on related area to acquire sufficient understanding in the sentiment analysis approach implemented to tackle the problems discussed, which includes cyberbullying and hate speech.

Table 3: Research on Similar Area

Authors	**Purpose of Research**	**Methods**	
López-Martínez *et al*. (2019)	Proposed, designed and constructed CyberDect, a web-based cyberbullying detection system to monitor **Spanish** cyberbullying tweets for the platform, Twitter.	**Tool**	
		Stanford CoreNLP Natural Language	
Paschalides *el al.* (2020)	Proposed and implemented MANDOLA, a powerful big data online hate speech detection and monitoring system with the employment of sentiment analysis technique. It allows the public to access and identify real-time **English** hate speech occurrences around the world	**Machine Learning**	**AUC Score**
		Support Vector Machine (SVM)	90.4%
		Logistic Regression (LR)	91.1%
		Ensemble Method	**AUC Score**
		CHASE (CNN/RNN)	89.9%
		HybridCNN (CNN)	89.3%
		GBDT with LSTM embeddings (GBDT/LSTM)	88.8%
		Unified NN (RNN/DNN)	90.1%
		WordCNN (CNN)	89.7%

		MANDOLA 3-layer Stacked Ensemble	91.8%
Liew and Kasturi Dewi Varathan (2015)	Proposed and constructed a prototype of web-based cyberbullying detection system intended for NGOs to monitor **English-based** cyberbullying incidents happening on Twitter specifically in Malaysia. Unlike most systems compared here, the current research detects cyberbullying sentiments through keyword-based approach, and these keywords are identified from research experts.	Keyword-Based	
Rohit Pawar Rajeev and R. Raje (2019)	Proposed and constructed a **multilingual (Hindi and Marathi)** cyberbullying detection classifier for assorting cyberbullying messages, tweets and movie reviews. In this paper, they have selected and compared multiple machine learning algorithms which are applied on the derived dataset for each individual language to achieve the optimal accuracy on both classifier. They concluded that LR performed the best on both languages.	**Feature Extraction**	
		Bag-of-Words	
		Language	**Machine Leaning** / **Best Accuracy**
		Hindi	Stochastics Gradient Descent (SGD) / 93.22%
			Multinomial Naive Bayes (Multinomial NB) / 94.91%
			Logistic Regression (LR) / 94.52%
		Marathi	SGD / 94.82%
			Multinomial NB / 96.55%
			LR / 97.56%

Amgad Muneer and Suliman Mohamed Fati (2020)	Selected and compared multiple machine learning-specific algorithms to be applied on global **English** Twitter datasets in order to verify each of their usability as well as their accuracy in classifying cyberbullying and non-cyberbullying tweets. Their result concluded with LR being the better algorithm in terms of accuracy and prediction time. LR was also observed to have greater performance as data sizes expands.	**Feature Extraction**	
		TF-IDF, Word2Vec	
		Machine Learning	**Accuracy**
		Logistic Regression (LR)	90.57%
		Light Gradient Boosting Machine (LGBM)	90.55%
		Stochastic Gradient Descent (SGD)	90.6%
		Random Forest (RF)	89.84%
		AdaBoost	89.30%
		Multinomial Naïve Bayes (Multinomial NB)	81.39%
		Support Vector Machine (SVM)	67.13%
Del Vigna *et al*. (2017)	Proposed and developed the first **Italian** hate speech classifier. In their research, they have selected and compared state-of-the-art algorithms of two various approaches, machine learning and deep learning approach to determine which is better at detecting hate speech. In the end, they concluded with the deep learning algorithm, LSTM yields better result.	**Feature Extraction**	
		Part-of-speech, Word2Vec, Continuous Bag-of-Words, N-grams, Word Polarity, Text Features	
		Machine Learning	**Accuracy**
		Support Vector Machine (SVM)	80.60%
		Deep Learning	**Accuracy**
		Long Short-Term Memory (LSTM)	79.81%
		Feature Extraction	

Shrikant Tarwani, Manan Jethanandani and Vibhor Kant (2019)	Proposed and created one-of-a-kind, code-mixed language cyberbullying classifier for **Hindi and English (Hinglish)**. In order to achieve optimal performance in detecting code-mixed cyberbullying comments, multiple machine learning algorithms are applied on the same self-created Hinglish dataset collected from Instagram and YouTube to compare performance. Five machine learning models that performed the best will then be combined to form a hybrid model. The hybrid model is then tested again to measure its performance. The research concluded that the hybrid approach outperforms all the other selected ML classifiers in every category; Accuracy, precision, recall and F1-score.	TF-IDF, N-grams	
		Machine Learning	**Accuracy**
		Logistic Regression (LR)	76.39%
		Linear Support Vector Classification (Linear SVC)	80.26%
		Multinomial Naïve Bayes (Multinomial NB)	79.83%
		Passive Aggressive Classifier	78.97%
		Bernoulli Naïve Bayes (Bernoulli NB)	56.22%
		AdaBoost	74.25%
		Decision Tree	78.11%
		Deep Learning	**Accuracy**
		Perceptron	76.82%
		Ensemble Method	**Accuracy**
		Hybrid Model	80.26%

From the multitude of research listed in the table above, it has proven more than enough that the fact of incorporating sentiment analysis is a viable option in building a cyberbullying detection system. Apart from that, most research have applied machine learning-based approach in detecting either hate speech or cyberbullying since it was determined to be the state-of-the-art approach as mentioned earlier, and it was observed that different feature extraction method and algorithms affect the accuracy unsteadily. Therefore, the development of the proposed system will require the implementation, tweaking and comparison of different models to identify the top-notch model that yields the best accuracy in classifying tweets.

2.3 Similar Systems

This section will converse about the systems that are similar with the proposed system. The similarities include areas from the overall purpose of the system developed to the technologies applied in the system. The discussion comprises systems from not only the ones that are available in the market, but also systems that have been mentioned in Section 2.2.4 wherein these systems are in published journal articles and books. These comparisons all in all assist the researcher in identifying the crucial features as well as enhancements to be inherited in the proposed system.

2.3.1 Discussion of Similar Systems

2.3.1.1 Bark & Bark for Schools

Figure 1: Bark Mobile App (Bark Technologies, 2021a)

Bark is a paid service developed by Brian Bason in 2015 with the goal of protecting children across United States (US) mostly on the cyberspace (Bark Technologies, 2021b). First and foremost, Bark empowers parents to monitor **English and Spanish** cues of cyberbullying, suicidal thoughts and other unfortunate incidents amongst different social media platforms and even emails gathered through connected devices utilised by their children. Whether it is via web app, desktop app or mobile app, the parents will be alerted in their device whenever the Bark's deep learning-based algorithm, Recurrent Neural Network (RNN) has detected an anomalous message transmitted in their children's device, in which they can view such message in the alert page. Judging by the

severity of the alert, the parents are free to decide on whether to look at recommended measures tailored by Bark's child psychologist experts or limit their children's access either by imposing time constraints of device usage or blocking visibility on certain website. There is also a function whereby the parents may request check-ins from their children's device in order to locate their current GPS-based location, so that the parents may know they are in safe place.

Apart from parents themselves, Bark also provides a similar service called Bark for Schools to K-12[2] public and private US schools that monitors threat-inducing messages in school-issue accounts, except it is free and packed with more functionalities as well, all for the purpose of protecting the future of promising students (Bark Technologies, 2021c).

Figure 2: Bark for Schools - Graphical Statistics Report (Bark Technologies, 2021d)

[2] Kindergarten to 12th grade.

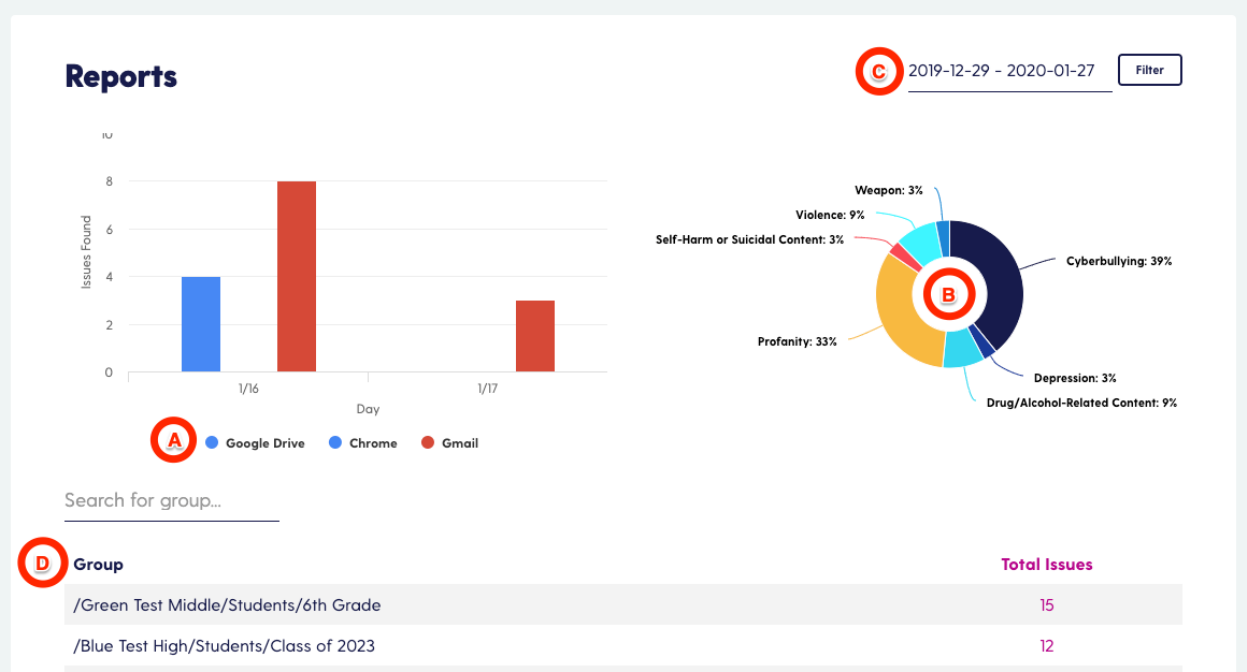


Figure 3: Bark for Schools - Graphical Statistics Report (Richards, 2020)

One of the new functionalities is a reporting page with date filter option that contains various graphical representation of statistical information including technologies usage amongst the students as well as the ratio of recurrent problems such as cyberbullying and self-harm that are disrupting students' safety. Furthermore, Bark for Schools also have another free-of-charge feature called Parent Portal whereby parents or guardians can be invited to monitor happenings of cyberthreats on their children's school-issued accounts, getting alerts when their children receive malicious messages or express self-harm behaviour, which essentially strengthening the protection for their children even during weekends or holidays (Bark Technologies, 2021e). By purchasing premium features, Bark will also provide 24/7 review and response through text, phone call and email to the school's review team for emergency cases (Bark Technologies, 2021f).

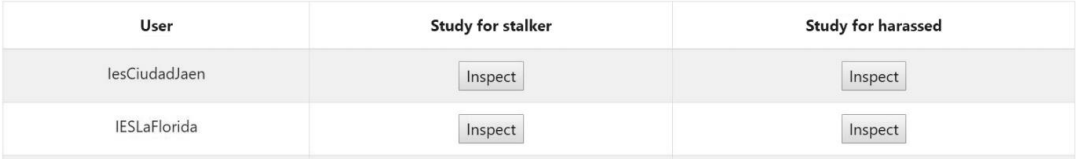
2.3.1.2 CyberDect

CyberDect is a web-based cyberbullying detection system proposed, designed and constructed by López-Martínez *et al*. (2019) to monitor Spanish cyberbullying tweets for the platform, Twitter. Instead of continuously extracting public tweets and classifying these tweets as harassing or non-harassing tweets, this system uses the input approach by having the system user to input specific

Twitter account username so as to extract any cyberbullying tweets on that single account. The usage of the system is as follows:

Figure 4: CyberDect - Username Field (López-Martínez et al., 2019)

1. The system user first input a Twitter account username in the username field to be investigated.



User	Study for stalker	Study for harassed
IesCiudadJaen	Inspect	Inspect
IESLaFlorida	Inspect	Inspect

Figure 5: CyberDect - Study Options (López-Martínez et al., 2019)

2. The system user then selects whether to inspect that specific account for any signs of harassing or victimised.

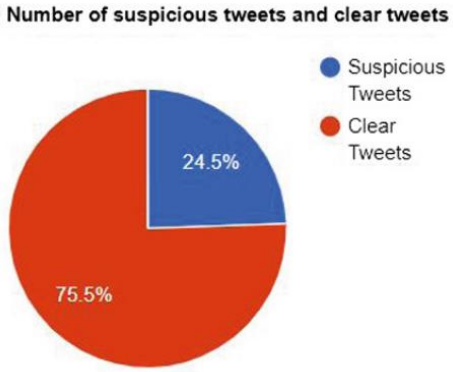
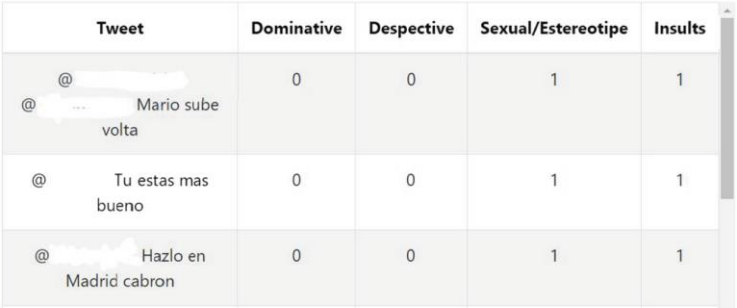


Figure 6: Ratio of Suspicious and Clear Tweets in Pie Chart Format (López-Martínez et al., 2019)



Tweet	Dominative	Despective	Sexual/Estereotipe	Insults
@ @ Mario sube volta	0	0	1	1
@ Tu estas mas bueno	0	0	1	1
@ Hazlo en Madrid cabron	0	0	1	1

Figure 7: Categories of Harassment in Tabular Format (López-Martínez et al., 2019)

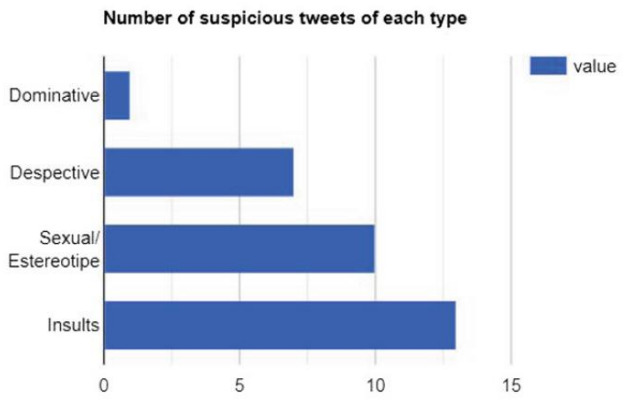


Figure 8: Categories of Harassment in Horizontal Bar Chart Format (López-Martínez et al., 2019)

a. If the system user chooses to inspect for harasser, the system will classify and tally the amount of tweets that are considered as suspicious or unsuspicious/clear, the ratio of both types of tweets will then be displayed on the dashboard using pie chart for analysis. Moreover, the suspicious tweets will also be further categorised into four types including dominative, despective, sexual and insults. These categorisations will then be displayed on the dashboard in both forms, table and horizontal bar chart.

b. If the system user chooses to inspect for victim, the system will just list all the tweets and its corresponding account targeted towards the specific account on the dashboard. The system user will then analyse these tweets one by one to identify any suspicious tweets are occurring.

2.3.1.3 MANDOLA

MANDOLA is a powerful big data online hate speech detection and monitoring system with the employment of sentiment analysis technique. It allows the public to access and identify real-time hate speech occurrences around the world (Paschalides *et al.* 2020). The system usage revolves around the dashboard which include functionalities as follows:

- System user shall be able to annotate a global event to be analysed to find correlation with the burst of hate speech by providing the event title, date and duration. The system user may also add location either by pinning down a place in a map or attaching an article URL that has correlations to the event, in which the location will be obtained using the gazetteer

index. Appending location allows the event annotated to appear in the map-based hate speech visualisations.

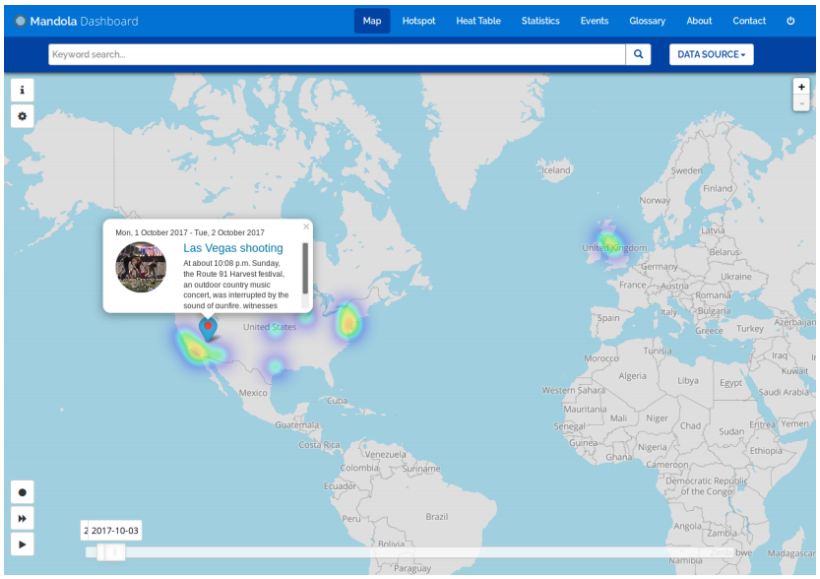


Figure 9: MANDOLA - Hate Speech Hate-Map Visualization (Paschalides et al. 2020)

Figure 10: MANDOLA - Hate Speech Hotspot Visualization (Paschalides et al. 2020)

- Hate-map and Hotspot map graphical visualisations in map view. Using heat-maps allows the analyst to identify the concentration of hate speech in terms of intensity of colour in individual locations. In either view, the system user is provided the capability to filter the data based on date and hate topic to assist analysis process.

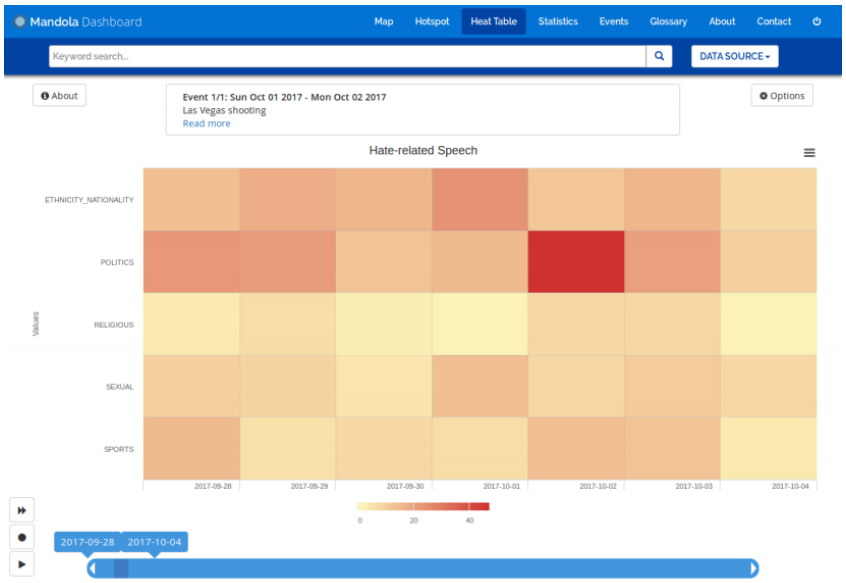


Figure 11: MANDOLA - Hate Speech Heat-Table Visualization (Paschalides et al. 2020)

- Heat-table depicts the amount of hate speech of each hate topic detected on daily basis.

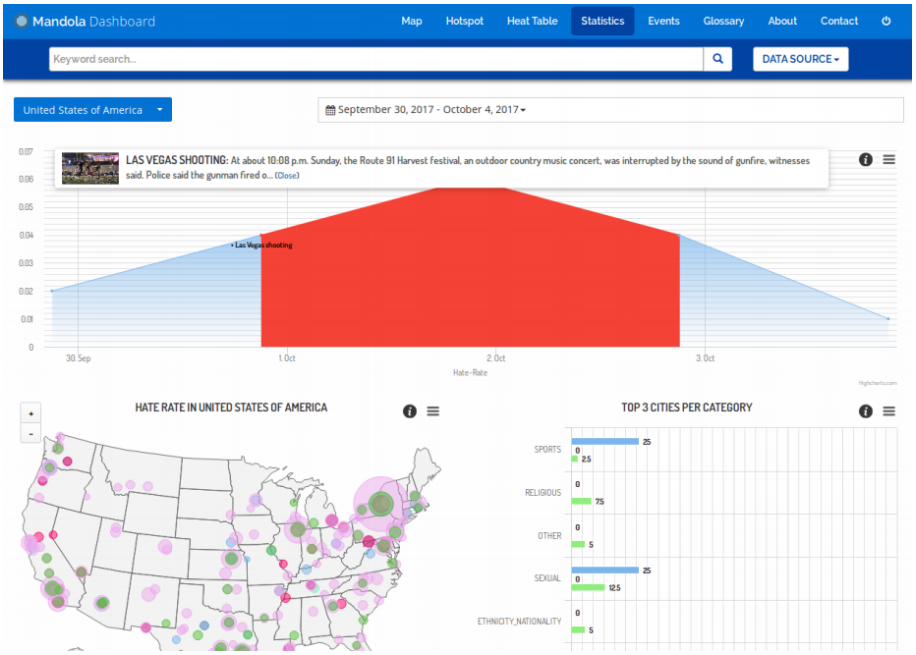


Figure 12: MANDOLA - Graphical Visualizations of Overview of Hate Speech Occurrence (Paschalides et al. 2020)

- Graphical visualisations of different statistics to provide an overview of hate speech detected. These graphical visualisations provided are immensely helpful to quickly identify

any surge of hate speech occurred in real-time. Moreover, the system users may also associate an event to the surge of hate speech that may fuel unexpected movement and actions, assisting authorities in monitoring and preparing preventative measures swiftly to calm the storm. Such valuable information may also aid policy makers in facilitating their policies to mitigate online hate speech.

2.3.1.4 Cyberbullying Detection on Twitter

Liew and Kasturi Dewi Varathan (2015) too proposed and constructed a prototype of web-based cyberbullying detection system intended for NGOs to monitor cyberbullying incidents happening on Twitter specifically in Malaysia. Unlike most systems compared here, the current research detects cyberbullying sentiments through keyword-based approach, and these keywords are identified from research experts. This system as well has a robust number of functions which comprised of:

- Timeline occupied with critical information such as the Twitter account username, the cyberbullying tweet content, the date of when the tweet is posted and even the city-based location of the Twitter account.

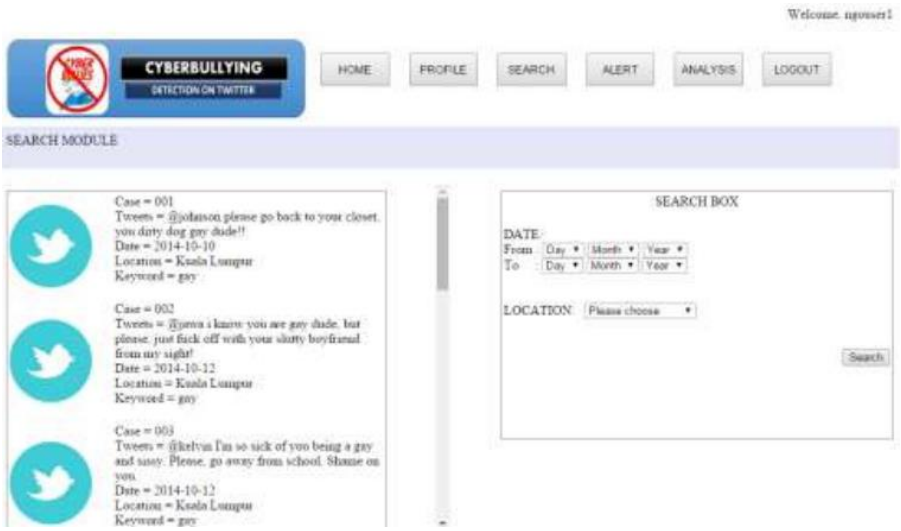


Figure 13: Search Module (Liew and Kasturi Dewi Varathan, 2015)

- Search module whereby the system user can identify cyberbullying tweets occurred on chosen date and location.

Figure 14: Alert Module (Liew and Kasturi Dewi Varathan, 2015)

- Alert module wherein any cyberbullying occurrences will provide an alert notice to the system user. From this module, the system user will have access to more detailed information regarding both the cyberbully and the victim so the system user can offer guidance or counselling support. Furthermore, the module has equipped with the functionality of enabling system user to create a police report and email the report to the police station at the vicinity.

Figure 15: Analysis Module (Liew and Kasturi Dewi Varathan, 2015)

- Analysis module in which every cyberbullies identified will further be scrutinised. Each victim that are associated with each cyberbullies will be tabulated and displayed in the system.

2.3.2 Comparison of Similar Systems

Table 4: Comparison of Similar Systems

Authors/ Applications	Market/ Journal Article/ Book	System Features	Advantages and Disadvantages
Bark & Bark for Schools	Market	**Bark** - **Automatic extraction of messages** transmitted across social media and emails for connected device(s). - **Automatic alert to the parents** when dangerous message is sent to or from the connected device(s). - **Display monitored children** on the **dashboard.** - **Display dangerous messages** detected in the **alert page**. - **Limit system usage** by imposing time constraints or blocking access to certain websites.	**Advantages** - Able to act quickly based on the messages detected before any catastrophic incidents from happening. - Allow schools to understand the most dominant issues currently based on the information derived from the graphical statistics and henceforth dimmish it through organising campaigns or talks. **Disadvantages** - Stern parents may enforce too many limitations for the likings of their children. Children may rebel against their parents and could effectuate worse behaviours.

		- **Locate children's location** through requesting check-ins. **Bark for Schools** - Generate **graphical statistics** in charts concerning various information such as **ratio of recurrent problems** happened in schools. - Capable to **filter the graphical reports** based on date. - Invite parents to **monitor and receive alerts** from detected dangerous messages in school-issued accounts. - **24/7 emergency response** from Bark's review team.	
CyberDect	Book Chapter	- Inspect a particular Twitter account for **identifying either a harasser or victim**. - Generate **graphical statistics** of the different information in charts including ratio of suspicious	**Advantages** - Quick and comprehensive detection towards a single profile.

		and unsuspicious tweets as well as the categories of harassment tweets sent by the particular user. - Display **lists of all tweets** and its respective users targeted **towards the victim**.	- Easily identify whether the profile has concerning harassment record in the past based on the graphical statistics generated. **Disadvantages** - Lack filtering options for the graphical report, could have the risks of accounting tweets from years ago. The particular Twitter user may have already reflected on their actions and moved on from long ago. - Overwhelming normal tweets may also trick the ratio presented. - Lack of automatic harassment detection on lists of tweets targeted towards the victim.
MANDOLA	Journal Article	- **Detect** online hate speech in **real-time**. - **Annotation of an event to be analysed** for specific date and duration. Location of the event can be provided during annotation to display the event added on the map-based visualisations.	**Advantages** - Authorities across the globe have the capability to administer hate speech in real-time and initiate appropriate actions to alleviate them.

		- Generate **graphical representations** of the hate speech detected in different view including map and table. - Capable to **filter the graphical reports** based on date and hate topic.	- Policy makers may employ this system and gather imperative information to push their policies in an effort to restrict diffusion of hate speech. **Disadvantages** - Although the detection coverage extended to the entire world, some countries might not use the language English as much, leaving many online hate speeches undetected.
Liew and Kasturi Dewi Varathan (2015)	Journal Article	- **Timeline that shows general information** regarding Twitter **user including the tweet** for each cyberbullying tweet retrieved and detected. - **Search** capability for cyberbullying **tweets on particular date and location**. - **Stores** information about the user including **email and contact number**. - **Alert** function to notify the **system users** of any cyberbullying happenings. Also equipped with feature to report incidents to police forces.	**Advantages** - Able to quickly derive cyberbullying tweets on specific date and location. - Able to act swiftly based on alerted cyberbullying incidents. - Establish communication between cyberbullies with victims and NGOs., easier to provide guidance and counselling.

		- **Tabular view of association** between each cyberbully and every corresponding victim.	- Establish communication between police forces and NGOs, easier to report severe cyberbullying incident to nearby police station. **Disadvantages** - No graphical statistics to monitor the prevalence of cyberbullying in Malaysia and impact of system in reducing cyberbullying acts over months. - Ineffective detection due to the application of keyboard-based approach.

2.3.3 Analysis of Similar Systems

From the comparison made on the selected similar systems, numerous crucial features have been discovered to be essential in a cyberbullying detection and communication system. Besides, there are several fascinating functionalities and concepts can be considered to be incorporated into the proposed system. First of all, the proposed system should undoubtedly be able to extract messages and classify them as either threatening or non-threatening. This is the most fundamental and most important function that is embedded into each and every of the systems compared so they can serve the core purpose of identifying online threats. However, each of the systems conversed are designed slightly different, some are designed to detect tweets in real-time, some are designed to search and detect tweets based on input given, and some are designed to include both methods. Since the proposed system will be developed for authorities and NGOs to act swift based on the detected cyberbullying tweets on Twitter, real-time is a must. Nevertheless, the search functionality will be included into the proposed system to provide further insights regarding certain users for both parties, only if there are still available development time.

Secondly, the functionality of generating graphical representation in charts based on the statistics calculated accompanying the filter feature which both were included in most systems shall be incorporated as well. The statistics that will be visualised inside the proposed system dashboard mainly encompass time-basis cyberbullying incidents occurrences including daily and monthly in which can be switched in between with the help of filter function. With said feature, the system users will be able to make analysis with regards to the occurrences of cyberbullying over time in Malaysia to understand when does cyberbullying incidents usually occur the most and also to gauge the effectiveness of the system in terms of mitigating cyberbullying cases. If time permits, the graphical representation of cyberbullying tweets in map view will be implemented as well, similar to MANDOLA. This is because through map view, the authorities can scrutinise and derive which area has the most cyberbullying incidents occurred, which the authorities can then devise strategies such as organising campaigns or talks in those areas in an effort to alleviate cyberbullying cases in Malaysia. Alongside the graphs, the functionality proposed in few systems where the profiles and the detected cyberbullying messages are shown in the main page shall be accommodated into the dashboard as well, so that the system users may straightforwardly monitor the cyberbullies, cybervictims and the tweets detected as cyberbullying. On top of that, this feature

can be improved in the proposed system by allowing the system users to remove misclassified tweets because the machine learning algorithm may not assort every tweet with perfect accuracy, through this refinement, the system users shall be able to focus only on the users that were cyberbullying.

Other than that, since it was discussed earlier of the fact that instead of waiting for the victims or the bystanders to report their cyberbullying experiences, authorities and the NGOs should be the one to approach them directly. In the system constructed by Liew and Kasturi Dewi Varathan (2015), the system stores the contact number and the email of both the cyberbullies and the cybervictims so as to allow the NGOs members to reach out to them, although not implemented by other systems due to different purposes being served, it is considered to be one of the most indispensable features to be implemented into the proposed system. Nonetheless, the feature was later discovered to be impossible to implement as the option to extract contact number and email has been deprecated by Twitter, hence will not be incorporated into the proposed system. Moreover, due to the fact that cybervictims have different sensitivity level against these incidents, some may feel apathetic towards them while some may feel strongly influenced by it, therefore this feature can instead be converted to by allowing the system users to Direct Message in Twitter to send a pre-written message not only to offer counselling support if desired but also to warn cyberbullies against their actions. However, because not everyone in Twitter will activate the option to permit "strangers" to Direct Message them, the functionality of forthrightly replying to the particular tweet or sending an SMS to both parties will be incorporated into the proposed system. Also, if possible, the proposed system will include the functionality of chatroom in between the system users and the cyberbullies or cybervictims to establish two-way communication in the system itself rather than just sending one-way pre-written messages from the system users.

Additionally, most systems are equipped with alert functionality. This feature makes perfect sense to be added into the proposed system because by integrating the alert functionality, the system users will always be aware whenever a cyberbullying incident happens, so the cyberbullying incidents can be dealt immediately. Other than these features, there was an interesting concept introduced in CyberDect whereby the cyberbullies are evaluated based on the suspicious tweets and normal tweets posted. This concept can and should be integrated into the proposed system so as to allow the system users to gauge the level of toxicity of each cyberbully, which ultimately

determine their decisions on handling each individual. However, seeing that this concept can be maneuvered due to the fact that tweets from years ago are accountable meanwhile the ratio can be tricked through the posting of overwhelming of normal tweets as compared to cyberbullying tweets, the feature is enhanced. The enhancement involves defining levels of toxicity for cyberbullies into three; Low, medium and high based on the number of cyberbullying tweets posted by each cyberbully over the past month. Through this distinction, the evaluation of urgency against these cyberbullies will be much more precise and accurate. Several other features in these similar systems that are not mentioned will be not incorporated into the proposed system due to the fact that these features were deemed to bring not much value.

A table is drawn below to summarise the existing and improved functionalities, features or concepts that will be implemented into the proposed system. The considered ones will be summarised into the table as well.

Table 5: Functionalities/Features/Concepts in Proposed System

Functionalities/Features/Concepts		
Existing	**Improved**	**Considered**
- Extract and detect cyberbullying tweets in real-time.	-	- Search cyberbullying tweets based on input given such as username, date or location.
- Generate graphical representation of statistics in charts accompanying filter option into the dashboard.	-	- Generate graphical statistics in map-view.
- Display Twitter profiles alongside the cyberbullying messages into the dashboard.	- Also able to remove misclassified tweets to streamline monitoring process.	-

- Display additional information for each cyberbully and cybervictim including contact number and email. (The contact number and email will not be displayed as the feature was deprecated by Twitter)	- Able to send pre-written message using Direct Message to Twitter accounts that are classified as cyberbullies or cybervictims. - Reply directly to a particular tweet or send SMS. (The option to SMS will not be available as the contact number cannot be extracted due to the feature being deprecated by Twitter)	- Chatroom between system users and cyberbullies or cybervictims.
- Alert system users whenever cyberbullying incidents are detected.	-	-
- Evaluate cyberbullies based on ratio between cyberbullying tweets and normal tweets.	- Evaluate cyberbullies based on toxicity level instead, (Low, medium and high) which will be defined by the number of cyberbullying tweets posted by each cyberbully over the past month.	-

2.4 Research Gap

Based on the literature review including the related research in Section 2.2.4 and similar systems carried out, most research as well as the system from the market are only focused on one language or multilanguage and have failed to consider the factors of countries with diverse ethnicities that practices code-switching, which would influence the cyberbullying messages being conveyed. One of the prime examples is Malaysia, where the citizens of different ethnicities may or have mastered certain degree of eloquence in the three main languages in Malaysia; Bahasa Malaysia, English and Mandarin, which most of the time influences the way they use these languages and the way they speak with different ethnics. This statement can be supported by Albury (2017) where he discovered that Malaysians especially the youths use Bahasa Rojak, a smooth exploitation of different languages in communicating with other individuals based on the context and ethnicity. Another study by Tan, Shahidatul Maslina Mat So'od and Bahiyah Abdul Hamid (2019) also unveiled that Malaysians uses code switching which is switching from English to Malay and vice versa to insult other people on Twitter. It is evident that the research gap on code-switching cyberbullying detection system in Malaysia is present and is a crucial aspect to be considered.

2.5 Summary

In conclusion, the process of literature review from myriad of past research has proved to be extremely informative to the researcher in the effort to understand the domain of this project, which includes cyberbullying and sentiment analysis. First and foremost, it is immensely understood of the fact that the word 'cyberbullying' is not at all synonymous to the word 'sympathy'. Vulnerable victims often subjected to affective disorders, lower academic performance and social issues. These observations solidify that the issue of cyberbullying is not forgivable and must be combated to the core. Apart from that, it was identified that masses of cybervictims and bystanders from countries including Malaysia do not report experienced or seen cyberbullying incidents to the relevant parties such as authorities nor even the parents. This unfortunate information has suggested that there could very well be victims anguishing in complete silence, which has significantly helped the researcher to further moulds the shape of the system to be developed in this project, sharpening the features to best cut down the problems. Moreover, the categories of cyberbullying were conversed to understand the full coverage of cyberbullying and how cyberbullying can be identified more effectively and more comprehensively. After that, the nitty-gritty of the technology including the process, sentiment analysis is deliberated meticulously. This knowledge is incredibly beneficial to the researcher in not only confirming the feasibility to construct the proposed system and comprehending the different approaches one could have in dealing the identified problems but also recognizing the implementation steps involved as well as its applications on other fields. In addition to that, multitude of research on similar area was discussed. Through the reading of these research, the researcher has understood the variety of techniques that can be applied into developing the system, so as to achieve the optimal performance.

Aside from domain research, several similar systems were selected, discussed and compared to pinpoint the essential features as well as the enhancement that can and could be incorporated into the proposed system. One of the most essential features is being able to detect cyberbullying cases in real-time so as to allow the system users to respond swiftly. Another feature involves the capability of the system to generate graphical representation of statistics calculated in charts accompanying filter function to assist the system users in comprehending when does cyberbullying incidents happen the most and also in gauging the competency of the system in terms of alleviating cyberbullying cases in Malaysia. Thirdly, the system will display the cyberbullies' Twitter profiles

with its corresponding tweets meanwhile allowing the system users to remove misclassified tweets to ease cyberbullying monitoring process. Other than that, the system will also include the information of the cyberbullies and cybervictims with the addition of being able to Direct Message to Twitter accounts or reply tweets to send pre-written messages to the cyberbullies and cybervictims. Furthermore, the system will also be able to alert the system users whenever a cyberbullying tweet is detected. Finally, the system users can evaluate cyberbullies based on the toxicity level, (Low, medium and high) which will be defined by the number of cyberbullying tweets posted by each cyberbully over the past month. Depending on the toxicity level displayed, the system user can determine the actions to take in confronting the cyberbully.

Last but not least, it is identified that there are very scarce research papers that have explored cyberbullying detection system in a multilingualism country of different ethnicities such as Malaysia where code-switching is exorbitantly used amongst the citizens. Therefore, this paper will be filling the research gap by proposing a code-switching cyberbullying detection system in Malaysia.

Chapter 3: Technical Research

This chapter delineates all the essential and reasonable technical elements necessary to implement the proposed system to its completion.

3.1 Programming Language Chosen

3.1.1 Machine Learning Model Development

Prior to developing the front-end and back-end of the proposed system, the mechanism, machine learning model to detect cyberbullying messages must first be built. In the midst of composing the model, processes such as loading, cleaning, analysing the data as well as training and testing the model necessitates the utilisation of a programming language. For the purpose of accomplishing these data science-related processes effectively and efficiently, the selection of the programming language that is best suited the current project circumstances is extraordinarily important.

As of current, there are an abundant of programming language that are highly favourable in executing these data science-related processes. And amongst all these programming languages, two of the widely used programming languages, Python and R are chosen and compared on the table below in multiple aspects to decide which programming language is most appropriate in implementing the model considering the context of the current project.

Table 6: Comparison of Programming Language - Machine Learning Model Development

Properties	**Python**	**R**
Simplicity: Is the programming language simple to code?	Relatively simpler. Python is a high-level programming language. Its English-like syntax and conciseness makes Python a very simple language to operate on whether in terms of coding or debugging, ultimately allowing shorter development and delivery time (Sayantini, 2019).	Relatively harder. R is a lower-level programming language. Additional lines of code are typically required to achieve common tasks, therefore will be more error-prone and result in slower development (Sayantini, 2019).

Learning Curve: Is the programming language easy to learn and adapt?	Shallower learning curve. Since Python is a high-level language, the developer can pick up the language fairly quicker than most languages, therefore can transition to development stage faster.	Steep learning curve. As for R, the developer will have harder and tougher time in adapting the language because its syntax is relatively more complex, demanding the developer to spend longer time in learning.
Developer Familiarity: Is the developer accustomed to the utilisation of the specific programming language and its respective data science-related libraries?	Yes. The developer is very familiar with Python based on the past experiences of developing software application with Python. In terms of the data science-related libraries, the developer is relatively familiar with them and have applied them quite a couple of times.	No. The developer has not explored, learned nor developed any application with R or its libraries before.
Libraries: What are the libraries available to complete these data science-related tasks?	pandas, scikit-learn, matplotlib, TensorFlow and more.	H2O, dplyr, ggplot2 and more.
Popularity of Libraries: How popular each programming language is in terms of carrying out data-science related projects with the help	More popular. According to ActiveWizards (2018), there are as much as 1.5 thousand of contributors to the library, TensorFlow followed by 1.1 thousand contributors that maintains the scikit-learn library. With the huge community	Less popular. From the statistics gathered by ActiveWizards (2018), the contributors to some of the important libraries are only amount to as high as 286, signifying smaller community around the usage of these libraries. Utilising R to build the machine

of its respective libraries?	support for these libraries, there are bound to be more discussion concerning the features and bugs faced which are already resolved. Moreover, these facts imply that there are more online tutorials that explains the nitty-gritty of these libraries. These supports provided will definitely help the developer in not only constructing the model swifter but also more effectively with higher accuracy.	learning model could be an astronomic challenge to the developer because the issues faced when incorporating these libraries might not be resolved and discussed by the public, hence subsequently forcing the developer to either spend an enormous time fixing the issue with no guidance or straight away switch to different libraries.
Field Focus: Which field does the language excel at?	Machine learning. Thanks to its simplicity of usage, flexibility of platforms and robustness of the libraries, Python is regarded to be the superior ones in the field of machine learning (Data-Driven Science, 2018).	Statistical learning. Although R can be used to build machine learning models, its strengths are more focus towards statistical learning. R is currently dominating data visualisation area with complex yet stunning graphics, which translates to easier and better understanding and analysis of the data (Data-Driven Science, 2018).

Based on the comparison between two programming languages made above, the Python (Version 3.9.0) language was deemed to be more suitable in this project in order to build the machine learning model. First and foremost, Python is inherently simple. With its simplistic syntax, the developer will not only have a comfortable time and a faster pace coding the model, but the code

will also be much more concise which streamlines the process of debugging, essentially shortens the development time. Moreover, Python has shallower learning curve compared to R, meaning that the developer can adapt to the Python environment much rapid. Plus, the developer is familiar with Python and had experienced developing applications with it, thus the developer will not need to spend unnecessary time purposely to comprehend its fundamentals and usage. In terms of data science-related libraries, both languages have plentiful of them to accomplish more than what was required. However, since the developer has some familiarity with Python's libraries, it allows the developer to quickly adopt these libraries and build the machine learning model much earlier. Furthermore, Python's libraries have much larger community, thus searching, grasping and applying the knowledge from the online tutorials or the solutions to resolve issues encountered would be a breeze. Lastly, Python is deemed to be excel at machine learning field due to its simplicity, flexibility and robustness unlike R which has more focus on statistical learning despite being able to build machine learning models as well. To ensure smoother development, Python is regarded as the safest and better choice than R.

3.1.2 Software Front-end Development

In order to display the necessary contents of the web application on the web browser, the front-end development is inevitable. Technically, the core building blocks of the front-end is not a programming language but is in fact a markup language, known as HyperText Markup Language (HTML). The skeleton of the website can then be beautified using Cascading Style Sheet (CSS), a style sheet language. The programming language actually does come into play when the website needs to be interactive, which can be achieved using one of the most well-known programming languages, JavaScript (JS). Other than plain JS or often called vanilla JS, there are tons of JS frameworks that have been released as of current that enhances front-end developer in multiple ways including encourage reusability of components, facilitates maintenance process and reduce the overall implementation time. Therefore, this project will adapt a JS framework to streamline development process. However, since there are myriad of JS frameworks to choose from, two of the popular ones will be selected and compared beforehand.

Table 7: Comparison of Frameworks – Software Front-end Development

Properties	React	Angular

Type of Framework: What is the type of framework and what it is suitable for?	Although React has always been under the misconception of being a framework, it is in fact purely a library that can become a full-fledged framework through the addition of critical libraries. React is compatible for both small and large web apps as well as capable of building single-page web applications, web apps that requires zero reloading.	Angular is a full-fledged mobile and web framework for merely front-end development. It is equipped with numerous powerful tools whereby the developer can utilise them to build large-scale web apps. Angular is also capable of building single-page web apps.
Features: What features and capabilities possessed by the framework?	- JavaScript XML (JSX). JSX is a very handy tool in React that eases front-end development by allowing HTML to exist in JavaScript code seamlessly, so that the developer can both design and configure logic at the same time, it makes debugging process simpler as well. - One-way data binding. One-way binding implicates that the data flows only one direction, also known as unidirectional data flow, whereby changes in model state will be reflected in the user interface. The concept of supporting only one-way data binding makes the data flow to be predictable, hence making the debugging process less	- Inherently adapts MVC (Model, View and Controller) architecture. MVC is an architecture that divides codebase into structurally sound unit; One to handle purely data, one to handle the user interface and one to handle the way both interacts with each other. This partition makes debugging process much coherent and hassle-free even in large and complex apps. - One-way and two-way data binding. Two-way binding implicates that the data flow from two direction, also known as bidirectional data flow, whereby changes in model state will be reflected in the user interface and vice versa. Moreover, the one-way

	confusing and smoother (Romanyuk, 2019).	data binding in Angular also works from UI elements to the model state. In Angular, a watcher is automatically created for every binding. The fact that Angular supports both one-way and two-way data binding, it facilitates framework flexibility and are typically easier to operate on (Romanyuk, 2019).
Performance: What is the performance of the framework in terms of rendering the web app?	Similar performance, affected negatively but only slightly as the app grows. React enhances the performance of the elements rendering in web apps through the implementation of virtual DOM (Document Object Model). Virtual DOM is basically a replication of the actual DOM, a virtual DOM is created every time changes towards the components in the web app is made, the new virtual DOM will then be compared to the previous DOM so as to allow the actual DOM can be updated with as minimal effort as possible (Hamedani, 2018). Since React applies the concept of only one-way data binding, no watcher is necessary to observe the	Similar performance, affected negatively and more significantly as the app grows. Even though Angular utilises the real DOM, which can be less efficacious compared to virtual DOM as it updates the whole tree structure, Angular takes advantages its change detection capability to determine elements that are required to be modified. As mentioned earlier, Angular supports two-way data binding. Since watcher is created for every binding, the performance drops more evidently as the complexity and size of the app grows (Romanyuk, 2019).

	data changes in view, hence the performance drops will not be as significant as the complexity and size of the app grows (Romanyuk, 2019).	
Learning Curve: Is the framework easy to learn and adapt?	Shallower learning curve. Since React is purely a library, it allows the developer to learn and adapt to the concepts and the usage of it, hence transition to development stage in shorter time. However, developing web apps with React typically necessitates the import of other libraries, which needs some time for the developer to adapt to, still, not anything too demanding.	Steeper learning curve. Since Angular is a full-fledged framework with higher complexity of philosophy and syntax, the learning pathway will be much longer and rougher, thus requiring the developer to take more time to adapt to its concepts and usage before being well-equipped enough to start implementing web applications using it.
Developer Familiarity: Is the developer accustomed to the framework's usage?	Yes. The developer is very familiar with React based on the past experiences of developing web applications with React.	No. The developer has not explored, learned nor developed any application with Angular before.
Popularity: How popular is the framework?	Extremely popular. According to npm (2021a), there are over 10 million weekly downloads of React with as much as 67 thousand and still counting of packages depending on React.	Much less popular. Based on the statistics given by npm (2021b), there are roughly 2.5 million weekly downloads of angular and around 11 thousand of packages depending on Angular.

After the comparison and the assessment on the two JS frameworks discussed above including the consideration of the current project's context, React (Version 17.0.1) is determined to be the best fit for front-end development in this project. First and foremost, since the proposed system, functionality wise is not overly large nor complex, React is deemed to be the smarter choice because React is purely a library, the usage of a full-fledged framework would be overstretched, plus the developer can just import any necessary yet well-maintained libraries that are required to achieve certain capabilities. Hence why React is suitable for small web apps including the proposed system. Moreover, React has a couple of unique features such as JSX and one-way data binding which helps the developer in building and debugging the front-end of the proposed system swiftly and seamlessly. Although not as structurally sound and flexible as Angular, the proposed system is not that complex to the point those two attributes would become the main concern. In the aspect of performance, React and Angular has achieved similar performance thanks to their optimisation techniques, virtual DOM and change detection. Even though Angular performance drops more significantly than React as the web app grows, the proposed system is not huge enough for that issue to be under the checklist of elimination. React may be the better option if considering future enhancement of the proposed system, however, as of now, the comparison under this category does not matter much. With that said, React does conquer the categories of learning curve, developer familiarity and popularity for it to be decided as the definite choice of front-end framework in this project. As said earlier, React is just a library, hence the learning curve will be considerably shallower as compared to the full-fledged framework. The developer will not need to consume as much time to adapt to the concept and environment of React and only able to start developing the proposed system. On top of that, the developer has familiarity in implementing web apps with React, which is a huge advantage as the developer will be able to commence the development stage almost instantaneously instead of wasting time and energy to understand its usage and syntax and subsequently dealing delay project. Last but not least, React is an extremely popular framework with over 10 million weekly downloads, such huge community revolves around React signifies more discussion regarding its usage and solutions to the issues developers commonly have, which can be very beneficial to the developer in ensuring the proposed system to be developed in a speedy yet effective manner by taking advantage of these useful resources.

3.1.3 Software Back-end Development

In order to create a dynamic web application that displays dynamic content, implementing front-end alone will not cut it. By incorporating back-end into the website, it enables server-side processing that handles the coordination between the users and the database, hence permitting content to be modified and displayed as according to the users. At present, there are countless back-end programming language to be chosen specifically for composing web application. As many choices as there are, choosing the one that suits the project's context the most is at utmost importance. And for that very purpose, amongst these languages, two back-end programming languages were selected and differentiated. The comparisons will be shown in the table underneath.

Table 8: Comparison of Programming Language - Software Back-end Development

Properties	**Python**	**Ruby**
Language Level: What level does the programming language belongs to?	High-level. High-level language inherently offers higher level of abstraction. This means that the code will be much more human-readable and concise which translate to simpler learning process and faster development compared to low-level programming language, although usually comes with the sacrifice of lesser control without the help of libraries. Python heavily prioritises explicit and readable code.	High-level. Despite being fairly similar with Python in terms of being a high-level programming language, it thoroughly emphasises on human aspects of programming that is innovation friendly.
Performance: How performant is the programming	Slightly faster. Python can execute its instruction just a tad bit quicker than Ruby. However, since both are high-level languages, the performance difference between	Slightly slower. Again, Ruby is a high-level language that utilises an interpreter much like Python. The

language in terms of its execution speed?	these two languages is almost negligible (Eggleston, 2018).	execution speed of Ruby is lower just by a small margin.
Flexibility: How flexible is the language in the sense of accomplishing a specific task?	Lesser flexibility. To maximise its simplicity and readability, Python instils the concept of one-way approach, meaning that the developer will only ever need to adopt one method in tackling a particular task (Rohit Sharma, 2020).	Greater flexibility. As mentioned earlier, Ruby encourages creativity and ingenuity. Therefore, Ruby is designed to offer multiple approach in accomplishing a specific task. This idea, however, comes with the price of possibly making the code more difficult to read for other programmers (Rohit Sharma, 2020).
Popularity of Language: How popular is the programming language?	Very popular. According to UpGuard (2020a), there are as much as 8.2 million users of Python.	Much less popular. Popularity wise, Ruby falls short with 1.8 million users (UpGuard, 2020a).
Web Frameworks: What are the web frameworks available for the programming language and is the developer familiar with any of them?	Django, Flask, CherryPy and more. Amongst these frameworks, the developer has worked on Flask previously, having a good grasp on web frameworks allows the system to be implemented in shorter span of time.	Ruby on Rails, Hanami, Grape and more. The developer has no experiences in whichever frameworks Ruby has, therefore requires time to learn and adapt into the proposed system.
Extensiveness of Libraries: How huge of the field coverage has the programming	Very huge. Python contains almost over 150 thousand of libraries to import from. Python's libraries cover huge range of uses cases.	Relatively smaller. Although Ruby has almost just as much of libraries available, most libraries emphasise on simplifying the process of

language provides with the readily available libraries?	Some libraries enhance web development process, and there are also an abundant of libraries that provide the capabilities to perform data science tasks (Maldonado, 2019; Ramya Shankar, 2020).	building a complex and huge web apps that can withstand higher traffic of users (Ramya Shankar, 2020; EDUCBA, 2020).

By taking the comparisons made, the project circumstances and the programming language chosen for developing the machine learning model into account, Python (Version 3.9.0) is selected as the most suitable programming language for back-end development in this project. Before anything else, both languages compared are high-level languages and have comparatively similar performance. Employing high-level programming language shortens the development time by a mile thanks to their adaptation of high abstraction, which translates to code that are simpler and more concise to achieve the same operation, hence allowing the developer to deliver the end product in a timely fashion. In the aspect of performance, there are not much to be compared here despite Python having slightly greater performance than R because both are interpreted language, the difference between their performance is very minor. Plus, Python has decent enough execution speed to achieve what is required in the current project. The strengths of Python with relation to this project illuminates in the comparison above in terms of popularity, frameworks and extensiveness of libraries, not in flexibility however. Python exchanges its flexibility of approach in accomplishing a specific task for simpler and readable code, which in fact is a plus for the current project because the simplicity of code helps the developer in implementing and debugging the proposed system faster and more efficient, meanwhile the flexibility as provided in R does not bring any value to the system nor to the project. On the topic of its strengths, Python has an overwhelming size of community, making it a very prevalent programming language. As the community grows, the number of resources and conversation about the language augments as well. By taking advantage of these plethora of materials, the developer will without a doubt able to develop the proposed system in a much effective and efficient manner, leaving the possibility of project failure near to zero. In the sense of web frameworks, both equally have quite the number of them. Employing web frameworks can enormously help the developer to implement the proposed system in a much efficacious and productive manner. Due to the fact that the developer

has knowledge and experiences in one of the Python's web framework, Flask, it will undoubtedly speed up the development process without having the developer to spend an unknown period of time to learn the framework. Having to purposely learn the web frameworks before implementing may actually backfire on the project timeline instead. Last but not least, Python has an extensive number of libraries that even permits and eases data science operations. Since the proposed system require constant stream of tweets from Twitter to be extracted and classified as cyberbullying or non-cyberbullying, the tweets will first need to be preprocessed and vectorised before any classifying happens, therefore these libraries are more than necessary in order for this project to succeed.

3.2 IDE (Integrated Development Environment) Chosen

First and foremost, the project will utilise two IDEs to develop the proposed system, one for building the machine learning model to predict the outcome, while another one for implementing both the front-end and the back-end of the system. As for the former purpose, Google Colaboratory or in short, Colab is chosen.

Figure 16: Google Colaboratory Logo (Korstanje, 2020)

Colab is a cloud-based IDE developed by Google that supports multiple programming language including Python and runs on web browsers (Quinn, 2018). Colab takes advantage of Jupyter, an open-source software that provides the capabilities to perform extensive data science-related tasks, and hosts it into the cloud server (Google, 2021). There are substantial benefits from using Colab which comprised of:

- Free-of-charge, allowing cost-effective development.
- No configuration needed with dependencies necessary for data science related tasks such as pandas and TensorFlow pre-installed, ensuring smooth and quick development.
- Given as much as 12 GB of RAM, 50 GB of hard disk space and also free access to GPU on the cloud virtual machine. Thanks to the virtual machine, it enables the developer to shift most of the computing operations to the Google cloud server, such migration is

especially beneficial during training the machine learning model, which can take a considerable amount of computing resources. Moreover, the training of deep learning model can be accelerated immensely with the usage of GPU (Dsouza, 2020). Therefore, it is wise to employ the virtual machine to its fullest to prevent tremendous decrease of local machine performance.

- IntelliSense-like feature. Akin to the IntelliSense feature provided in the Visual Studio Code (Microsoft, 2021a), Colab too supports code auto-completion suggestions, parameters hinting as well as methods explanation. The utilisation of said feature will without a doubt, increase the developer's productivity significantly in terms of both coding and debugging.
- Readily available revisions history (Quinn, 2018). Amazingly, Colab stores the changes made towards the codebase. The essential information it tracks consists of the entire codebase, date and time of modification and also the person (Google Account) who modifies them. Having histories of codebase offers the developer the opportunity to trace back the previous codebase in case of breaking changes.

To develop the front-end and the back-end of the proposed system, the IDE, or more specifically the code editor, Visual Studio Code (Version 1.52.1) is utilised.

Figure 17: Visual Studio Code Logo (Canonical, 2021)

Visual Studio Code, popularly known as VS Code, is an open-source, cross-platform (Windows, macOS, Linux) code editor introduced by Microsoft (2021b). Again, VS Code has its own fair share of advantages that have enticed a large community, and the advantages are as follows:

- Free-of-charge since as mentioned earlier, it is an open-source code editor, therefore it allows the project to be proceeded with lower costs.
- Lightweight (Microsoft, 2021c). This implies that VS Code inherently employs less system resources, which can be extremely crucial in maintaining a progressive system development, avoiding any unwanted crashes and possibly losing hours of development progress.

- Powerful debugger tool. VS Code has a debugger tool pre-installed with a dedicated debug console to streamline debugging process. It even allows the developer to create breakpoints throughout the codebase to inspect the program during execution (Microsoft, 2021d).
- Myriad of extensions (Microsoft. 2021c). It was discussed earlier of the fact that VS Code is indeed a code editor, however, with a couple of extensions installed, VS Code can closely simulate an IDE for any programming language too, provided that there are extensions for the specific programming language. For example, the default debugger in VS Code accommodates only Node.js runtime, by installing an appropriate Python extension (Microsoft, 2019), the developer can now debug in Python as well, essentially taking a step closer to create an IDE for Python-specific software projects.
- Visual Studio Code IntelliSense. As explained previously, IntelliSense provides additional convenience in coding to reduce the time to write code along with the risk of writing incorrect code. This feature will undoubtedly assist the developer in constructing the proposed system quicker.

3.3 Libraries/Tools Chosen

In this fast-paced technological era, everyone demands speed and efficiency. The same goes to software development. In order to achieve utmost efficiency during development yet still retains the best software quality, countless libraries and tools have been developed and applied. This project too, will utilise libraries to streamline the development process, so as to ensure prevent unnecessary project delay. The followings are some of the essential libraries that will be employed into the system in terms of building the machine learning model or constructing the web app itself.

3.3.1 Flask

Figure 18: Flask Logo (seeklogo.com, 2020)

Flask is a back-end Python-based web application framework that incorporates both Werkzeug WSGI[3] library as well as Jinja2 template engine. Web application framework or widely referred as web framework establishes the structure to code meanwhile provides the tools and modules that eases the development process. For instance, Werkzeug by itself contains a powerful yet interactive debugger with insightful explanations provided along with a development web server to test the API endpoints created, which alleviates the debugging process significantly (Ronacher, 2020a). Other than that, Jinja2, the template engine which essentially allow the creation of dynamic web pages through the combination of markup language such as HTML and XML with Python data variables (Ronacher, 2020b), offers security mechanism through HTML escaping system to impede any cross-site scripting (XSS) attacks, ensures exceptional performance through just-in-time compilation to Python bytecode and also simplifies the effort to achieve uniform design through template inheritance (Ronacher, 2020b).

Aside from easing development process, applying web frameworks can be extremely beneficial in the long run since it facilitates code reusability (Gill, 2019), thence the web app will be much more scalable and maintainable. Out of all the web frameworks out there, Flask however, is specifically called a microframework due to the fact that it allocates only essential building blocks for developing web applications, any additional required functionalities can be just written or imported from the plethora of Python libraries on the spot, hence succinctly explains why Flask is such a lightweight web framework (Educative, 2021a). Most importantly, Flask has shallow learning curve compared to other web frameworks plus, it is absolutely free to use. All in all, employing Flask (Version 1.1.2) allows the developer to adapt quicker as well as to implement the proposed system with higher performance, better security, lesser storage consumption without sacrificing huge project resources in the aspects of time and costs. In terms of front-end development, React will be utilised as established earlier, hence despite the greatness of Jinja2 Flask provides, Jinja2 will not be used.

3.3.2 mysqlclient

Since the programming language, Python and the database, MySQL were deemed to be the most appropriate technologies to be integrated into the proposed system, the mechanism to establish the

[3] Web Server Gateway Interface, a standardised mediator between web server and web application (Long, 2019).

communication between these two technologies is imperative, so as to equip the system to execute CRUD (Create, Read, Update and Delete) operations. Out of the variety of libraries out there, mysqlclient (Version 2.0.3) was chosen. mysqlclient library is a C library-dependent driver, forked from legacy version of MySQLdb (GitHub, 2021a), that can be imported into Python projects to communicate with MySQL databases. There are multitude of reasons as of why mysqlclient was chosen. First and foremost, mysqlclient makes operations on database remarkably simple, such as a single line of code *connect()* to connect to the database in addition to *execute()* to perform SQL queries on the database. Through these straightforward commands, the developer can learn and create CRUD functions in the proposed system almost immediately. Despite the library mysqlclient being not as popular as other libraries such as MySQL Connector/Python with as much as 23 thousand of users on GitHub (GitHub, 2021b), the syntax of these two libraries is relatively similar. This signifies that the discussions posted online regarding bugs or optimisation methods can be applied correspondingly, which can be very beneficial to the developer in debugging or improving the proposed system without unnecessarily wasting huge amount of time. On top of that, the library, mysqlclient has incredibly outstanding performance compared to many if not every other relevant library including MySQL Connector/Python, sometimes outputting ten times the speed when performing queries even on the large dataset (Nagy, 2015). Although there are also other libraries such as SQLAlchemy that embeds the concept of ORM (Object-Relational Mapping) that allows the developer to interact with the database through object-oriented paradigm wherein promotes rapid development and scalable systems, it trades its convenience with lower performance since it adds a layer of abstraction between the communication (Rogers, 2019), the constant conversion from raw data to objects and vice versa can heavily affect the system performance when reading and writing data into the database especially when large data is involved (Makai, 2021). The fact that the proposed system comprised of extracting and detecting cyberbullying tweets in real-time and be displayed into the charts accordingly, the performance between the application server with the database server is a major concern, thence mysqlclient in overall is considered to be the best choice.

3.3.3 Tweepy

Tweepy is another Python library that can be imported into Python projects to gain access to Twitter API (Rigden, 2018). Tweepy simplifies the operations provided by Twitter through objects

and methods. In that regard, not only does that speed up the development of proposed system, but also ensures the code looks much cleaner and more readable, thus making system highly maintainable. Additionally, Tweepy as well has a large community, implying that most well-known issues will already be discussed and resolved, which saves the developer time in figuring out these issues solitarily. Therefore, Tweepy (Version 3.10.0) will be selected to ease the procedure of retrieving tweets as well as the user profiles.

3.3.4 pandas

Figure 19: pandas Logo (NumFOCUS, 2021)

pandas is a renowned, open-source, Python-based library specially designed to process data (pandas, 2021). Through pandas, it is able to convert most data format including Excel, JSON and most importantly CSV into DataFrame, which is identical to a two-dimensional table that contains rows and columns. Since DataFrame is an essential part of the Python ecosystems, it tends to be faster, and much robust than tables or spreadsheets themselves. With the help of DataFrame, the process of exploratory data analysis can become quicker too. Exploratory data analysis, also known as EDA, is an approach utilised to scrutinise data sets, commonly assisted with the application of data visualisation techniques in order to identify anomalies within the data, find patterns or to verify assumptions (IBM Cloud Education, 2020b). Aside from purely converting data format, pandas has also equipped with functionalities to clean data, manipulate data as well as calculate data such as means and median with minimal effort (Fawcett, 2020), all for the purpose of simplifying the process of EDA. In order to build a machine learning model with optimal accuracy, the usage of pandas (Version 1.2.0) is unavoidable.

3.3.5 Matplotlib

Figure 20: Matplotlib Logo (Sherpa, 2020)

As mentioned earlier, EDA involves data visualisation techniques to better visualise and analyse the data. To accomplish said feat, the Python plotting library, Matplotlib will be applied to work in tandem with pandas. Matplotlib has an enormously huge community with a whopping 307k users on GitHub (GitHub, 2021c). Such amount of community does not come without reasons. What makes Matplotlib so popular is due to the fact that not only is Matplotlib capable of delineating myriad of diverse charts including histograms, boxplots, scatter plots and much, much more, but it is also able to devise these charts in just a few lines of code (Aniruddha Bhandari, 2020a). With such an enormous amount of community around the library, any tutorials on its usage or resolutions to its bugs can be found easily. To achieve the goal of performing EDA accurately and swiftly in which translates to greater accuracy for machine learning model, Matplotlib (Version 3.3.3) is without a doubt, the best choice.

3.3.6 scikit-learn

Figure 21: scikit-learn Logo (Yin, 2018)

scikit-learn is one of the most notable and powerful Python libraries out there for machine learning projects whether it is used to resolve classification, regression or clustering problems. This library works hand-in-hand with some of the libraries discussed previously including pandas and Matplotlib, which reduces the need to convert from one data type to a different data type nor the need to purposely study new programming language or libraries just to accomplish simple operation such as plotting charts. Moreover, scikit-learn is exceptional in terms of beginner-friendliness because the creation of the machine learning algorithms can be accomplish with just a single line of code. For example, the developer can simply use the code,

sklearn.linear_model.LinearRegression() to instantiate the linear regression algorithm which can be applied towards the data to create a linear regression model (Codecademy, 2021a). Through scikit-learn, the developer can quickly develop and improve the accuracy of the machine learning model without the hassle of constructing the algorithm itself, essentially saves time and increases chance of project success. In addition to that, scikit-learn website has well-designed and well-elaborated documentation on each and every one of the API usage, making it easy for the developer to understand the API and better tune the hyperparameters when training the machine learning model for greater accuracy. To top it all off, this library is completely free to use with only minor legal limitation, which is not at all a concern for this project, hence it is entirely reasonable and beneficial to incorporate this library, scikit-learn (Version 0.24.0) to build the machine learning model necessary to predict cyberbullying tweets on Twitter (Pavan Vadapalli, 2020).

3.3.7 TensorFlow

Figure 22: Tensorflow Logo (Kubeflow, 2021)

Since it was stated by the scikit-learn developers themselves of the case that the deep learning models deployed in scikit-learn library is not optimal, mostly due to lack of GPU support and variability in constructing deep learning architecture (scikit-learn, 2020), another library that is more robust on the deep learning field is explored. After some research, TensorFlow (Version 2.4.0), an open-source library developed by Google was determined to be the most suitable library for this project, even though most deep learning models will be developed using the submodule *tf.keras*. This is because Keras is a neural network, high-level library built on Python that offers simple syntax to build and deploy deep learning model, similar to how scikit-learn library works. The reason why the entire TensorFlow library is employed instead of purely importing the Keras package is because TensorFlow itself contains a huge bundle of features such as TensorBoard that helps in data visualisation and debugging of nodes which Keras alone does not have (Yashwardhan Jain, 2018), essentially killing two birds with one stone. Plus, TensorFlow tends to work better with larger datasets, hence if large datasets were to gathered, the developer can switch to using TensorFlow instead to build the model (Terra, 2020). Moreover, TensorFlow has a large user base

with roughly 115k users on GitHub (GitHub, 2021d), which allow the developer to search for learning online resources easily as well as finding resolutions to issues encountered much faster, saving project budget and time in the long run.

3.4 Database Management System Chosen

Database management system, also known as DBMS, refers to a software application that prioritises in retrieving, recording and manipulating data into database or databases effectively and efficiently. DBMS mainly acts as a mediator or interface that interconnects the communication transmitted between the end-users through application and the database (Sahiti Kappagantula, 2019). Currently, there are countless DBMS introduced into the market, each with unique and fine-tuned functionalities and design to accommodate different technologies and clients. These DBMS are usually fall under a certain type; One of the most prominent DBMS type is called RDBMS. RDBMS, or relational database management system is a DBMS that manages relational database, a type of database that contains tabular structure, with rows and columns (Codecademy, 2021b). Meanwhile, its counterpart, nonrelational DBMS manages nonrelational database, a different type of database that stores documents that are flexible in nature (IBM Cloud Education, 2020c). In order to determine the most logical and practical DBMS to be incorporated into the proposed system, the two of the most renowned and used DBMS amongst the community, MySQL and MongoDB will be compared in the following table.

Table 9: Comparison of DBMS

Properties	**MySQL**	**MongoDB**
Type: What type of database does it belongs to?	Relational database, also known as SQL database. Relational databases retain data in multitude of tables called relations. These tables with well-defined rows and columns have relationships that interconnects each other to	Nonrelational database, also known as NoSQL database. There are four types of nonrelational databases, and MongoDB inherits the document-oriented database. MongoDB retains data in multitude of BSON documents. The data stored in each document are represented as key-

	mitigate data redundancy (Aniruddha Bhandari, 2020b).	value pair (Mihir Shah, 2017; Simic, 2020).
Cost: Are there any amount of costs related to the usage of the specific DMBS?	No. The DBMS is open-source, therefore no costs will be imposed from the usage of it.	
Developer Familiarity: Is the developer accustomed to the usage of the specific DBMS?	Yes. The developer has sufficient knowledge and understanding in the DBMS due to past experiences from working on projects using the DBMS.	No. The developer has not learned nor developed any application using MongoDB before.
Flexibility: How flexible can the schema design be?	Low flexibility. Adding or changing attributes/columns requires redesign of the database schema, which can take significant period of time. Forcefully adding different data type in the predefined column may crash the application. MySQL supports the storage of only structured data, data that are highly organised and formatted.	High flexibility. Attributes can be appended or modified in new documents without affecting the database schema nor the other documents. MongoDB supports the storage of not only structured, but also semi-structured and unstructured data, data that are highly variable (Aniruddha Bhandari, 2020b).
Performance: How well can the DBMS perform in terms of speed of	Lower performance. In MySQL, different data are partitioned into different tables to reduce data redundancy and data duplication as minimal as possible, however	Higher performance. In MongoDB, the read and write operations are commonly performed on a single spot rather than across different relational tables such as in MySQL, therefore

retrieving and writing data?	that benefits come with the sacrifice of high performance as reading and writing data into the databases usually requires travelling across multiple tables.	MongoDB reigns supreme in terms of performance.
Scalability: How can the DBMS be scaled for accommodating larger traffic of data?	Vertically scaled. In order to adapt to higher traffic of data in SQL databases, the only way to do so is to upgrade the server that is running the database in terms of CPU, RAM or SSD, which can be very expensive. This is because SQL database are designed to run on a single server to preserve the utmost cohesion amongst the table mappings. Moreover, scaling SQL databases typically require modifications in the application itself or shutting down the server temporarily, which is not ideal. (Allen, 2021; MongoDB, 2021a)	Horizontally scaled. Scaling in MongoDB is extremely easy, cheap and failproof because thanks to the concept of sharding introduced in MongoDB, database operations can be spread across different commodity hardware (MongoDB, 2021a).
Development Time: How does employing the DBMS affect the system development time?	Longer development time. Prior to developing the actual application, the developer must design the database scheme with care and attention, which can consume quite the amount of time. Same goes to when changes are required to be made to the database schema during application development.	Shorter development time. Due to its flexibility in terms of database schema, MongoDB enables the developer to implement and expand the application and the database hand in hand, having the application to control the structure of the database instead of the other way around, henceforth avoiding valuable time to

	Moreover, since there are tables with relationship joining them together, when retrieving or writing specific data into the database, the developer may have to write complex queries in order to perform these tasks, which yet again can be troublesome towards the project timeline as well.	be wasted on designing the 'perfect' database schema, less headache on the developer too. In addition to that, MongoDB straightforwardly maps the documents into the data structure supported in most programming language, including Python, therefore interacting with the database will be much more intuitive and simpler, ultimately streamlines the development process remarkably. Furthermore, the data in MongoDB are usually stored within a single document, therefore generally these data can be retrieved with simple queries without resorting to complex queries like in MySQL (MongoDB, 2021b).

By taking the comparison of the two DBMS made above and the project's current budget, timeline, system architecture and the developer's knowledge into account, MySQL (Version 8.0.24) was identified and determined to be the most appropriate DBMS to be incorporated into the proposed system. Based on the comparisons made, the choice might look bizarre as MySQL seems to have many shortcomings across several categories in contrast to MongoDB. However, there are good reasons as to why the choice is valid and optimal. First and foremost, although MySQL has lower flexibility, the proposed system objectives as well as its architecture the developer has personally drafted does not require adaptive flexibility to function. In fact, the rigid structure simplifies the maintenance process for the developer as well. Moreover, in theory, MySQL possesses poorer performance in comparison to MongoDB due to the fact that reading and writing data necessitates the travelling across several tables. Nevertheless, this phenomenon is only true if there are no relationships between the data or scarce updating required within MongoDB. According to the

purposes intended to be delivered through the proposed system, it is almost impossible to not have relationships across the tables nor many modifications towards the data. With these restrictions imposed, implementing the proposed system in tandem with MongoDB can make the performance even worse than using MySQL, which will not be ideal when providing almost real-time information to the system users is highly prioritised. Furthermore, despite the emphasis of the proposed system needing to handle large amount of data streamed from the platform Twitter, the system will only need to store data only relevant to cyberbullying to fulfill its core purpose, the non-cyberbullying data will be filtered out from the server-side of the system. On top of that, not only MySQL can already handle millions of records by nature, but there are also solutions to support horizontal scaling for MySQL such as MySQL Cluster wherein the switch, if necessary, can be executed seamlessly and instantaneously as the sole difference is that MySQL Cluster uses separate storage engine. Apart from that, albeit employing MySQL hypothetically causes slower development time than using MongoDB, the developer's knowledge and proficiency in respective DBMS plays a significant role in determining development time as well, potentially more so than other factors. Due to the fact that the developer has utilise MySQL for multiple years, designing the database schema or writing complex queries are not major problems at all to the developer, hence will definitely not stagnate the development progress. Whereas, diving straight down towards an unfamiliar territory when the developer has to learn other challenging technologies including machine learning and natural language processing could pose immense danger towards the development progress. In overall, with the reasons provided alongside it being open-source, MySQL shall be employed within the proposed system.

3.5 Operating System Chosen

Figure 23: Windows 10 Logo (SHI, 2021)

The chosen operating system (OS) to develop the proposed system will be the Windows 10 64-bit version. The primary reason for said selection is because the computer the developer currently owns and has been used for a decent period of time employs Windows 10. Purposely switching to other operating system such as macOS or Linux can take a toll on the project resources in terms of costs and time. Not to mention, transitioning to other operating system demands time and effort

for the developer to adapt into unfamiliar territory. Additionally, Windows is one of the, if not the most popular computer operating system as of current, which implies that most software will be developed to be compatible with Windows, VS Code being one of the examples, so as to allow as many users as possible to access the software provided. Thus, in order to save project resources, maintain developer's familiarity and access most state-of-the-art software products, the said selection is more than sufficient. Development aside, operating system should be pondered over when deploying the proposed system to the live environment as well. Since the chosen web server, Apache supports the deployment of web app on most platforms, Windows 10 will again be selected. The reason behind that selection is mainly because the developer has experiences in deploying web app through Apache. Deploying on other platforms may have unforeseen configuration required that may delay the time to deploy. In an addition to that, as mentioned before, the developer owns a computer with Windows 10 running in the background, which comes in very handy as the developer can carry out a pre-test on deploying the web app on the current computer to make sure everything run as expected, essentially helps in streamlining the actual deployment stage.

3.6 Web Server Chosen

According to MDN (2021), the word 'web server' may refer to either the hardware, software or the combination of both. From the hardware perspective, a web server is a computer that stores web-related files and the web server software itself. With the help of the configured web server software it stores, it is responsible for delivering the requested content to the target device, provided that both parties are connected into the Internet. Meanwhile from the software perspective, a web server is an intermediary software that at the very minimum, utilises the Hypertext Transfer Protocol (HTTP) to interconnect the communication between the user's browser and the physical server, so as to not only allow the users to view the requested web content but also grant authorised users to perform operations on the web app such as order products, update profile and much more. Web server software can be configured in different aspects, including the hosted web app's domain name to simplify access to it or the SSL certificate to strengthen the web app security. Since the end product of this project is a full-fledged cyberbullying detection web application, a web server will be required to host the web app so as to allow the end users, government agencies and NGOs members to access and perform actions on the system. After

taking the current project allotted timeline, budget, developer's expertise as well as the capabilities of the most prominent web server available in the market into account, Apache HTTP Server (Version 2.4.46) or Apache in short, was deemed to be the most suitable web server software to be incorporated into the proposed system. As for the web server in terms of hardware, it is planned to be hosted on one of the Windows OS-based computers running in government agencies' environment.

Figure 24: Apache Logo (Cline, 2020)

First and foremost, Apache is an open-source web server software that adapts the process-based architecture to process HTTP requests. To be specific, every time a request for establishing connection between the physical server and the client is transmitted, a thread called the parent process, which is responsible for constantly listening to connection requests, will assign the request to another thread called the child process to handle the operation needed. Such architecture design can be detrimental to the performance when a large number of users are requesting for connections concurrently. However, since the proposed system is only aimed for members from cyberbullying-focused government agencies and emotional support-focused NGOs, and not for huge number of public users, performance issue caused by high network traffic between clients and web server is very unlikely to occur in this context. To clarify, the traffic between the clients and the web server with the traffic between the web server and the database server belongs to different territory. Besides, even if performance concerns came to light due to reasons such as expanding the system for public users, there are multiple approaches that can be taken to sort out this issue. For example, Apache inherently pre-installed and pre-load quite the amount of modules when it was initially set up. Amongst all these modules, the unused ones can be removed which naturally leads to a better performance web server. Moreover, Nginx, another well-recognised web server can be extended to the current composition whereby Nginx acts as the reverse proxy to handle static files meanwhile Apache handles data processing (UpGuard, 2020b), Through described arrangement, the performance will skyrocket to an even higher level, providing more users to surf the website simultaneously which frankly, is not necessary at all for the current project.

During the discussion above, Nginx was mentioned. Nginx is also an open-source web server that employs event-driven architecture. Compared to Apache, Nginx excels at performance outstandingly due to its capability of handling HTTP requests asynchronously (Bradley, 2018). However, as explained several times earlier as well, performance problem due to high network traffic is not of any concern in this project. Moreover, Nginx supports Windows OS only partially. For example, while there can be multiple Nginx worker processes to be started on Windows OS, the requests transmitted into the web server will only be handled by one worker process unfortunately (nginx, 2020). Thence, in order to fully utilise the capabilities Nginx provides, the developer must switch to other supported platforms such as Linux, Unix or macOS, which was again, clarified previously of the fact that the developer is not familiar with these operating systems at all. All in all, deploying the proposed system on Nginx indicates unknown risks, which is not the case for Apache because Apache supports Windows OS, an operating system the developer both possess and familiar with. Furthermore, deploying web app on Apache is simple and requires very low effort, plus the developer has experience in the past regarding Flask-based web app deployment using Apache, which matches the back-end technology that will be used for the proposed system. Therefore, using Apache allows the developer to spend lesser time in deploying the web application yet without accidentally exposing the proposed system with loopholes and making the system much more vulnerable to malicious attacks.

Speaking of attacks, Apache is equipped with many modules to enhance the security of the web server as well. Modules like *mod_evasive* can be used to impede brute force attacks or denial-of-service (DDoS) attacks while switching on the *ModSecurity* module can deter SQL injection (UpGuard, 2020b). By utilising these modules appropriately, the proposed system will be much more secured when deployed on the live environment. On top of that, due to the popularity Apache has throughout the years, the community around the web server has grown significantly as well (Gudeliauskas, 2020). With such an enormous community, most issues can be sought and resolved immediately, thereby avoid exhausting a huge amount of effort and time just to solve simple problems.

3.7 Web Browser Chosen

Figure 25: Microsoft Edge Logo (Warren, 2019)

Although every website developed can be technically accessed by all the browsers, both the website's design and functionalities the web browser is projecting however, may be variant; The design may not be uniform, the functionalities may not work. Therefore, to accommodate the project budget and time constraints, one dedicated browser will be selected. After conducting extensive research to determine the most suitable web browser, Microsoft Edge was deemed the most promising web browser to run the proposed system. Therefore, Microsoft Edge (Version 87.0.664.75) will be selected as the web browser to construct, test and operate the proposed system.

As its name implied, Microsoft Edge was introduced by Microsoft, particularly in 2015, with the purpose of rebranding Internet Explorer (IE) (Meisenzahl, 2019). As the browser has been established for quite some time, not long ago, Microsoft Edge has yet again undergone an enormous change. The new Microsoft Edge is built using Chromium, an open-source project which acts as the foundation for the well-known Google Chrome as well. As for that reason, the Microsoft Edge now inherits all the Chrome's properties and luxurious capabilities, even the previously incompatible Google-based websites in old Microsoft Edge is now compatible.

Based on the benchmarking process of several categories including performance, central processing unit (CPU) usage and memory usage performed on Chrome, Firefox, Edge and Opera by Paul (2020), Edge reigns supreme on both the CPU usage and memory usage categories amongst the other browsers, meaning that Edge utilises the least processing power and memory. In terms of performance, the result is indeterminate. However, recent benchmarking test carried out specifically on web browser's performance by Howse (2020) has proven that Edge is the most performant web browser by achieving the best results in most of the tests including Speedometer 2.0, Jetstream 2 and Octane 2.0, beating Firefox, Opera and even Chrome. Having great performance on the browser helps in running the website quicker and smoother, consistently giving the users top-notch experience. On the other hand, Edge does support lesser HTML5 and CSS

syntax (Leenheer, 2016; W3Schools, 2021), which realistically does not matter much as most of the essential syntax are still available and are more than enough to fully implement the proposed system.

Furthermore, Microsoft Edge is currently compatible with multitude of operating systems including Windows 7 to Windows 10, Android 4.4 or above, macOS Sierra or higher, iOS or above and there is also a beta version of Microsoft Edge for a few Linux distributions such as Ubuntu and Debian (Microsoft, 2020a; Vaughan-Nichols, 2020). Since Microsoft Edge is available in most operating systems, it indicates that devices with lower system specifications will still be able to access the proposed system uniformly in terms of layout, design and functionalities.

According to Liu (2021), there were 166 million Microsoft Edge users in 2019, which was nowhere near the number of users of the juggernaut, Google Chrome with 2.6 billion with the number one lead. This implies that more users are familiar with Chrome. However, since Microsoft Edge was built upon Chromium as explained earlier, developing and deploying the proposed system on Microsoft Edge is still completely logical because the differences of user experience on either browser are seemingly unrecognisable, using the proposed system on Edge will not feel off at all even for the long-term Chrome users.

More importantly, Chromium-based browsers have a powerful tool named DevTools. This tool allows the developer to:

- Examine which source code belongs to which section of the website.
- Directly modify the content as well as the design and view how changes are being rendered on the website.
- See all the messages printed on the console and also place breakpoints throughout the codebase which can be useful during debugging process.
- Change the screen sizes dynamically to ensure that the website displays the proper layout for different devices.

On top of that, Microsoft Edge also has a place called Chrome Web Store where the developer may download extensions to further enhance the debugging process (Microsoft, 2020b). By fully capitalising these features, the development process can become more effective and efficient, thus producing a high-quality software and ultimately guaranteeing project success.

3.8 Summary

In overall, the in-depth research on the various technical elements has been tremendously helpful for the developer in comparing, evaluating and identifying the best instruments necessary to play the most beautiful and soothing melody for the project. The selection of these tools is determined with utmost consideration, not only from the technical capabilities but also the project circumstances in terms of time, monetary resources as well as the developer's knowledge. Without careful scrutinisation and selection of these technical tools, the project could nosedive into the pit of failure from factors including incompatible tools chosen that result in unusable system with poor quality and also novel tools selected yet with high difficulty spike that kept the developer stagnant in the learning stage for long period of time, thus gradually reducing available development time and ultimately delaying the entire project.

Selecting the most appropriate version for these technical tools and libraries is crucial to the utmost quality of the proposed system and project success. As for this project, the proposed system will be built using the latest (as of this writing) and the most stable version. This is because the latest version of these tools is optimised to the core whether it is in the aspect of features, stability, performance and more. Employing outdated versions may subject the proposed system to security issues and being unstable, making it vulnerable and unsatisfying to the users, which implies that the proposed system can become obsolete in no time despite the enormous amount of effort and time poured into its development.

A table is constructed below to summarise the technical tools and libraries chosen including the version selected.

Table 10: Tools/Libraries Chosen

Name	Type	Version
Python	Programming Language – Machine Learning Model Development & Software Back-end Development	3.9.0
React	Programming Language/Framework – Software Front-end Development	17.0.1
Google Colaboratory	Integrated Development Environment (IDE) - Machine Learning Model Development	Web IDE, therefore, no version.

Visual Studio Code	Integrated Development Environment (IDE) – Software Front-end & Back-end Development	1.52.1
Flask	Library – Software Back-end Development	1.1.2
mysqlclient	Library - Software Back-end Development	2.0.3
Tweepy	Library - Software Back-end Development	3.10.0
pandas	Library – Machine Learning Model Development	1.2.0
Matplotlib	Library – Machine Learning Model Development	3.3.3
scikit-learn	Library – Machine Learning Model Development	0.24.0
TensorFlow	Library – Machine Learning Model Development	2.4.0
MySQL	Database Management System (DBMS)	8.0.24
Microsoft Windows	Operating System (OS)	10 64-bit
Apache	Web Server	2.4.46
Microsoft Edge	Web Browser	87.0.664.75

Chapter 4: System Development Methodology

4.1 Introduction

System development methodology is a standardised approach in developing system, ranging from planning, designing, up until maintaining (Alliance Software, 2020). There are various system development methodologies established whereby they share similar concepts, yet each were attentively and carefully fine-tuned to cater different projects and even different organisation as well. By applying appropriate methodology based on the given situation, the project will foresee a higher chance of success, bringing huge satisfaction to both the clients and the development team. Therefore, the selection of a system development methodology cannot be taken lightly.

In this particular chapter, two system development methodologies which are Waterfall Model and Rapid Application Development (RAD) will be thoroughly compared, and the most suitable methodology to be applied to this project will be selected.

4.2 Comparison of Methodologies

Table 11: Comparison of Software Development Methodologies

Properties	**Waterfall Model**	**Rapid Application Development (RAD)**
Project Size: What kind of project size does the methodology support?	Small projects. This methodology is ideal for short projects especially when the requirements are distinctly established. This is because when the project is large and complex, the more likely the requirements are going to change in order to adapt to the ever-changing business and technical environment, and changing requirements during	Small to medium-sized projects. Even though the adaptability and flexibility of RAD exceeds other methodologies tremendously, it sacrifices control and restraints far more likely than others as well. This makes RAD not being suitable for large projects because administering the development of system with

	development process can be very costly since the complete documentation and designs are composed in early stages (Rouse, 2019).	huge scope and high volatility without proper procedure and documentation can be very difficult (Amruta Deshpande, 2020).
Degree of Flexibility: What is the level of flexibility the methodology possesses in terms of adapting changes during the system development life cycle?	Low to none. As explained earlier, changes during the implementation stage can be tremendously expensive in this methodology because everything has already been defined and documented thoroughly at early phases.	High. Reasonable changes including the system requirements itself proposed by the clients can be reflected and modified onto the system during any phases in this methodology due to its iterative nature of building functionally independent prototypes (O'Carroll, 2020).
Documentation: Does the methodology emphasise documentation of the system throughout the system development lifecycle?	Yes. The methodology heavily focuses on complete and comprehensive documentation throughout the phases (Lucidchart, 2020).	No. In RAD, the documentation is only composed during the cutover phase (O'Carroll, 2020), which because this methodology is based on agile principles, whereby working software is highly prioritised and documentation are only formulated when deemed necessary.
Business Involvement: Does the methodology encourage frequent involvement from the	No. The methodology only allows clients' involvement during the early phase to	Yes. RAD is a methodology specifically tweaked to include clients' feedback

clients during the system implementation stage to provide their insights towards the system based on their needs and preferences?	identify the complete requirements on the system and only the late phase to conduct user acceptance testing (UAT) on the system. This instance can be particularly beneficial for projects where the clients cannot participate consistently during the development stage to provide feedbacks.	during the development of the system. In fact, the lack of communications may result the project in utter failure. Through clients' feedbacks, the developers can better tune the system to their requirements, better simulate a system they had in their mind, eventually satisfying both parties (O'Carroll, 2020).
Risk Level: Does employing the methodology induce high risks?	Yes. The proposal of changes by the clients after the requirements specification phase can be extremely expensive to be accommodated because everything done previously will have to be re-evaluated and refined again (Pal, 2019).	No. The practice of rapid prototyping and testing from the relevant stakeholders permits the requirements changes to be implemented easily based on the feedbacks they provide, therefore satisfying their needs. Not to mention the fact that such practice allows software bugs to be detected much earlier and be resolved almost instantly. Patching up errors at the beginning will significantly mitigate the debugging effort at later stages. Moreover, ascertaining whether the project is still within the

		timeline and budget can be done from assessing the nature of feedback from the clients as well as the constant iterations (O'Carroll, 2020).
Developer Knowledge and Expertise: Does the methodology required skilled and experienced developers to ensure project success?	Yes. Although the methodology is simple and easy to be adapted, the developers are still required to have a comprehensive understanding regarding the technology that will be utilised in building the system (Mohamed Sami, 2018).	Yes. Due to the rapid nature of RAD, adopting such methodology requires a team of skilful and knowledgeable members regarding to not only the system development tools being utilised but also the methodology itself in order to construct a system swiftly yet equipped with sublime quality (Rana, 2020).

4.3 Justification on Chosen Methodology

By taking the comparison of the methodologies made above as well as the various aspects of the current project into consideration, it is determined that rapid application development would be the most compatible methodology to this project. First and foremost, the project is considered medium based on the project scope defined as well as the allocated timeframe of a few months, wherein the rapid application development methodology is suitable for. Unlike the waterfall model whereby rigid process and fixed requirements are enforced pairing with the absolute minimum business involvement, the highly flexible nature of the rapid application development methodology with the application of rapid prototyping and testing allows the developer to interact with the clients, in this case would be the government agencies and NGOs, regularly especially during the system implementation, collect insightful feedbacks and from those responses make the necessary changes to the system accordingly with ease and speed. As such, the proposed system developed would almost be a guarantee to meet the clients' expectations, therefore impeding any

dissatisfaction that could cause catastrophic instances such as dissipating another immense number of resources to modify the system as required or even as worse as abandoning the project and the system itself. All in all, incorporating RAD within the current project imposes much lesser risks compared to the waterfall model due to the fact that a single change could incur a snowball effect towards the work completed during the previous stages, thus necessitating all the effort to be refined again. Furthermore, since the documentation are only formulated when deemed necessary, the developer will need not to spend an excessive amount of time in composing additional documentation where some might barely bring any value, the developer can utilise the extra time in perfecting the system instead. In terms of developer knowledge and expertise, the RAD methodology requires the developers to be skilled and knowledgeable in the technology that the system will be based on. Even though the developer in this project has minor knowledge on the technologies the system will employ, the developer will manage time efficiently to learn all these technologies in-depth in order to make this project a success through the RAD methodology.

4.4 Rapid Application Development

Rapid application development (RAD) is a system development methodology that emphasises swift prototyping through constant iterations and continuous user feedbacks (Ankita Singh, 2019). RAD falls under the category of agile methodologies, and unlike traditional methodology, it emphasises flexible requirements, encourages continuous user involvement as well as prioritises working software over comprehensive and complete documentation, which can be the perfect methodology for projects that requires functioning system under compact deadline. There are four major phases in the rapid application development methodology as shown in the diagram below.

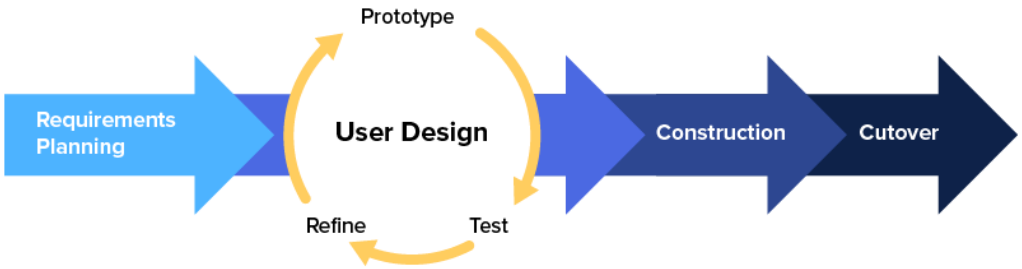


Figure 26: Rapid Application Development – Phases (Kissflow, 2021)

Requirements Planning

The initial phase of the rapid application development methodology commences with the requirements planning wherein it, as its name suggested, analyses, defines and plans the project scope and requirements with the relevant stakeholders. Within this phase alone, there are several key operations to be performed. For starters, without an absolute problem, there would be no absolute solution, thus, its beginning operation involves investigating the domain problem to be resolved in thorough detail. From the root problem unearthed, the requirements that formulates the foundation of the system would then be conceptualised, elaborated, determined and concurred amongst the stakeholders. Apart from that, the potential risks that could be encountered during the project alongside its contingency plans would be discussed during this phase as well. Therefore, it is excruciatingly imperative to have the relevant stakeholders to express their opinions and suggestions yet have their thoughts aligned towards the same objective before the development process initiates, or else the repercussions would involve something much more important than merely monetary expenses (Lucidchart, 2021).

User Design

As soon as the project scope and requirements have been established, the development process would then be initiated in the second phase, user design, in which the system will be implemented both iteratively and incrementally. Each iteration in this phase entails a newly chosen deliverable amongst its other deliverables to undergo three main processes; Materialise the prototype; Demonstrate the prototype to the clients; Refine the prototype based on the remarks collected. Through employing such approach, each and every feature would be individually developed and polished to ensure the clients' demands and requirements are comprehensively satisfied. In addition to that, the iterative testing of independent deliverable conducted with the clients allows the flaws and bugs to be discovered much earlier, thus resulting in the system less error prone as the developers are given the opportunity to debug them prematurely.

Construction

The third phase, construction, involves the integration of the individual prototypes built earlier into a fully functional system. Subsequently, the system must go through an in-depth and exhaustive amount of testing including unit, integration, system and most importantly, user acceptance testing

to ascertain that not only are the features are operating as intended, but also the system meet the clients' expectations and requirements. Hence, modifications towards the system regardless of functionalities, quality attributes such as performance and security as well as the aesthetics as desired by the clients are still welcomed as ever even reaching upon this phase (Vijay Singh, 2020).

Cutover

As for the final phase, the new system would be deployed into the organisation environment through an appropriate system changeover strategy, thus minimising potential risks and maximising benefits simultaneously. During the transitioning phase, several procedures are performed as well including further testing to ensure the system can operate under real-life situation, comprehensive documentation alongside meticulous training so that the system engineers within the organisation are well-equipped with the knowledge in maintaining the new system meanwhile the system users are thoroughly taught regarding the system usage and able to employ them instantaneously into providing business values (Lucidchart, 2021).

4.5 Implementation of Chosen Methodology

Requirements Planning

During the requirements planning phase, the developer will commence with identifying the problem context that leads to the justification of implementing the proposed system. Thus, for starters, the developer will investigate the cyberbullying issue in detail, understanding as of why cyberbullying in Malaysia is still prevalent as of today. Thereafter, the developer will meticulously scrunitise the past research alongside the systems with similar objectives and functionalities to comphrensively understand various aspects regarding cyberbullying as well as the fundamental and vital features to be implemented within the proposed system. On top of that, a research survey together with an interview will be conducted to further grasp the perception of the public concerning the cyberbullying issue as well as the requirements and improvements the target users have towards the proposed system respectively. Once these processes have been properly addressed, the developer will then move on to the development phase.

User Design

Within the user design phase where iterative and incremental development approaches are heavily emphasised, the development process for the proposed system would initiate with segregating the proposed system into several deliverables, which in this case decided by the features, meaning each feature represents one deliverable to be implemented as individual prototypes. For example, the graphical statistics feature would be considered as a deliverable and the moment the graphical statistics dashboard prototype has been developed, the prototype would be showcased to the target users and their remarks towards it will be utilised for further improvement before proceeding to the next deliverable. At the end of the phase, there will be a multitude of complete prototypes developed in accordance with the feedbacks received to be integrated at the following phase.

Construction

During the construction phase, all the prototypes such as the machine learning model and the graphical statistics dashboard feature developed in the previous phase will be consolidated into a full-fledged functioning system. From then on, the necessary test plans will be concocted to ensure a complete and thorough testing across the system features. First and foremost, the unit testing will be performed to verify that the system features operate as planned in a fine-grained level. For instance, the components within the add organisation feature such as the name field and the username field will be tested on whether they will be highlighted as red independently when wrong input was given on each field correspondingly. Subsequently, the integration testing comes into play wherein several components integrated will be tested. For example, after the add organisation feature was merged in terms of front-end and back-end, an organisation will be added from the client-side as an attempt to identify whether the new record of organisation exists in the database or not. As such, each integration will be paired with an affirmation, ascertaining that the integrations across components went successful. Moving on, in system testing, the entire system will be examined and evaluated as a whole by the developer, to verify that the system aligns with the clients' previously discussed functional and non-functional requirements such as displaying the graphical statistics within four seconds. Last but not least, the user acceptance testing would be conducted wherein the target users will have a hands-on experience on the system itself, and from then, determine whether the system requires additional tweaking to maximise the impact in mitigating or even resolving the problem context identified earlier.

Cutover

Reaching at the final phase, the system will be transitioned into the target users' environment through employing the direct cutover system changeover strategy as the proposed system would be an addition to the organisations to monitor cyberbullying incidents rather than replacing any existing mechanisms. During the deployment phase, another series of testing would be carried to ensure the deployment smoothly. Moreover, the essential documentation will be composed in order to provide full context and insights to the target users regarding the system in a comprehensive manner. Apart from that, the target users will be given methodical guidance on the system usage, thus help them make the most out of the system.

Chapter 5: Research Methodology

5.1 Introduction

This chapter excavates into the discussion of the data collection method selected as well as the design of these methods so as to conduct an effective and efficient research. Despite the in-depth study and analysis carried out by the researcher amongst various resources, different timeline, demographics and other factors may influence the results of the research. Moreover, the target users may have different opinions or preferences regarding the proposed system and its features. Therefore, a well-designed research must be executed in order to validate the information retrieved, affirm the fundamental concept and features of the proposed system and also gain further insights on certain topics and domains.

As for this project, two data collection techniques have been determined to be crucial in gathering the information that are considered essential to the success of this project. First of all, the technique, survey will be utilised for the purpose of understanding the Malaysian victims' emotion towards cyberbullying experiences, the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and language presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system or government and NGOs' strategies in better handle cyberbullying incidents in Malaysia. As for the other technique, interview will be conducted with the target proposed system users (Cyberbullying-focused government agencies and emotional support-focused NGOs) to acquire greater insights on the prevalence of cyberbullying cases in Malaysia from their perspective, their domain itself in handling cyberbullying incidents and their opinion and requirements for the proposed system.

5.1.1 Survey

Survey is a technique specialised in gathering data from a large, predetermined group of people in a short period of time for the purpose of generalising specific knowledge, trait, perception or other attributes of a targeted population (Qualtrics, 2021; Syed Muhammad Sajjad Kabir, 2016). To conduct survey, a set of questions or commonly known as questionnaire will be employed as the

instrument. These answers to these questions will then be compiled and analysed to perform statistical and critical analysis. There are two main types of questions that can be inquired in the questionnaire, which are closed-ended and open-ended questions. Closed-ended questions are questions that provide participants to answer based on a predefined series of responses such as dichotomous questions and multiple-choice questions. Dichotomous questions involve simple answers such as yes/no or true/false. Meanwhile, multiple-choice questions itself have several varieties with some of the most frequently utilised include either 5-point or 7-point Likert Scale questions and Rank Order questions (QuestionPro, 2021a). Closed-ended questions are typically employed to collect quantitative data, data that can be quantified and further mathematically or statistically analysed. On the other hand, open-ended questions are questions that provide participants to articulate their answers more expressively and more precisely according to their knowledge, belief and sentiment. Open-ended questions are asked to acquire qualitative data, non-measurable data that can be categorised based on the characteristics and features of the answers given. These data are important to obtain greater and thorough understanding regarding certain subject matter (QuestionPro, 2021b; Streefkerk, 2021).

To properly conduct a survey, the population must first be determined. The term population particularly in the research field refers to the people that share similar traits (Explorable.com, 2021). Based on the objectives defined for this survey research, the population has been ascertained to be anyone who is a Malaysian, 18 years old or above and have either experienced or witnessed cyberbullying incidents. Although the population size is unknown due to the fact that victims of cyberbullying and bystanders may not report the incidents, it can be undoubtedly claimed that the population size is huge especially when Vimala Balakrishnan (2018) has discovered in her paper that more than 40 percent of both parties do not report cyberbullying incidents, which totalled up to hundreds of Malaysians. Not only that these population are both large and hard to identified, but the fact that the current project has limited resources and time makes the impossibility and impracticality of surveying the entire population even more so. For those reasons, sampling is ineluctable. Sampling is a procedure or technique utilised in deciding the group of people that will actually participate in the research study which will represent the entire population being studied (McLeod, 2019). The data will be collected from sample size of 40 for the current research. There are several types of sampling technique available out there, and amongst all those techniques, the snowball sampling technique is determined to be the most appropriate technique for the research.

Snowball sampling sometimes referred as chain-referral sampling is a non-probability-based sampling technique that requires primary data subject studied in appointing other possible data subjects having similar characteristics being studied that may participate in the research study. The process of nomination by each data subject repeats until the data is regarded to be sufficient to be analysed and make a conclusion on. In snowball sampling, the technique is further partitioned based on the reference methods. The classes of snowball sampling include linear snowball sampling, exponential non-discriminative snowball sampling and exponential discriminative snowball sampling (QuestionPro, 2021c). To ensure the samples can be gathered efficiently, the technique, exponential non-discriminative snowball sampling is selected because every referral mentioned by each data subject will be recruited in the research study. Snowball sampling technique is extremely suitable for the current research because the population are hard to reach out, especially the victims of cyberbullying as previous research has mentioned the tendencies of victims not reporting their incidents due to low self-esteem or afraid being regarded as weak. Techniques that belong to probability sampling are impossible to apply in current research. This is because these techniques ensure everyone in the population has the same chances to participate in the research study. However as clarified earlier, the population is huge and difficult to recognise, the randomisation cannot be applied in the first place hence making these techniques obsolete for the current research.

With the large-scale of the population and sample size defined, survey is viewed as the most appropriate technique to be applied so as to gather such amount of data effectively and efficiently. There are few ways a survey can be distributed which comprised of face-to-face, telephone, online and more. Amongst these methods, online survey has been deemed to be the best option of distribution for this project, specifically using Google Forms. Through the usage of Google Forms, not only it is extraordinarily economical because it is free to use, there are no costs needed in calling or printing the surveys, but it is also highly flexible and scalable because the surveys can be shared to countless participants through emails, social media and many more platforms, thus allowing the researcher to conduct the survey in a cost-effective and quicker manner to accommodate the current project resources in terms of both time and budget. Moreover, Google Forms will automatically generate pie charts and bar charts based on the answers collected for closed-ended questions, which helps the researcher significantly to perform statistical analysis. Furthermore, online surveys are generally more convenient and offer more control to the

participants as they are able to answer the survey at their own pace and at their own time without feeling being rushed, which provide higher objectivity to the results due to that interruption may possibly influence their thinking process and subsequently sway their answers and eventually produce inaccurate results. Last but not least, participants will feel more at ease answering online surveys because of anonymity, knowing their identity will not be known by public leads them to writing more truthful answers (Sutherland, 2019). Since the current project involves victims of cyberbullying, such advantage has proved that online survey is a solid method.

5.1.2 Interview

Interview is another data gathering technique that involves verbal conversation between the interviewer and the interviewee. Interview by nature is targeted towards extracting qualitative data regarding certain topics or subject being studied as open-ended questions are typically asked. In interview, the interviewee will be able to express their words towards the matter discussed in more detail based on their experiences, beliefs, opinion and attitudes, permitting the interviewer to acquire in-depth information that may unveil unexplored or unknown ideas and knowledge. As far as the researcher concerns, there are three types of interview: Structured interview, semi-structured interview and unstructured interview. In structured interview, the questions listed are fixed and no additional details will be probed towards the interviewee, such interviews are generally applicable when an extensive list of interview questions has been identified. Meanwhile in semi-structured interview, it is basically structured interview except for the fact that more questions can be asked against the interviewee to further comprehend certain area of topics discussed as the interviewee might brought up interesting remarks that can be beneficial to explore (Statistics Solutions, 2021). Lastly, unstructured interview is considered to be the least practical interview type from the research perspective as no questions are prepared beforehand, even though it provides the most flexibility, different questions enquired to different interviewees can impose great challenges for analysis and comparison purpose (Lumen Learning, 2020). There are many methods interviews can be conducted, the most common ones include face-to-face interview and online interview.

As for the current project, the interview will be conducted on the target users of the proposed system which involve two parties: cyberbullying-focused government agencies and emotional support-focused NGO in Malaysia, hence these two are regarded as the population for the interview data collection method. As for the sampling technique, the judgmental sampling

technique is regarded as the most suitable and logical technique because the organisations and members selected must be relevant to the objectives defined. As for the sample size, one member from MyCERT, MCMC, Childline Foundation and Vanguards4Change will be sufficient to represent the population. Despite that interviews are conducted for different parties, the overall objectives of the interviews are to acquire greater insights on the prevalence of cyberbullying from their perspective, their domain itself and most importantly, their opinions and requirements for the proposed system.

Interview is regarded as the most suitable data collection technique for this scenario as they are the target users for the system, therefore in-depth information regarding the system requirements must be retrieved so that the system functionalities and features suit their needs as close as possible. To ensure the researcher can gain as much information as feasible from the interview sessions, semi-structured interview will be employed so as to allow the interviewer to probe additional details from the interviewee to better understand the subject matter discussed. Semi-structured interview also allows the interviewer to prepare and standardise the questions beforehand so as to guarantee the questions do provide significant value to the research outcome meanwhile enabling the interviewer to ask the questions in a consistent manner (QuestionPro, 2021d). Moreover, interview prevents misunderstanding and misinterpretation as obscure questions or responses can be cleared up at that instant unlike survey. Interview sessions also nurture relationship between the interviewer and interviewee if conducted well. Although slightly, closer relationship may influence the interviewee to be open up towards the interviewer and leads to more detailed and expressive answers, thus adding greater value to the research outcome. Apart from that, interviews especially online and telephone interviews cost lesser compared to most methods (Rashid and Bappi, 2013; Suttle, 2019), which suits the current project circumstances as the project has limited resources. Although interview generally takes longer time to conduct, the current research only interviews few participants, hence will not be a huge concern nor detrimental to the project.

5.2 Design

5.2.1 Survey

Before the survey is distributed, the potential victims and bystanders are first identified amongst the researcher personal networks. Once these two individuals are identified, the Google Forms URL link to the online survey will be given to them to complete. As soon as they completed the survey, these two individuals will be inquired to determine whether they recognise anyone who fits the description of the population that may willing to participate the research study. After that, the researcher will reach out to the suggested individuals to ask for their inclination to fill in the survey. The cycle continues until a sample size of 40 has been achieved. In the survey, there are several closed-ended and open-ended questions which amounts to around 34 questions. The data gathered will then be studied and analysed using charts or categorisation for the purpose of understanding the Malaysian victims' emotion towards cyberbullying experiences, the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and language presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system in better handle cyberbullying incidents in Malaysia. Before they can start fill in the survey, the participants will first be informed with the details of the project and objectives of the survey. After that, they will also be prompted to provide consent for their participation so as to ascertain they have fully grasped the terms and conditions imposed on the survey. The participant may leave their email as well only if they want to be debriefed about the study and survey results.

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

Dear participant,

Thank you sincerely for partaking in the survey. My name is Hoh Kok Young and am currently pursuing a degree in software engineering at Asia Pacific University of Technology & Innovation (APU).

The current survey is conducted for my final year project "Code-Switching Cyberbullying Detection and Communication System in Malaysia". The aim of this project is to develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government authorities and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets (Text-based only) generated on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia. The system revolves around two main components; Monitoring and communicating. The users will first be able to monitor detected public cyberbullying tweets on Twitter, the users can then provide warnings to cyberbullies and offer counselling session for victims if desired.

The outcome of this survey will contribute to the understanding of the Malaysian victims' emotion towards cyberbullying experiences and the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and languages presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system or the government and NGOs' strategies in better handle cyberbullying incidents in Malaysia. Your participation in this survey will contribute to this project significantly in developing a well-rounded system for the greater good of Malaysian citizens. All the data gathered from this survey will be used as a reference to carry out project analysis and requirements gathering.

Figure 27: Project and Survey Details – Part 1

This survey is conducted solely for academic purposes. This survey takes roughly 10 to 15 minutes to complete. Your participation in this survey is absolutely voluntary and all the responses collected will be strictly confidential, which could and will solely be accessible by the researcher, the project supervisor and the project examiner (Second marker). Moreover, Your responses will also not be associated with any personal identifiable information. Furthermore, the survey does not impose any risks (either physical or psychological distress or discomfort) to the participant. Most importantly, you are given the opportunity and the right to withdraw from the survey at any time and for any reasons.

Your honest responses in this questionnaire are highly appreciated. If you have any inquiries or concerns regarding the survey, please do contact me via email; tp046085@mail.apu.edu.my or phone; +60123429617.

Thank you once again for committing your valuable time and effort.
Sincerely,
Hoh Kok Young
Third Year Degree Student of APU
tp046085@mail.apu.edu.my
+60123429617

* Required

Figure 28: Project and Survey Details – Part 2

Survey Participant Agreement

Before completing the survey, you understand that:
1. The survey only accepts participants who are Malaysian, aged 18 or above and have either experienced or witnessed cyberbullying.
2. The survey is conducted for academic purpose only.
3. The survey does not impose any risks to the participant (Either physical or psychological distress or discomfort).
4. You are completely voluntarily participating in the current survey which you are required to provide some basic personal information and your honest opinion towards the topic.
5. Your responses will be strictly confidential, which could and will solely be accessible to the researcher, the project supervisor and the project examiner (Second marker).
6. Your responses will not be associated with any personal identifiable information.
7. You have the right to withdraw from the survey at any time for any reason.
8. You have the right to decide whether you want to be debriefed about the study and survey results after completing the survey.

Please ensure that you have read, understood and well-informed about the information of the project and survey.

Figure 29: Survey Participant Agreement – Part 1

Survey Participant Agreement *

☐ I hereby acknowledge that I have read, understand and agree with the terms and conditions of the survey.

Figure 30: Survey Participant Agreement – Part 2

Please enter your email here if you would like to be debriefed about the study and survey results.

Your answer

Figure 31: Email for Debrief Purpose

The survey contains several sections, each section contains sets of questions that fulfill different purpose that has significant contribution to the research outcome.

5.2.1.1 Section A

The first section of the survey consists of questions asking fundamental data about the participant including the demographic data, social media currently using, and the role participant played in cyberbullying incidents. There are a total of six questions in this section.

1. Gender *

○ Male

○ Female

Figure 32: Section A - Question 1

The first question involves the participant to inform their gender. This purpose of this question being asked is to identify the number of males and females participated the survey. Obtaining such information can help in indicating the gender that are more subjected to cyberbullying incidents in Malaysia.

2. Age Group *

- 18 - 24
- 25 - 31
- 32 - 38
- 39 - 45
- 45 or above

Figure 33: Section A - Question 2

The second question involves the participant to inform their age group. The purpose of this question being asked is to identify the number of each age group participated the survey. Obtaining such information help the researcher in understanding which age group is more familiar to the phenomenon of cyberbullying occurred in the cyberspace. This information may also be useful to future researchers in comprehending the range of coverage of the current research.

3. Race *

- Chinese
- Malay
- Indian
- Other:

Figure 34: Section A - Question 3

The third question involves the participant to inform their race. This purpose of this question being asked is to identify the number of each race participated the survey. Obtaining participants' race assists the researcher in identifying the race coverage of the current survey in terms of representativeness of the population. Due to the fact that different race may produce different survey results, understanding mentioned information help the researcher and future researchers in comprehending the limit of the current study.

4. Which state are you located at? *

- Selangor
- Sabah
- Sarawak
- Johor
- Perak
- Pahang
- Negeri Sembilan
- Kelantan
- Kedah
- Perlis
- Malacca
- Penang
- Terengganu
- Kuala Lumpur
- Labuan
- Putrajaya

Figure 35: Section A - Question 4

The fourth question involves the participant to inform their state they located at. This purpose of this question being asked is to identify the number of participants for each location who partake in the survey. Obtaining participants' location helps the researcher in identifying the location coverage of the current survey in terms of representativeness of the population. Due to the fact that different location may produce different survey results, understanding mentioned information help the researcher and future researchers in comprehending the limit of the current study.

5. Which social media are you currently using? *

- [ ] Facebook
- [ ] Twitter
- [ ] Instagram
- [ ] Youtube

Figure 36: Section A - Question 5

The fifth question involves the participant to inform their currently using social media. This purpose of this question being asked is to identify the popular social media currently being surfed by Malaysians. Since popular social media has greater messages flow that can lead to higher occurrences of cyberbullying incidents, obtaining such information helps the researcher in identifying whether most Malaysians uses Twitter, which justifies the project to continue focus on developing the proposed system to monitor cyberbullying messages on Twitter. The reason why other social media are also inquired in this question is to identify whether other social media are also popular amongst Malaysians, which can then be considered as future enhancement for the proposed system to monitor other social media.

6. Please select the role in cyberbullying incidents you associate with the most. *

Bystanders are ones who witnessed cyberbullyings.

- ( ) Victim
- ( ) Bystander

Figure 37: Section A - Question 6

The sixth question involves the participant to inform their role in cyberbullying incident they relate the most. Since one can be victim and bystander to cyberbullying at the same time, enquiring who they associate the most can help identifying their role precisely, hence providing more accurate results to the study. The purpose of the question being asked is to identify the ratio of bystanders and victims in Malaysia. Obtaining such information helps the researcher in identifying the severity of cyberbullying in Malaysia, which further justify the implementation of the proposed

system. The question also helps identify the role of the participant so they will be redirected to different sets of questions on the next section.

5.2.1.2 Section B

The second section of the survey contains questions that are slightly different between the victims and the bystanders. Although the survey for both parties involves questions asking their reporting tendencies to cyberbullying incidents and their reasons to fulfill one of the research objectives which is identifying the willingness of Malaysian victims and bystanders to report cyberbullying incidents, there is an extra question that inquire victim's emotion when they were cyberbullied not only to identify Malaysian victims' emotion towards cyberbullying experiences, but also to evaluate whether the sample of the current size matches the findings of previous studies. There are a total of three questions for the victims and two questions for the bystanders.

5.2.1.2.1 Victim

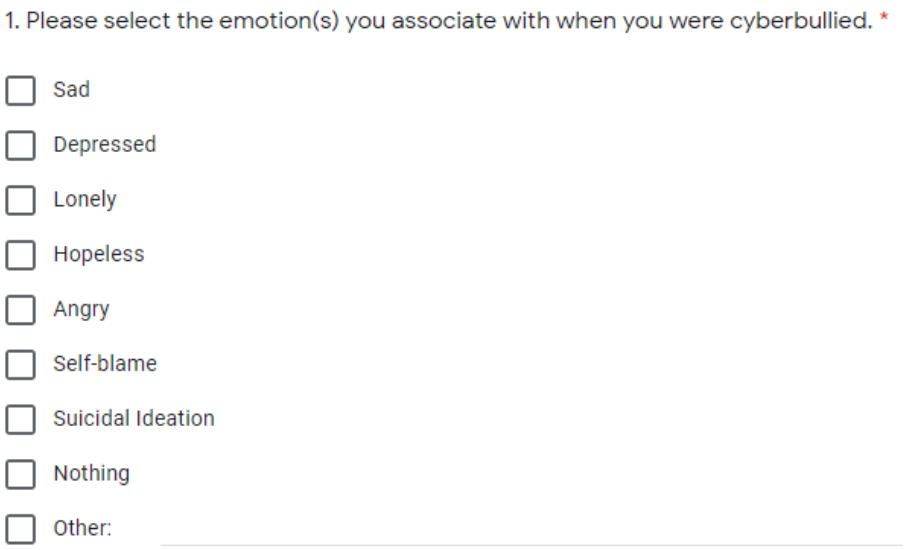


Figure 38: Section B Victim - Question 1

The first question involves the participant to inform their emotions they associate when they were cyberbullied. Through such questioning, the researcher can know whether Malaysia victims are afflicted with any affective disorders which was discovered in previous research, which helps validate if cyberbullying still induce the same effects throughout the years regardless of locations.

Depending on the severity of the results, it may as well indicate the urgency and significance on the implementation of the proposed system.

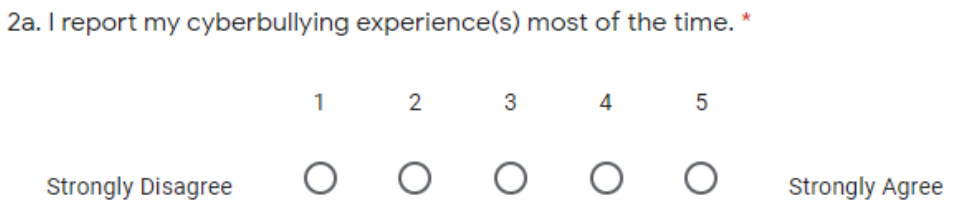


Figure 39: Section B Victim - Question 2a

The second question involves the participant to inform their tendencies to report their cyberbullying experiences. The purpose of the question being asked is to understand whether most cyberbullying experienced are reported by the victims. Obtaining such information helps the researcher in proving the hypothesis of whether there are cases of cyberbullying that go unnoticed, which legitimise the importance of monitoring cyberbullying messages in social media for the purpose of controlling cyberbullying incidents in Malaysia. The information retrieved can as well be validated against the previous studies to verify whether this phenomenon in Malaysia still holds after years.

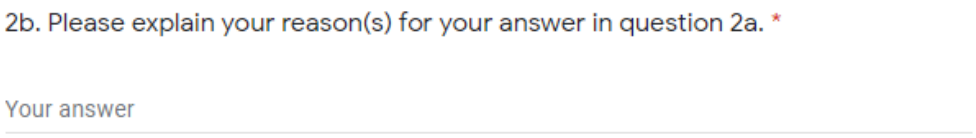


Figure 40: Section B Victim - Question 2b

The third question involves the victim to inform their reasons for the answer given in previous question. Unlike other questions previously, this question is a qualitative-based question with the intention to acquire in-depth understanding as to why victims report and did not report their cyberbullying experiences. The thorough apprehension could aid the researcher in evaluating how the proposed system can or cannot help the victims and therefore able to tune the system to better help the victims or at least control the cyberbullying incident more comprehensively.

5.2.1.2.2 Bystander

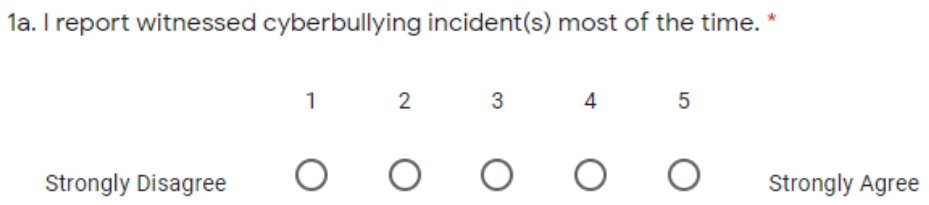


Figure 41: Section B Bystander - Question 1a

The first question involves the participant to inform their tendencies to report cyberbullying incidents they witnessed. The purpose of the question being asked is to understand whether most cyberbullying witnessed are reported by the bystanders. Obtaining such information helps the researcher in further proving the hypothesis of whether there are cases of cyberbullying that go unnoticed, which legitimise the importance of monitoring cyberbullying messages in social media for the purpose of controlling cyberbullying incidents in Malaysia. The information retrieved can as well be validated against the previous studies to verify whether this phenomenon in Malaysia still holds after years.

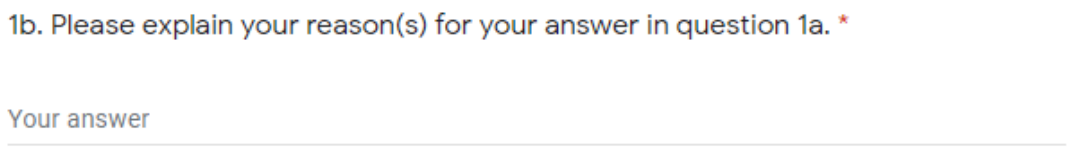


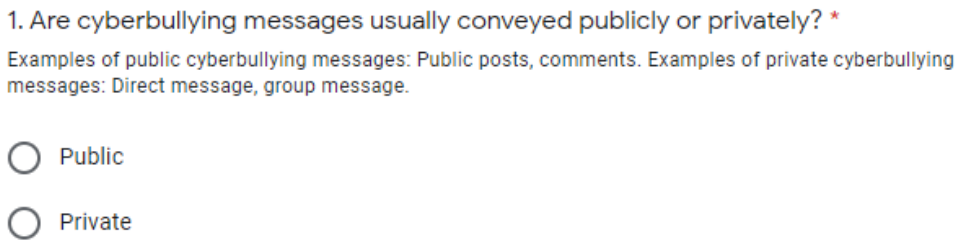
Figure 42: Section B Bystander - Question 1b

The second question involves the bystander to inform their reasons for the answer given in previous question. This question is yet again assisting the researcher to grasp deeper understanding as of why bystanders report or did not report the cyberbullying incidents they witnessed.

5.2.1.3 Section C

The third section of the survey consists questions to investigate the common patterns and language presented in cyberbullying messages in Malaysia. Achieving the objectives could help apprehend which languages to concentrate in this project when building the code-switching cyberbullying

detection system. There are a total of five questions in this section which required to be answered by both victims and bystanders.

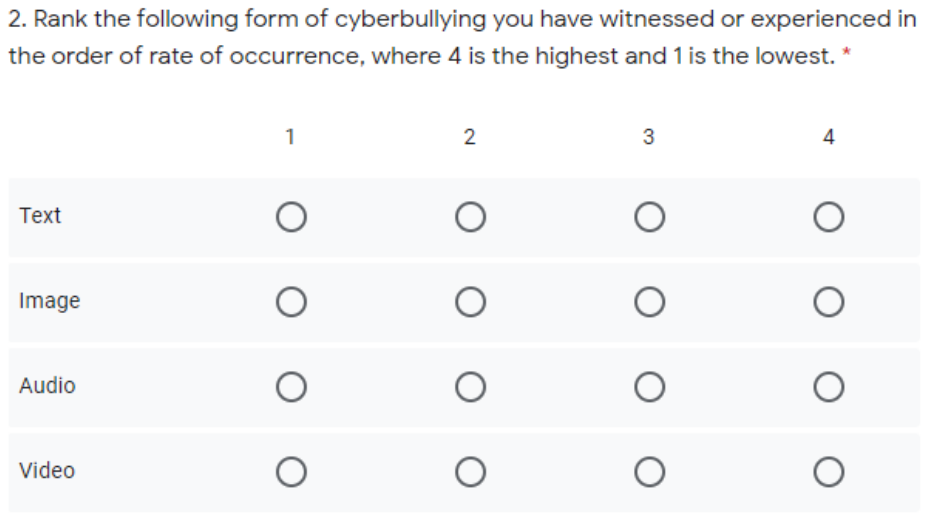

1. Are cyberbullying messages usually conveyed publicly or privately? *

Examples of public cyberbullying messages: Public posts, comments. Examples of private cyberbullying messages: Direct message, group message.

- Public
- Private

Figure 43: Section C - Question 1

The first question involves the participant to inform whether the cyberbullying messages they witnessed or experienced are mostly conveyed publicly or privately. The question aims to understand if the cyberbullying messages observed or received occur in public majority of the time so as to justify the proposition of the system implementation to effectively monitor public cyberbullying message and henceforth mitigating cyberbullying cases happening in Malaysia. If most cyberbullying messages are conveyed across privately, the system could be implemented for naught.


2. Rank the following form of cyberbullying you have witnessed or experienced in the order of rate of occurrence, where 4 is the highest and 1 is the lowest. *

	1	2	3	4
Text				
Image				
Audio				
Video				

Figure 44: Section C - Question 2

The second question involves the participant to rank the form of cyberbullying incidents witnessed or experienced. The question is asked with an objective in mind which is investigating whether

most cyberbullying messages are conveyed using text form. Understanding said fact assist in validating the implementation of the proposed system to monitor text-based cyberbullying tweets. The question can as well discover other popular form of cyberbullying messages conveyed in Malaysia so that the system can accommodate other form in future enhancement.

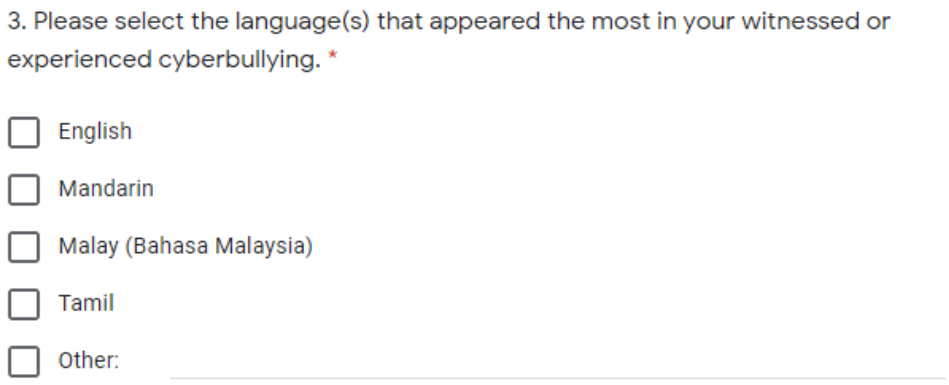


Figure 45: Section C - Question 3

The third question involves the participant to inform the languages that emerged the most in their witnessed or experienced cyberbullying incidents. Although the current project will only focus on code-switching cyberbullying messages, the inquiring of this question complements the Question 4b in which it later helps the researcher in identifying whether the prevalence of certain languages in cyberbullying messages directly dictates the regularity of code-switching cyberbullying messages between those popular languages.

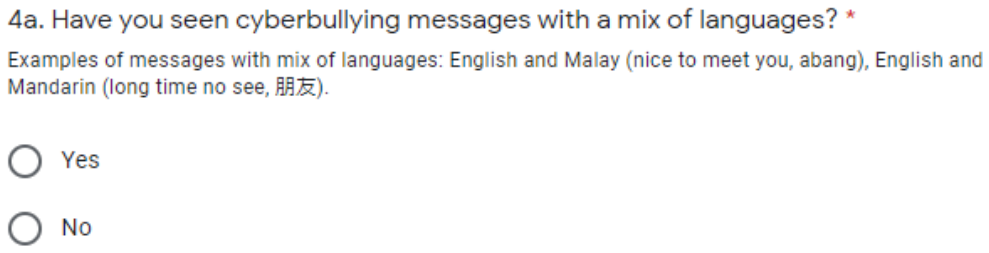
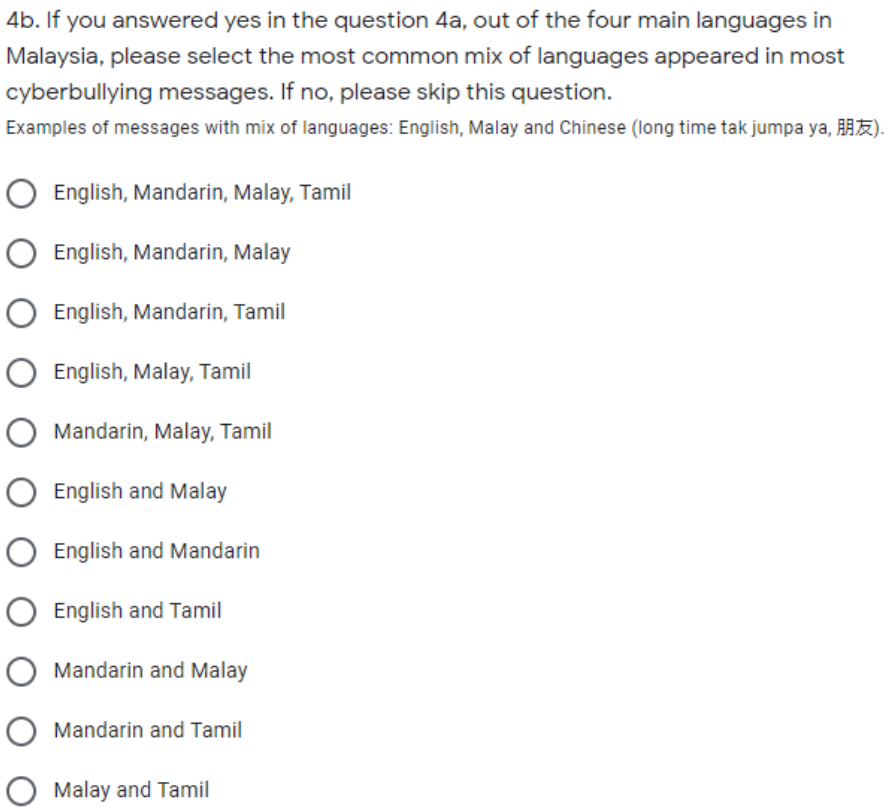


Figure 46: Section C - Question 4a

The fourth question involves the participant to inform whether they have seen mix of languages or essentially code-switching in cyberbullying messages. Based on the data collected from this question, the researcher can verify that whether Malaysians uses code-switching in their

conversation even when cyberbullying others, which helps the researcher to understand if the need of code-switching cyberbullying system exists or not, which contribute to filling the research gap. The information retrieved can as well be validated against the previous studies to identify whether this phenomenon in Malaysia still holds after years.


4b. If you answered yes in the question 4a, out of the four main languages in Malaysia, please select the most common mix of languages appeared in most cyberbullying messages. If no, please skip this question.

Examples of messages with mix of languages: English, Malay and Chinese (long time tak jumpa ya, 朋友).

- English, Mandarin, Malay, Tamil
- English, Mandarin, Malay
- English, Mandarin, Tamil
- English, Malay, Tamil
- Mandarin, Malay, Tamil
- English and Malay
- English and Mandarin
- English and Tamil
- Mandarin and Malay
- Mandarin and Tamil
- Malay and Tamil

Figure 47: Section C - Question 4b

The last question in this section involves the participant who have seen code-switching cyberbullying messages to inform the most common mix of languages out of the four main languages in Malaysia they seen that emerged in most cyberbullying messages. Despite the similarity between this question and question number three, the popularity between two languages may not imply that these two languages will appear concomitantly in either normal conversation or cyberbullying messages majority of the time. Through such questioning, the researcher will be able to pinpoint which code-switching language is the most prevalent in Malaysia as of current, so that the researcher can prioritise which code-switching language should the proposed system be monitoring on, which essentially helps filling the research gap too. The other popular code-

switching languages discovered after the data has been fully collected and analysed can be considered as future improvement as well.

5.1.2.4 Section D

The last section of the survey focuses on investigating the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs as well as the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents. There is a mix of both quantitative and qualitative-based questions in this section which amount up to 17 questions in total. Most of the questions in this section are for both victims and bystanders except for few of them in which are specifically for victims only as these questions are only logical to be answered by them.

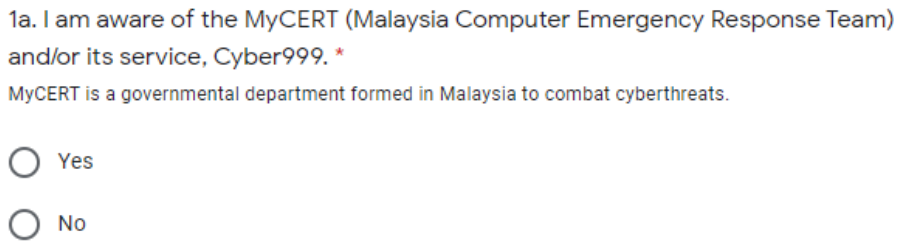


Figure 48: Section D - Question 1a

The first question involves the participant to inform their awareness and recognition of MyCERT or its service, Cyber999. As the main problem identified in this project being the prevalence of cyberbullying incidents in Malaysia despite the current approaches and strategies established, the question intends to determine the effectiveness of MyCERT and its reporting service, Cyber999 by understanding the citizens of Malaysians' awareness of these two key elements. The question is asked with the assumption that most Malaysians will not be aware of them which signifies the obsolescence and futility of such platform and service, therefore further justifies the statement that proactiveness from authorities and NGOs through the help of proposed system is important to reduce cyberbullying incidents in Malaysia.

1b. If you answered yes in question 1a, have you used MyCERT's service, Cyber999 to report a cyberbullying incident? If you answered no in question number 1a, please skip to question number 2a.

- ◯ Yes
- ◯ No

Figure 49: Section D - Question 1b

The second question involves the participant who were aware of the MyCERT or its service, Cyber999 to inform their tendencies to use said service. Based on the statistical analysis on the answers gathered for the question above, the researcher may gain insights on whether people use the available service provided or not. The ineffectiveness of the service in alleviating cyberbullying cases in Malaysia can be conclusively measured and proven based on the number of people who did not use the service.

1c. Please explain your reason(s) for your answer in question 1b.

Your answer

Figure 50: Section D - Question 1c

The third question involves the participant who were aware of the MyCERT or its service, Cyber999 to inform their reasons for the answer given in previous question. Such qualitative question is asked to gather in-depth insights on why the participants did or did not use the service, which may reveal interesting facts as to why such service is useful or not.

2a. I am aware of any NGOs (Non-Governmental Organisation) in Malaysia that offer emotional support. *

- ◯ Yes
- ◯ No

Figure 51: Section D - Question 2a

The fourth question involves the participant to inform their awareness and recognition of emotional support-focused NGOs. Due to the fact that one of the problems identified that heavily inspired the proposition of the current project being ineffectiveness of these NGOs that provide helpline services because most Malaysians are unaware of them, through this question, the researcher will be able to apprehend whether these NGOs in Malaysia throughout the years has gained enough traction amongst the citizens. Else, it implies that there are victims out there that could be suffering in silence and does not know where to reach out for support. Therefore, such fact can help legitimise the effectiveness and the practicality of the proposed system.

2b. If you are a victim and answered yes in the question 2a, have you ever contacted one of the NGOs to request a counselling session after being cyberbullied? If you are a bystander or answered no in question number 2a, please skip to question number 3.

- ◯ Yes
- ◯ No

Figure 52: Section D - Question 2b

The fifth question involves the victim of cyberbullying who were aware of the emotional support-focused NGOs to inform their tendencies to use these helpline service to request for counselling support after being cyberbullied. This quantitative question can provide the statistics concerning the number of victims who did or did not contacted them for counselling help, even though may not offer many insights because those who did not contact the NGOs may not feel as sensitive as others to the cyberbullying messages, thus there are no need for them to reach out for help, however, the next question will complement the current question to acquire in-depth understanding regarding the results obtained.

2c. Please explain your reason(s) for your answer in question 2b.

Your answer

Figure 53: Section D - Question 2c

The sixth question involves the victim of cyberbullying who were aware of the emotional support-focused NGOs to inform their reasons for contacting or not contacting these NGOs to request for counselling session. Based on the qualitative data collected in this question, the researcher may gather extensive understand on the victims' behaviour and thoughts that influence their decision on seeking for help from these NGOs. These perceptive data can help the researcher in recognising how the proposed system can or cannot help the victims.

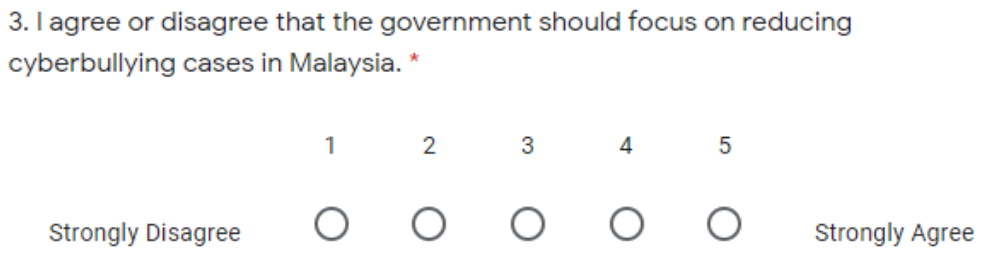


Figure 54: Section D - Question 3

This question involves the participant to inform their degree of agreement or disagreement regarding the government's effort in mitigating and alleviating cyberbullying cases in Malaysia. The statistical analysis of the data collected from this question will aid the researcher in determining the general Malaysians' opinion on whether the governmental bodies should take part in handling the cyberbullying cases in Malaysia, hence indicating that they recognise cyberbullying as one of the concerning issues in Malaysia as of current and government has the responsibility to combat them.

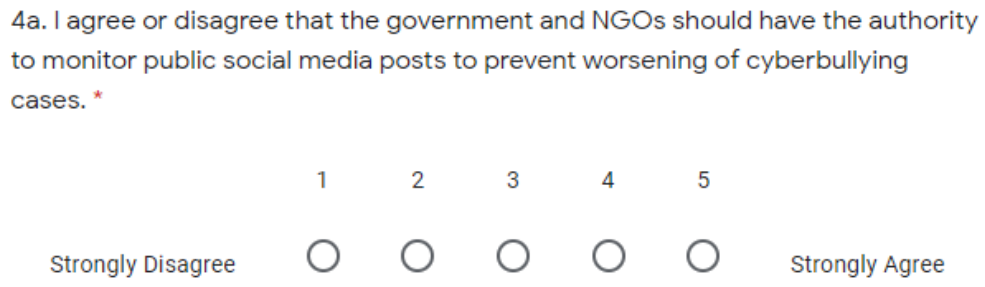


Figure 55: Section D - Question 4a

This question involves the participant to inform their degree of agreement or disagreement regarding the government and NGOs' authority in monitoring public social media posts for the purpose of preventing worsening of cyberbullying cases. Through the answers collected, the researcher can identify the whether the general public in Malaysia feels comfortable in being monitored for their public social media posts solely for reducing cyberbullying cases, therefore legitimising the proposition of the system for the current project.

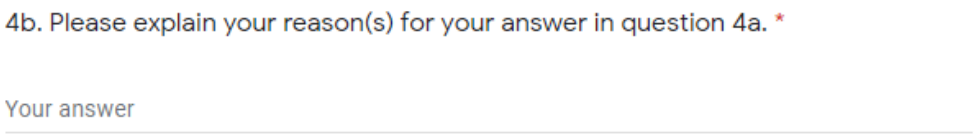


Figure 56: Section D - Question 4b

This question involves the participant to inform their reasons for the answer given in previous question. Such questioning helps to collect insightful data on public's in-depth opinion behind the fact of being monitored for the purpose of reducing cyberbullying occurrences in Malaysia, hence may explore ways in improving the proposed system to be more efficacious.

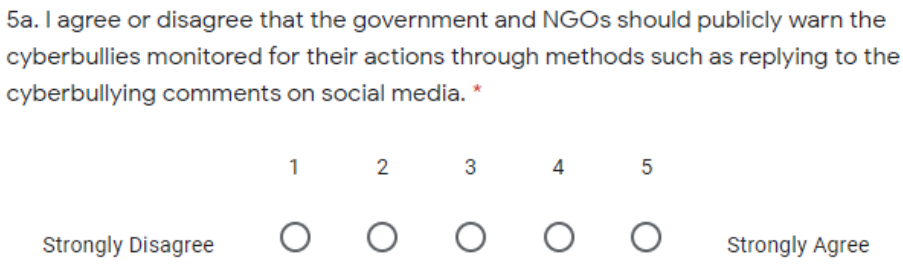


Figure 57: Section D - Question 5a

This question involves the participant to inform their degree of agreement or disagreement regarding the government and NGOs in warning the cyberbullies publicly in social media for their actions. This question is enquired because not everyone in Twitter will activate the option to permit "strangers" to Direct Message them, therefore the system users may resort to warn the cyberbullies publicly. Based on the opinion gathered, the researcher can evaluate on whether warning cyberbullies publicly would be wise or not, hence assist in gauging the effectiveness of the proposed system feature of warning cyberbullies through replying to their tweets.

5b. Please explain your reason(s) for your answer in question 5a. *

Your answer

Figure 58: Section D - Question 5b

This question involves the participant to inform their reasons for the answer given in the previous question. The qualitative answers collected from this question will aid the researcher to disclose the in-depth reasons as to why cyberbullies should be warned publicly or not for their actions, which the information can then be applied in assessing the proposed system in terms of the features and decide whether to maintain, improve or discard the feature.

6a. I agree or disagree that the government and NGOs should privately warn the cyberbullies monitored for their actions through either a phone call, SMS or personal messaging in social media. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Figure 59: Section D - Question 6a

This question involves the participant to inform their degree of agreement or disagreement regarding the government and NGOs in warning the cyberbullies privately in social media for their actions. Based on the opinion gathered, the researcher can evaluate on whether warning cyberbullies privately would be wise or not, hence assist in gauging the effectiveness of the proposed system feature of warning cyberbullies through Direct Message (DM), phone call or SMS.

6b. Please explain your reason(s) for your answer in question 6a. *

Your answer

Figure 60: Section D - Question 6b

This question involves the participant to inform their reasons for the answer given in the previous question. The qualitative answers collected from this question will aid the researcher to disclose the in-depth reasons as to why cyberbullies should be warned privately or not for their actions, which the information can then be applied in assessing the proposed system in terms of the features and decide whether to maintain, improve or discard the feature.

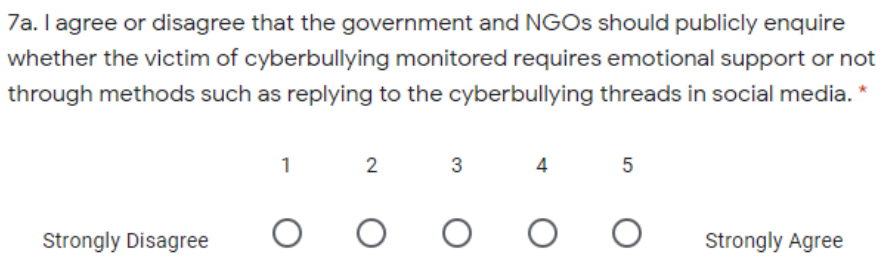


Figure 61: Section D - Question 7a

This question involves the participant to inform their degree of agreement or disagreement regarding the government and NGOs in enquiring the need of emotional support to the victims publicly in social media. This question is enquired because not everyone in Twitter will activate the option to permit "strangers" to Direct Message them, therefore the system users may resort to offer emotional support to the victims publicly. Based on the opinion gathered, the researcher can evaluate on whether enquiring the necessity of emotional support to the victims publicly would be wise or not, hence assist in gauging the effectiveness of the proposed system feature of replying to their tweets to offer emotional support.

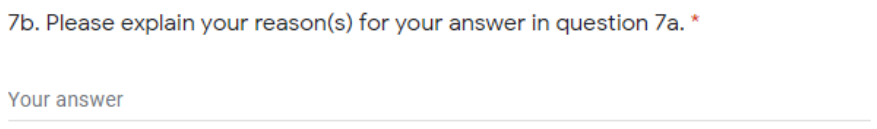


Figure 62: Section D - Question 7b

This question involves the participant to inform their reasons for the answer given in the previous question. The qualitative answers collected from this question will aid the researcher to disclose the in-depth reasons as to why cybervictims should be offered emotional support publicly or not,

which the information can then be applied in assessing the proposed system in terms of the features and decide whether to maintain, improve or discard the feature.

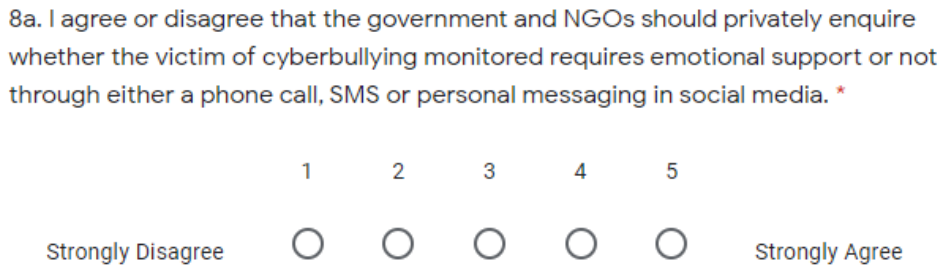


Figure 63: Section D - Question 8a

This question involves the participant to inform their degree of agreement or disagreement regarding the government and NGOs in enquiring the need of emotional support to the victims privately in social media. Based on the opinion gathered, the researcher can evaluate on whether enquiring the necessity of emotional support to the victims privately would be wise or not, hence assist in gauging the effectiveness of the proposed system feature of Direct Message, calling or SMS victims to offer emotional support.

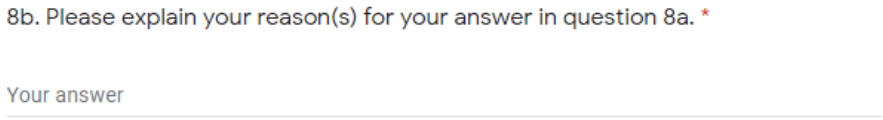


Figure 64: Section D - Question 8b

This question involves the participant to inform their reasons for the answer given in the previous question. The qualitative answers collected from this question will aid the researcher to disclose the in-depth reasons as to why cybervictims should be offered emotional support privately or not, which the information can then be applied in assessing the proposed system in terms of the features and decide whether to maintain, improve or discard the feature.

9. Please state your suggestions to what else should the government and/or NGOs do to reduce cyberbullying cases in Malaysia.

Your answer

Figure 65: Section D - Question 9

This question involves the participant to inform their suggestions of what either the government or NGOs should do to help mitigating cyberbullying occurrences in Malaysia. The opinions collected will be analysed and utilised to explore ways to combat cyberbullying incidents in Malaysia not only in the proposed system perspective but also in the general perspective so that the summarised information may be informed to either parties for them to ameliorate their strategies.

5.2.2 Interview

To conduct the interviews, relevant members from MyCERT, MCMC, Childline Foundation and Vanguards4Change will first be contacted through email or phone call to acquire approval for the interview session. Once the approval has been obtained, the date, time and the method (Face-to-face, online or telephone) for each interview session will be decided. Although the questions designed for these parties are slightly different, the objectives are still the same regardless, which is to acquire greater insights on the prevalence of cyberbullying cases in Malaysia from their perspective, their domain itself in handling cyberbullying incidents and their opinion and requirements for the proposed system. To achieve the first two objectives, government agencies and NGOs will be asked four and five unique questions respectively. As for the last objective, both parties will be inquired the same set of ten questions. The sample size of one member from MyCERT, MCMC, Childline Foundation and Vanguards4Change will be required in the interview to collect crucial information which will be analysed through the application of qualitative analysis technique so as to fulfill said objectives.

5.2.2.1 Government Agencies

Table 12: Government Agencies - Question 1

Question #1: Based on your opinion, what are the reasons behind the increase of cyberbullying incidents in Malaysia of more than two times the amount compared to last year?

Based on the statistics described in the problem context, it was illuminated that the cyberbullying cases in Malaysia has spiked for more than two times the amount as compared to last year. This question is inquired with the intention to understanding the underlying causes for the statistics given and from there, the researcher will more than likely be able to assess the proposed system's importance and urgency in alleviating cyberbullying cases in Malaysia.

Table 13: Government Agencies - Question 2

Question #2: Does MyCERT/MCMC currently has methods to identify cyberbullying threats in Malaysia other than the ones reported to your platform?

This question aims to discover whether MyCERT or MCMC consists of different mechanisms to recognise cyberbullying threats in Malaysia. The information collected will be examined to evaluate the effectiveness of these available mechanisms as well as the efficaciousness of the proposed system. The analysis result obtained will assist the researcher in determining the impact that the proposed system could bring in terms of pinpointing and alleviating cyberbullying incidents in Malaysia.

Table 14: Government Agencies - Question 3

Question #3: How do MyCERT/MCMC deal with cyberbullying incidents reported?

The purpose of this question being asked is merely to understand deeply concerning the MyCERT or MCMC's procedures taken in handling cyberbullying incidents reported, so that the researcher can grasp the knowledge on its domain more in-depth, although unexpected findings could bore fruit from this very question.

Table 15: Government Agencies - Question 4

Question #4: Does MyCERT/MCMC provide any form of help to the victims of cyberbullying and how?

The qualitative data collected from this question will help the researcher to comprehend the available form of help provided by MyCERT or MCMC to the victims of cyberbullying in detail.

This question is yet again inquired to understand their domain more in-depth, however, unique findings may be discovered.

5.2.2.2 NGOs

Table 16: NGOs - Question 1

Question #1: Based on your experiences and perspective, has cyberbullying incidents in Malaysia increases or decreases over the years?

From the answer provided to this question, the researcher will be able to measure regarding the prevalence of cyberbullying cases in Malaysia, which can help assess the need of the proposed system. However, since there could be many reasons as to why cyberbullying increase or decrease, a follow-up question shown below is inquired.

Table 17: NGOs - Question 2

Question #2: Based on your opinions and experiences, what are the possible reasons that lead to the increase or decrease of cyberbullying incidents?

As mentioned, this question is a follow-up question to the previous ones to identify the actual reasoning behind the increase or decrease of cyberbullying incidents in Malaysia, which eventually contribute to discovering unexplored insights as well as to evaluate the proposed system's importance and urgency in alleviating cyberbullying cases in Malaysia.

Table 18: NGOs - Question 3

Question #3: Based on your experiences, have any victims of cyberbullying ever expressed reluctancy to report their experiences and why?

Based on the investigations conducted on previous studies, it is discovered that there are quite the numbers of victims who did not report their cyberbullying experiences. This question is inquired to probe the NGOs on whether and why cybervictims display said behaviour. The data collected and analysed may unearth the possibility of many more victims who have yet to report their experiences to anyone and suffering in silence, which could end up with unfathomable consequences. From that information, the functionalities whereby the system can monitor and offer

counselling support will be undoubtedly to be justified as efficacious and most importantly, lifesaving.

Table 19: NGOs - Question 4

Question #4: What are the standard procedures for your NGO when approaching victims of cyberbullying who request counselling session?

Due to the fact that the proposed system consists of a feature to offer counselling support to the victims of cyberbullying, inquiring such question could help the researcher in identifying the fundamental process of approaching the victim including the careful thoughts and steps to be taken, this information can then be translated into shaping a much concrete and solid system. It helps the researcher to understand their domain more in-depth as well.

Table 20: NGOs - Question 5

Question #5: Does your NGO provide further check up on the individuals who requested counselling session previously and why?

The purpose of this question being asked is to understand whether NGOs are fundamentally allowed and proactive to inquire further on the victims' conditions and what are the benefits that could come from through these following check-ups. Through the comprehension, the researcher can effectively determine the internal structure of the system. For example, storing the information of the victims to permit continual conversation through the system or sending automatic support contact to the victims without storing their profile information.

5.2.2.3 Government Agencies & NGOs

Below is the list of questions that will be inquired to both parties after the previous questions have been asked. The proposed system is thoroughly explained in terms of its functions, its purposes and contributions before the interview session continues.

Table 21: Government Agencies & NGOs - Question 1

Question #1: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?

Based on the opinions gathered from both parties as system users, the practicality and validity of the very core function proposed in the system can be assessed, which help the deduction on whether to maintain, improve or alter the implementation.

Table 22: Government Agencies & NGOs - Question 2

Question #2: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?

Another important proposed system feature consists of warning the cyberbullies that are detected online, and the question is intended to obtain the perception of said feature from the system users to gain insights on whether the feature will bring significant impact on cyberbullies' behaviours which translates to the decrease of cyberbullying occurrences in Malaysia, therefore creating a much healthier social media environment.

Table 23: Government Agencies & NGOs - Question 3

Question #3: Do you think should the system users approach the cyberbullies publicly, privately or both?

Different approach towards the cyberbullies may have different affects. Thus, by receiving opinion from these two parties who are well-versed in the cyberbullying field, the researcher can identify which approach will bring the most value in terms of alleviating cyberbullying cases in Malaysia, and later help justifying which features (Direct Message and/or replying to tweets) to be implemented into the proposed system.

Table 24: Government Agencies & NGOs - Question 4

Question #4: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?

This is yet another system feature proposed that requires the clarification from both parties to understand their opinions and preferences on the importance of the feature. The information retrieved can assist the researcher in deciding on whether to maintain, improve or discard the feature.

Table 25: Government Agencies & NGOs - Question 5

Question #5: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?

As part of the core features proposed in the system, the qualitative answers gathered from both parties will be utilised to understand their insightful opinion regarding on whether such feature may help the vulnerable victims who were cyberbullied, providing them the support they need before they sunk into the pool of mental illness. The perceptions received will be the deciding factor of keeping, changing or removing the feature from the proposed system.

Table 26: Government Agencies & NGOs - Question 6

Question #6: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?

This is a follow-up question to the previous question to add more concrete details regarding the system feature due to the fact that cybervictims may have different reactions towards different approaches. By gathering and analysing the perceptions and expertise given by both parties, the system feature can either be maintained or even refined to better help the victims in the midst of chaotic situations.

Table 27: Government Agencies & NGOs - Question 7

Question #7: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?

Based on the analysis of the similar systems, most systems have a graphical chart of statistics with the filtering function, thus this question is formulated for the purpose of inquiring the opinions on its value that could bring towards both parties, therefore determining whether to maintain, modify or discard said feature.

Table 28: Government Agencies & NGOs - Question 8

Question #8: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?

Apart from charts, the alert function was equipped in most similar systems compared, hence the feature is deemed useful to be incorporated into the proposed system. However, this question is asked regardless to acquire genuine opinions from the actual users themselves since they will be the ones employing the system, understanding their needs and concerns will be utmost priority.

Table 29: Government Agencies & NGOs - Question 9

Question #9: What are the main quality attributes concerned do you have in the proposed system?

Features aside, the overall system attributes such as security, user experiences or performance might be of concern to the system users when they utilise the system. Therefore, this question is asked to collect and analyse their interests and worries that should be heavily considered when developing the system.

Table 30: Government Agencies & NGOs - Question 10

Question #10: Do you have any suggestions to improve the proposed system?

This is a general question inquired to gather the thoughts of both parties that will be used and processed to identify any feasible improvements that could be developed into the proposed system or even future enhancement, thus creating a well-rounded system in reducing cyberbullying occurrences in Malaysia.

5.3 Summary

In overall, the research methodology including the design of questions were attentively defined for the current research in order to acquire fruitful information. The quantitative and qualitative information analysed will be important in understanding not only the importance and impact the proposed system could bring but also the detailed specifications that should be incorporated and improved upon the system to further extends its capabilities and benefits. Without concrete methodology, the results obtained could deviate from achieving the desired objectives, which eventually delivering zero value to the current research nor project as well as wasting unnecessary amount of time and efforts, possibly forcing redoing the entire research and leading towards more resources being consumed.

The table below depicts the summarised version of the research methodology defined for the current research.

Table 31: Research Methodology Defined

Objectives	Data Collection Techniques	Population	Sampling Techniques	Sample Size
To understand the Malaysian victims' emotion towards cyberbullying experiences and the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and languages presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as	Survey	Malaysians who are 18 years old or above and either experienced or witnessed cyberbullying.	Snowball Sampling	40

suggestions that may improve the proposed system in better handle cyberbullying incidents in Malaysia.				
To acquire greater insights from cyberbullying-focused government agencies and emotional support-focused NGOs' on the prevalence of cyberbullying cases in Malaysia perspective, their domain itself in handling cyberbullying incidents and their opinion and requirements for the proposed system.	Interview	Cyberbullying-focused government agencies and emotional support-focused NGOs	Judgmental Sampling	One member from MyCERT, MCMC, Childline Foundation and Vanguards4Change

Chapter 6: Requirements Validation

The current chapter describes the detailed analysis carried out by the researcher on the data collected from both the survey and interview.

6.1 Analysis of Data

6.1.1 Survey

6.1.1.1 Section A

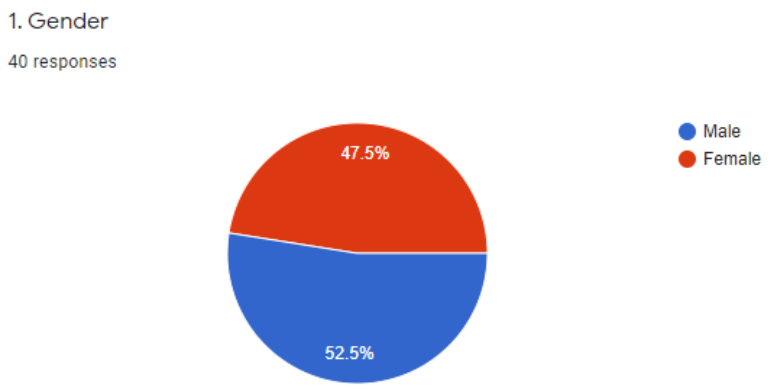


Figure 66: Analysis of Section A – Question 1

Based on the pie chart shown above, the gender ratio of the participants is fairly balanced with 52.5% being males while the other half, 47.5% are females.

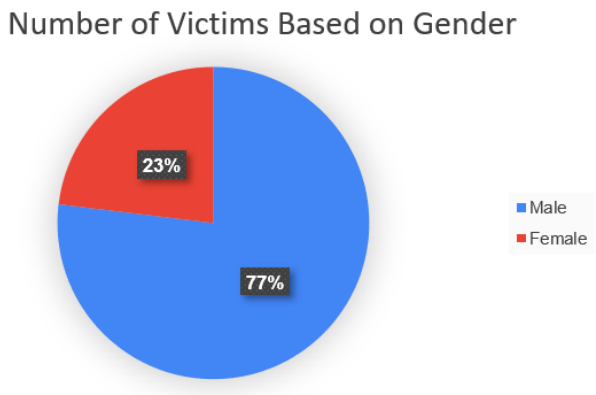


Figure 67: Ratio of Gender and Victims of Cyberbullying

Moreover, further analysis has highlighted that despite the participants who participated the survey study are almost equally balanced in terms of gender, it can be seen on the diagram above that more males (77%) are subjected to cyberbullying. This phenomenon occurrence can be assumed that the friends amongst the male participants are mostly males as well whereby they may show more aggressiveness and harshness in their speaking and behavioural manners. Extracting and disclosing this information can help future researchers in determining whether the phenomenon still holds true for different research variables such as the participants who live in other states.

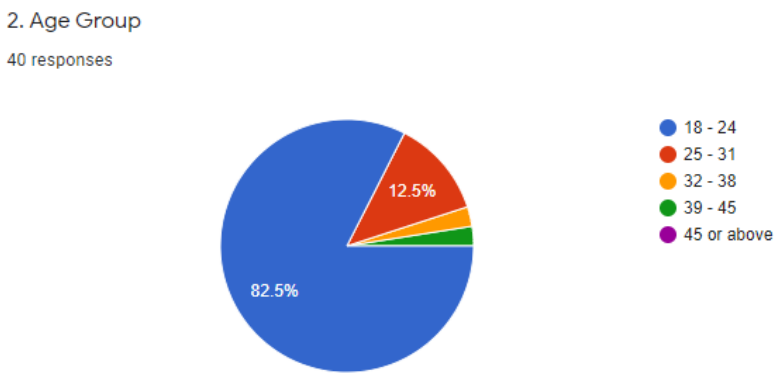


Figure 68: Analysis of Section A - Question 2

From the statistics calculated on the age group of participants, the age group of participants between 18 to 24 dominates the pie chart with a whopping percentage of 82.5% followed by 12.5% percent for the age group between 25-31. Based on the statistics displayed, it can be speculated that the younger the individuals are, the likelier they are prone or familiar to cyberbullying incidents. The information can be as well indicate the coverage of the current research, hence allowing future researchers to identify the suitability in applying the results to their research.

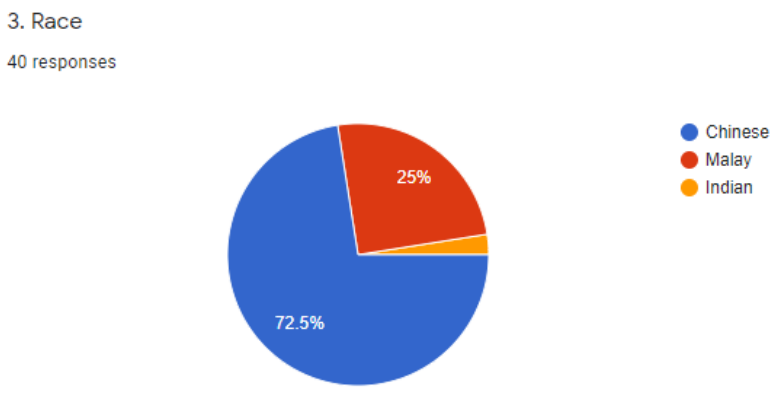


Figure 69: Analysis of Section A - Question 3

According to the results obtained on the races amongst the participants who partake in the study, the race with the most dominant percentage of 72.5% is Chinese, followed by Malay with 25% and Indian with only 2.5%. This information is extremely crucial to be reported to indicate the coverage of the current research, thus permitting future researchers to determine the suitability in applying the results to their research. The results informed can help other researchers in identifying the relationships between the survey outcome and the participants' races due to the fact that different races could affect the survey outcome.

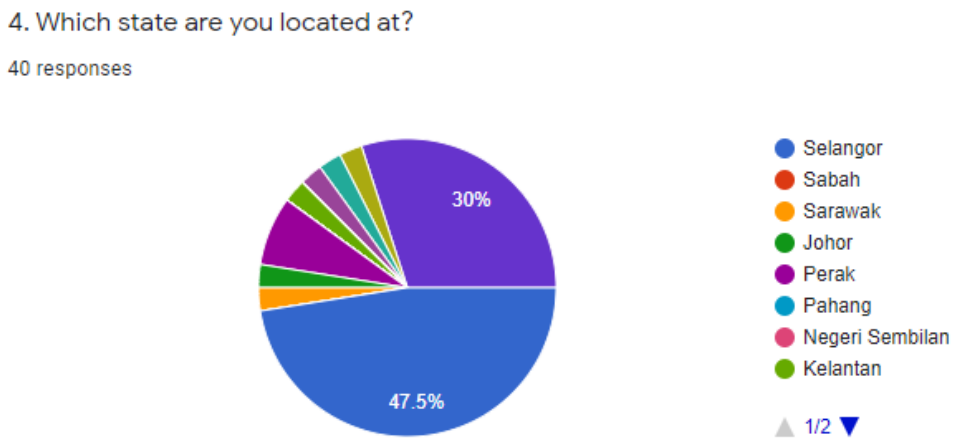


Figure 70: Analysis of Section A - Question 4

As for the states the participants in this study were located at, most participants who partake in the survey are from Selangor with the percentage of 47.5 percent. The second highest location is Kuala Lumpur, with an exact 30% of the total sample size. Additionally, 7.5% of the respondents who

answered the survey are from Perak, standing at third highest. The rest of the participants that are from Terengganu, Penang, Malacca, Kelantan, Johor and Sarawak occupies the pie chart with 2.5% each. The information reported can pinpoint the coverage of the current research, hence allowing future researchers to identify the suitability in applying the results to their research as well as understanding the relationships between the survey outcome and the participants' residing location.

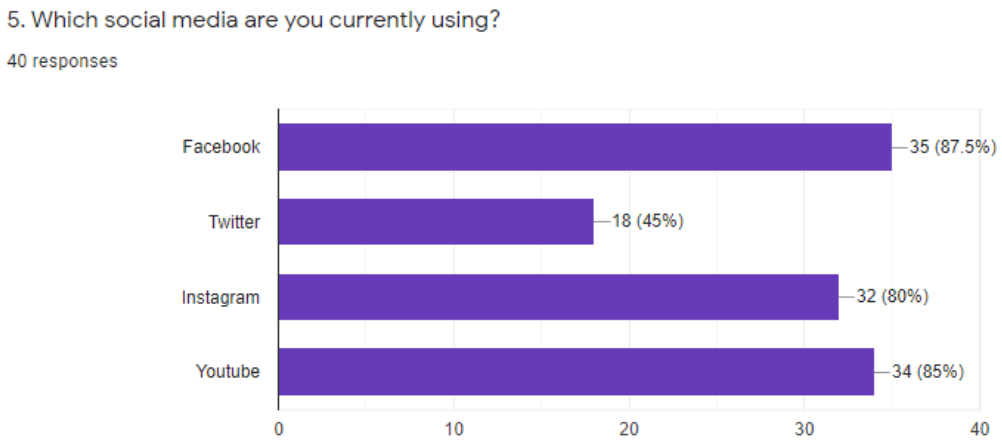


Figure 71: Analysis of Section A - Question 5

As displayed on the horizontal bar chart above, Facebook, Instagram and YouTube are the most popular social media Malaysian uses as of current with each reaching 80% or above in the statistics. It can be deduced that these social media induce more cyberbullying incidents in Malaysia because popular social media leads to higher messages flow. Although not as many Malaysians utilises Twitter which is what the current project proposed in terms of the social media selected to be monitored, there are still a fair share of 45% Malaysians who employs them currently, therefore the project will proceed as expected. Plus, upon further investigations, these dominantly used social media presently has immense limitations to the usage of its API, these limitations essentially hinder the desired functionalities to fulfill the project purposes effectively. Thus, the monitoring of these social media will be future enhancement for the proposed system once the limitations were lightened.

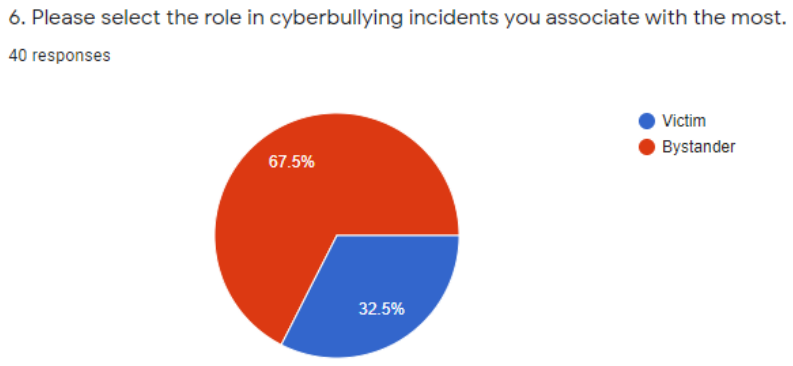


Figure 72: Analysis of Section A - Question 6

According to the pie chart on the ratio between bystanders and victims depicted above, most participants associated themselves as bystanders with percentage of 67.5%, which leaves with 13 or 32.5% of participants who relate themselves more towards victims. Based on the study made on previous study by Vimala Balakrishnan (2018), the calculated ratio between victims and bystanders to cyberbullying are roughly around 76% to 24%. This implies that the cyberbullying cases in Malaysia has gone much severe over the years due to the increase of victims. All in all, this unfortunate discovery has revealed the urgency and importance to implement the proposed system, so that cyberbullying occurrence in Malaysia can be properly controlled.

6.1.1.2 Section B

6.1.1.2.1 Victims

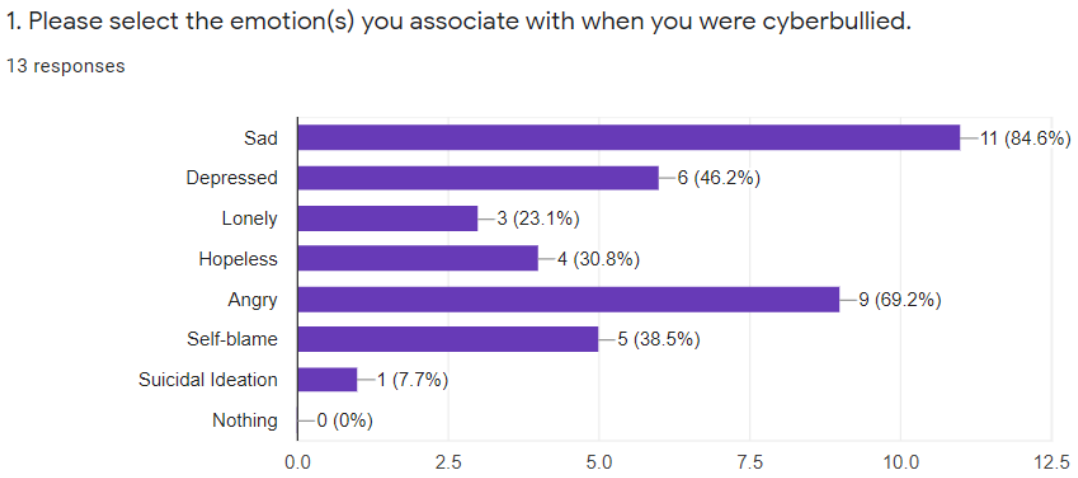


Figure 73: Analysis of Section B Victim - Question 1

As shown in the horizontal chart above, it is distinctly clear that the victims more or less are influenced by the affective disorders especially sadness and angriness with as much as 84.6% and 69.2% respectively. By comparing to the previous studies investigated, these statistics show that victims of cyberbullying regardless of locations and timeline are affected about the same. The fact that the victims who partook in the study manifest these emotions including one having suicidal ideation already proves more than enough that the cyberbullying cannot be dealt lightly, through the system proposed in this project, cyberbullying cases can be monitored and controlled meanwhile victims will be offered emotional support if desired, thus legitimising the significance to develop the system.

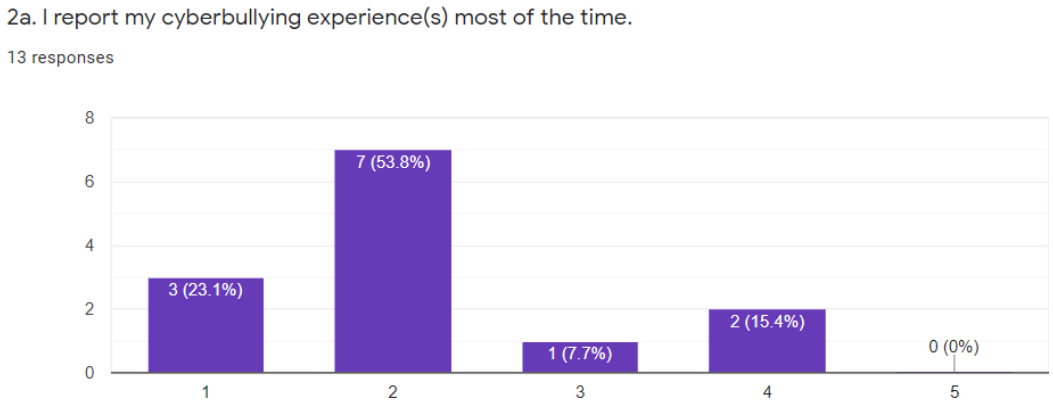


Figure 74: Analysis of Section B Victim - Question 2a

Amongst the 13 victims who participated in the research study, majority of them did not report their experiences most of the time wherein 3 (23.1%) chooses first point and 7 (53.8%) chooses second points, thus totalled up to 10 victims. This means that 76.9% of the time, victims generally do not report their cases, which is quite frightening. This very finding certifies the hypothesis that there are cases that would go unnoticed because no one was and will not be aware of them due to lack of reporting. Furthermore, instead of just verifying whether such phenomenon in Malaysia still holds after years whereby Vimala Balakrishnan (2018) concluded that 43.1% of the Malaysian victims did not report their incidents, this research has unveiled that the phenomenon became worse. There are various speculations could be made regarding the spike including the influence of the Chinese culture since most victims who partook in the study are Chinese (As shown in the figure below) or the lack of interaction between people nowadays that have shifted the behaviour of the victims or people in general to become more reserved than ever. All in all, the conclusion of this finding is that through the implementation of the proposed system, those vulnerable victims who are afraid to get help will be reached out instead, hence preventing any undesirable consequences, which ultimately justifies the significance of the system.

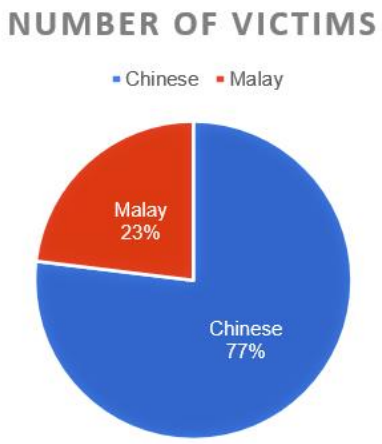


Figure 75: Ratio of Race – Number of Victims

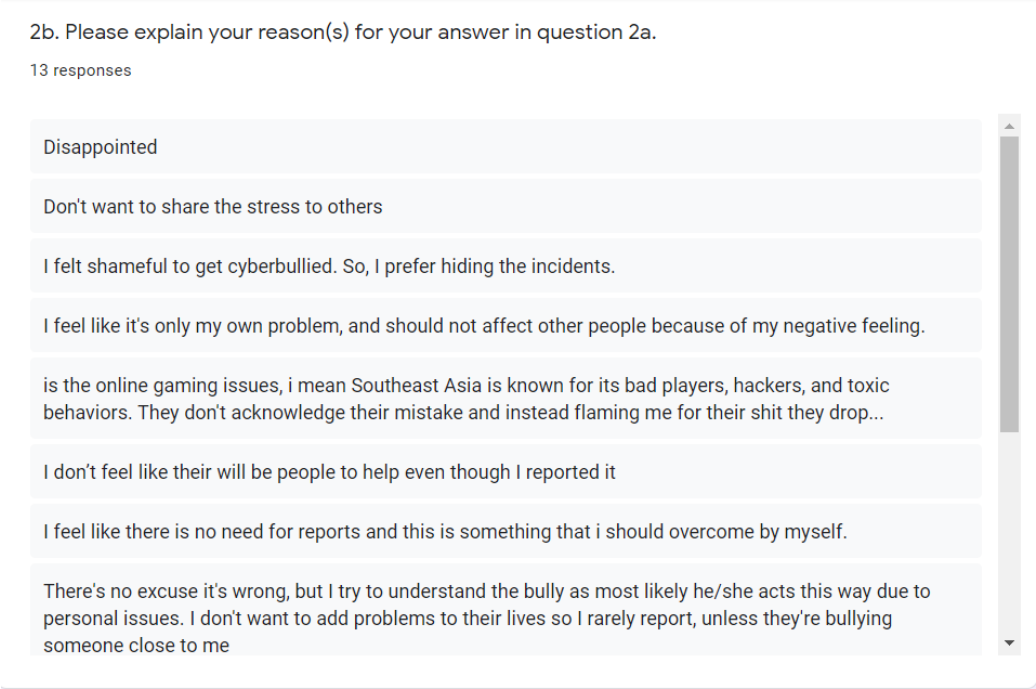


Figure 76: Analysis of Section B Victim - Question 2b

Table 32: Categorised Data of Section B Victim - Question 2b

- Shameful. - People regarded them as a joke. - Do not think it will help. - Own responsibility. - Do not know who or where to report.

- Understanding from cyberbullies' perspective.
- Having the right to report them.

According to the categorised data based on the qualitative answers given for this open-ended question, there are victims who felt shameful to report their experiences, have people regarded their experiences as a joke, do not think reporting will help deescalate the situation, think these incidents should be handled on their own or do not know who or where to report. Based on these phenomena identified, it can be confidently said that the proposed system will be able to help the victims, so that their experiences will be treated seriously and respectfully. From the qualitative data, it was observed that there are also victims who did not report because they try to understand the reason behind cyberbullies' mindset and actions as well as victims who report their experiences because they have the right to do so.

6.1.1.2.2 Bystanders

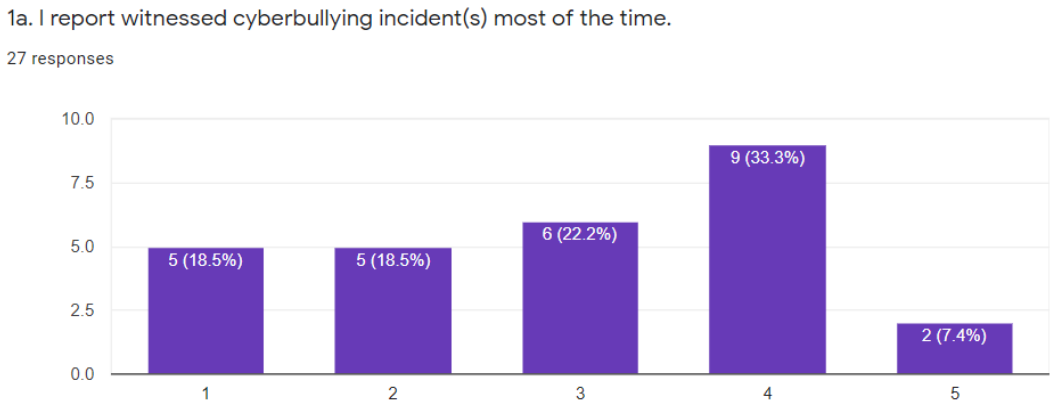


Figure 77: Analysis of Section B Bystander - Question 1a

Based on the bar chart drawn above, majority of the bystanders with percentage up to 40.7% report witnessed cyberbullying occurrences most of the time, followed by 22.2% who provided neutral answer, which can be speculated that the bystanders make decisions based on the severity of the cyberbullying occurrence perceived. Despite these facts, there are almost just as much of bystanders who did not report witnessed cyberbullying incidents most of the time as well wherein these individuals populated 37% of the charts. The finding of bystanders who did not report cyberbullying incidents aligns with the previous study conducted by Vimala Balakrishnan (2018),

whereby around 40.1% of Malaysian bystanders in overall who did nothing towards witnessed cyberbullying occurrences as well. In overall, the results yet again prove the hypothesis that there are cyberbullying incidents that are left unresolved despite the victims are in agony, which justify that the importance of the proposed system to proactively monitor these incidents instead rather than requiring others to report.

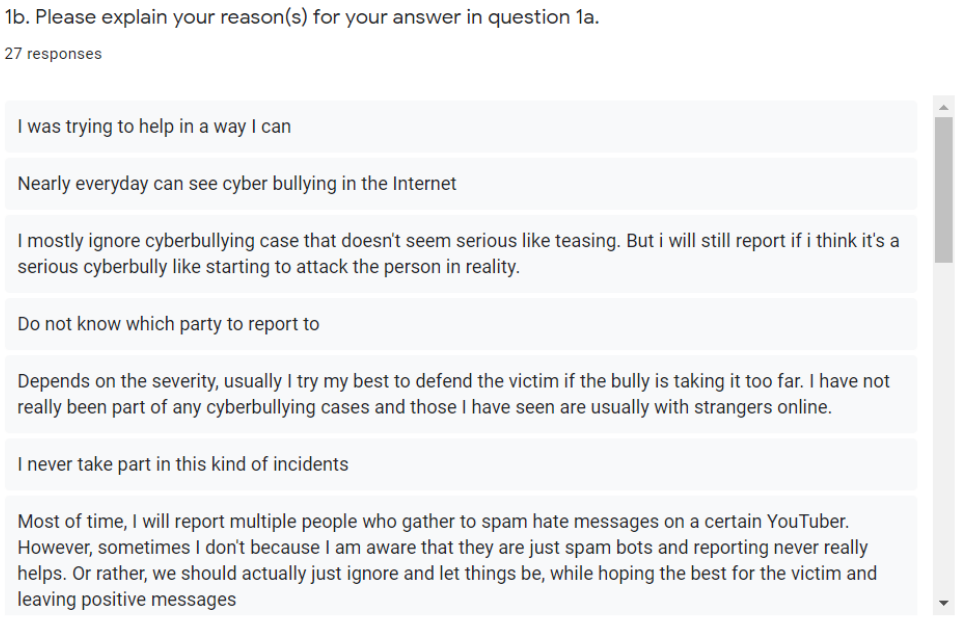


Figure 78: Analysis of Section B Bystander - Question 1b

Table 33: Categorised Data of Section B Bystander - Question 1b

- Do not know who or where to report. - Never take action. - Make decision based on the severity perceived or how acquainted the bystander is with the victim. - Help the victim.

Based on the qualitative data collected for this question, it was categorised and observed that the bystanders are either do not know who or where to report or just in general never took any action to report them. These observations help solidify and highlight the importance of the proposed system because the discovery of these cases will be handled by the system instead. Moreover, there are bystanders who make decisions based on the severity perceived or how acquainted the

bystander is with the victim. Although this implies there are cases that will be resolved, there are still cases being ignored as well, which would not be ideal because the perception of the incident by the victim who experienced them could be more heartfelt compared to the bystander who witnessed them, and only report based on the degree of acquaintances will also leave those ignored victims possibly suffering alone. Therefore, through the proposed system, the unreported cases will be identified instead. From the answers given, there are definitely bystanders who report most cases with the intention to help the victims too.

6.1.1.3 Section C

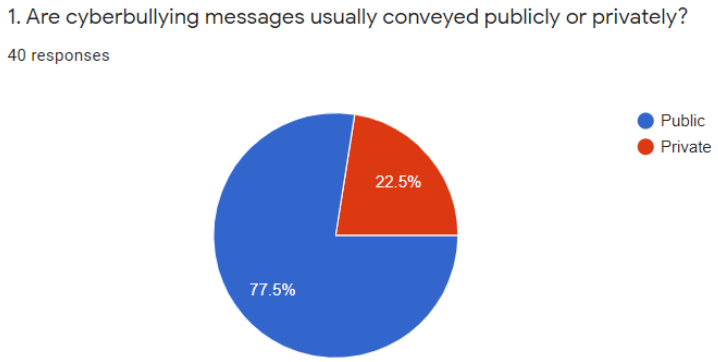


Figure 79: Analysis of Section C - Question 1

According to the pie chart shown above, it can be evidently observed that majority of the participants witnessed or received publicly transmitted cyberbullying messages with a dominating percentage of 77.5%, leaving only 22.5% of participants who thinks otherwise instead. Due to the fact that most cyberbullying messages are conveyed publicly, the implementation of the proposed system can be proceeded so as to monitor public cyberbullying message effectively and efficiently for the overall purpose of mitigating cyberbullying cases in Malaysia.

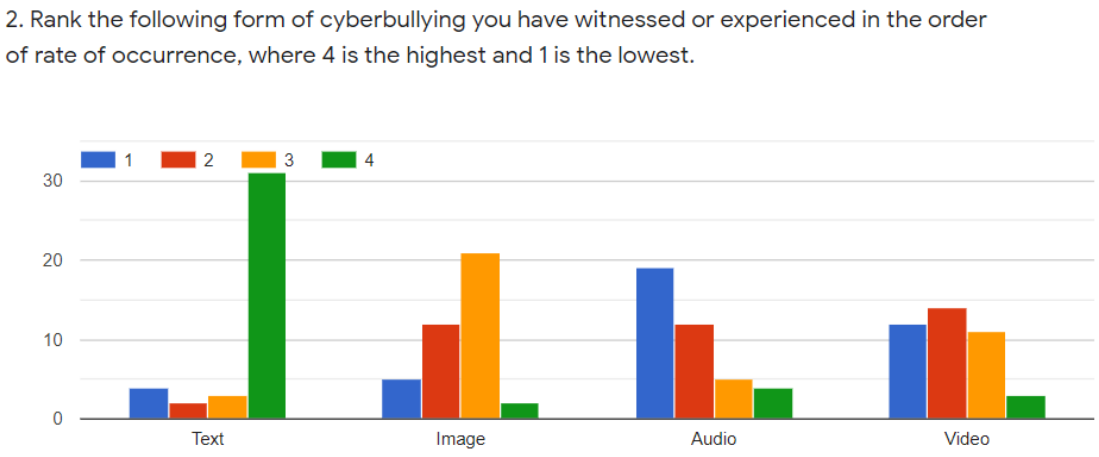


Figure 80: Analysis of Section C - Question 2

As displayed on the bar chart above that is based on a Rank Order question, it is exceptionally evident that text-based cyberbullying occurrences appear the most in participants' perspective with as many as 31 of them voted fourth point on text-based. This statistic illuminated the fact that Malaysian cyberbullies are leaning more towards texting than other mediums when cyberbullying others. Therefore, the system will proceed with the previous proposition which is developed to focus on monitoring text-based cyberbullying messages. As for the other forms of cyberbullying that are quite prevalent as well including image and video form with 21 and 11 participants voted third point correspondingly, these will be considered as future enhancements so as not to overload the project and causes the project to fail.

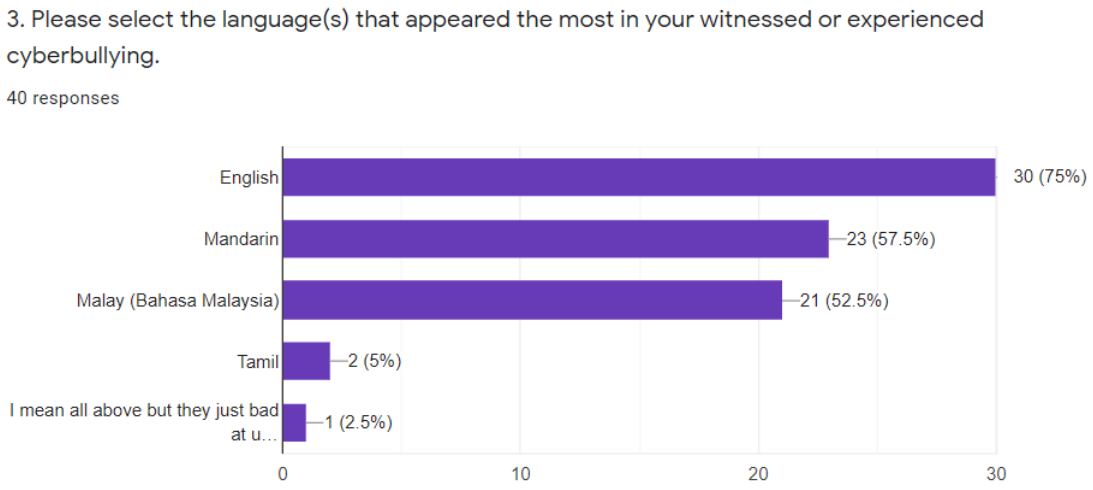


Figure 81: Analysis of Section C - Question 3

From the horizontal bar chart delineated above, most cyberbullying messages witnessed or received are English with the percentage of 75%, followed by Mandarin and Malay with the percentages of 57.5% and 52.5% respectively. Although the Tamil language only covers 5%, the conclusion regarding that Tamil is not prevalent in cyberbullying messages cannot be made because majority of the participants who partook in the survey research are Chinese and Malay.

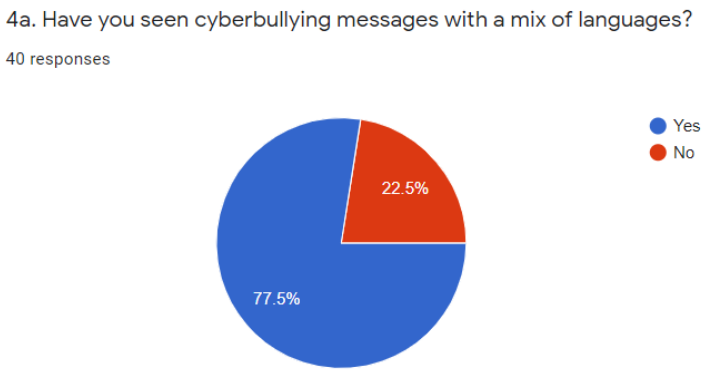


Figure 82: Analysis of Section C - Question 4a

According to the pie chart depicted above, majority of the participants agreed that they have seen code-switching cyberbullying messages, with a dominating percentage of 77.5% meanwhile 22.5% of the participants have not seen them. Such discovery signifies that Malaysian cyberbullies uses even code-switching language when they were conveying cyberbullying messages as well,

which proves the validity and the need of building a code-switching cyberbullying detection system, hence filling the research gap.

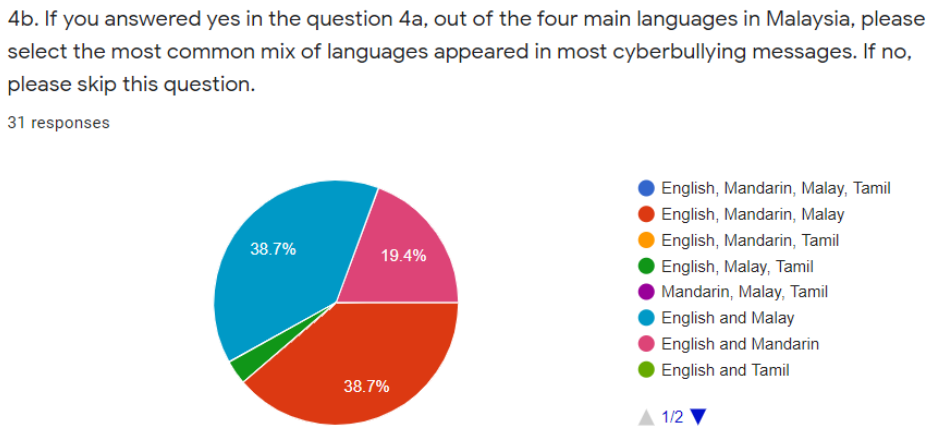


Figure 83: Analysis of Section C - Question 4b

Based on the pie chart illustrated above, there are two types of code-switching language that dominates the same percentage of 38.7% in the chart in which it includes English & Malay and English, Mandarin & Malay. The second highest occurrence of code-switching cyberbullying messages discovered is English & Mandarin with 19.4%. Again, since most participants from this survey are Chinese and Malay, hence the conclusion regarding the prevalence of code-switching language between Tamil and other languages cannot be determined. However, despite the number of Chinese participants partook in the survey as well as the prevalence of Mandarin language appeared in cyberbullying messages, the code-switching cyberbullying messages that contain language at least between English and Malay are more apparent. It can be speculated that due to the fact that both English and Malay are mandatory languages to be taught in Malaysia as well as the fluency between these two languages, hence such phenomenon is observed. For that reason, the proposed system will be implemented as intended previously to monitor code switching messages of English and Malay only. In order to restrict the scope of the project and prevent project delay, the code-switching language between English, Malay and Mandarin will be decided as future enhancement for the system.

6.1.1.4 Section D

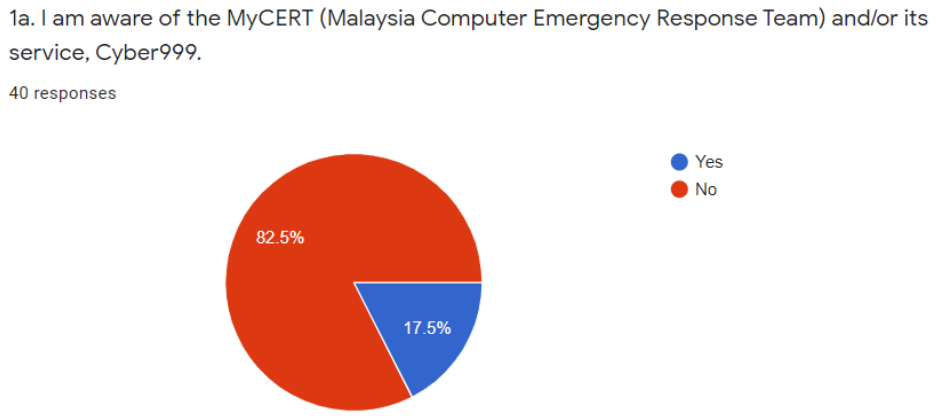


Figure 84: Analysis of Section D - Question 1a

According to the pie chart drawn above, there are as much as 82.5% of the participants who are not aware of the MyCERT nor its service, Cyber999, leaving only 17.5% of participants who are aware of them. The statistics shown have concretely proved that the platform and its service are unreliable because most people are ignorant of them, which aligns with the data found in Section B whereby several victims and bystanders do not know who or where to report, hence legitimising that the fact of the platform and its service being obsolete and having the proposed system to proactively monitoring the cyberbullying incidents instead would be more of use and effective.

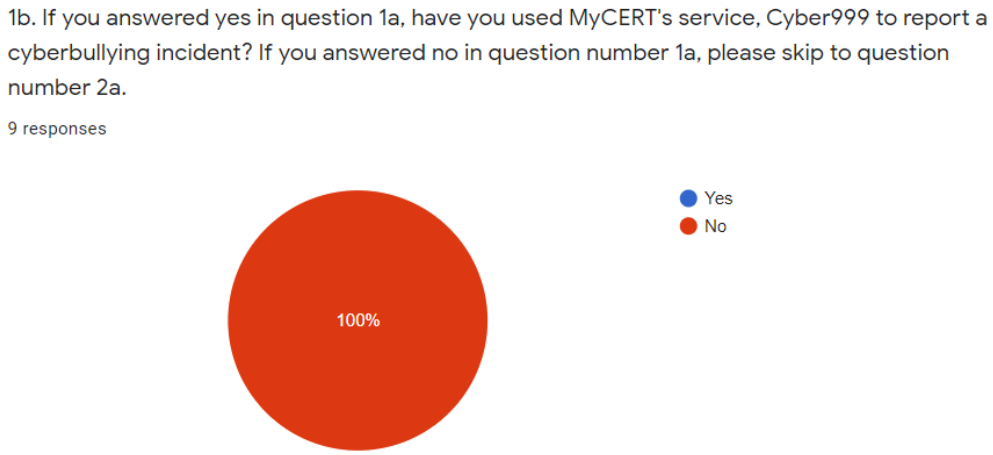


Figure 85: Analysis of Section D - Question 1b

As for the seven participants who are aware of the platform or its service, none of them have utilised the service to report witnessed or experienced cyberbullying incidents before, which further justifies that the available service is not practical at all. The fact that not only most people are not aware of it, but the people who are aware of it also do not even use it, hence again, having the proposed system to proactively monitoring the cyberbullying incidents instead will be better in controlling cyberbullying as well as offering emotional support for victims.

1c. Please explain your reason(s) for your answer in question 1b.

7 responses

I don't really know that

Don't know this service

I have never had the urge or need to use this service yet

I just reported to the social media platform, and I dont think there is a need to report to the others

I usually see cyberbullying in social media, and I report it through social media where they provide option to report if it is found as hate speech, cyberbullying, or nudity.

-

Figure 86: Analysis of Section D - Question 1c

As for the open-ended question shown above, there are not much data received in the study. However, the two most distinctive data that are insightful is that there are victims who directly report the cyberbullying incident to the social media platform or victim who feel that the incident are not serious enough to use the service and report it. These observations have shown that despite people knowing this service, the people typically either report on the respective platform instead or just not report at all, making the service obsolete and not useful.

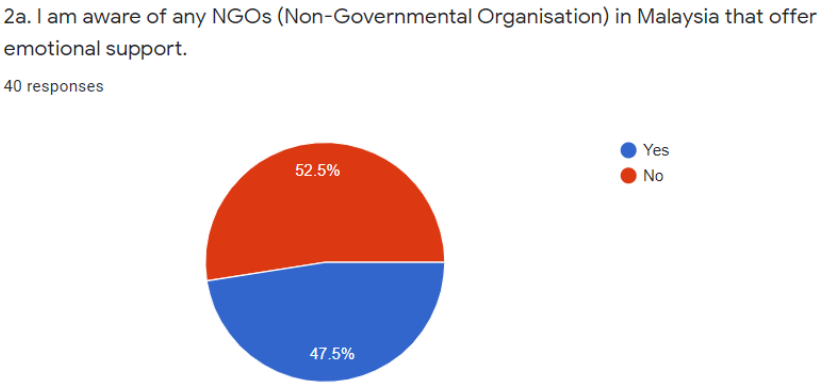


Figure 87: Analysis of Section D - Question 2a

Based on the pie chart shown above, there are more participants who partook in the current survey are not aware of any NGOs that provide emotional support, with percentage of 52.5%, just slightly over the ones who are aware of them with 47.5%. Although the percentage of people who are not aware of these services have decreased compared to the previously mentioned survey results (63%) reported by Bernama (2019), there are still many of them nonetheless.

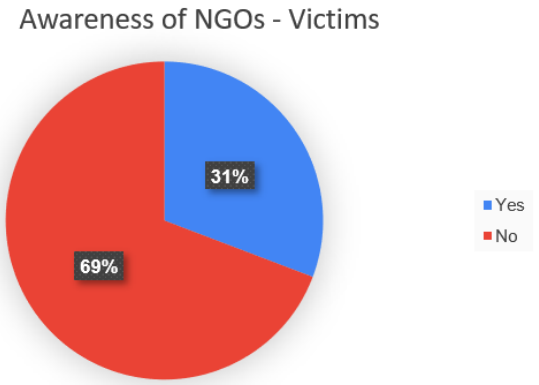


Figure 88: Ratio of Victims and Awareness of NGOs

Moreover, a further analysis has been made regarding the number of victims against their awareness of these NGOs and it was discovered that majority of them (69%) are not aware of these NGOs. This implies that there could be victims out there suffering in silence and does not know where to reach out for support. Hence, through the implementation of the proposed system, these victims will be the ones to be reached out instead, which prevent any unfortunate events from happening.

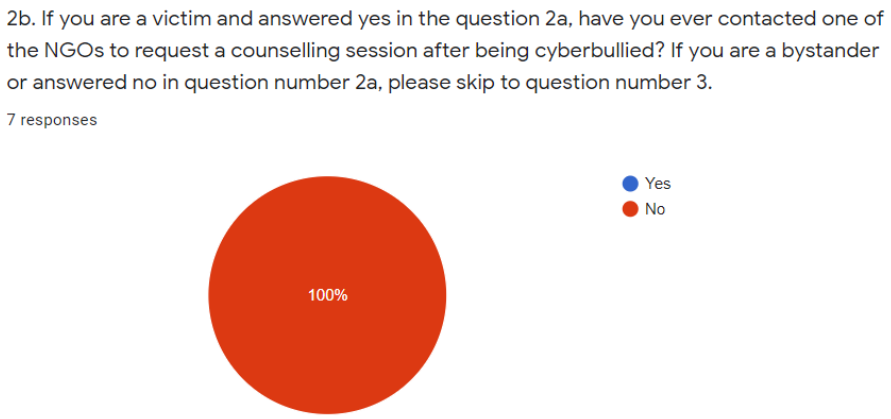


Figure 89: Analysis of Section D – Question 2b

According to the pie chart above, it is distinctly clear that 100% the victims who are aware of the NGOs does not use the service. From the statistics, it can be assumed that victims are either being afraid to tell anyone or they feel apathetic towards the minor cyberbullying cases. Based on the first assumption, that would solidify the concept and the implementation of the proposed system so that the victims are being approached instead, having pent up feelings can worsen the situation. However, a follow-up question will be asked to further probe the occurrence for deeper insights.

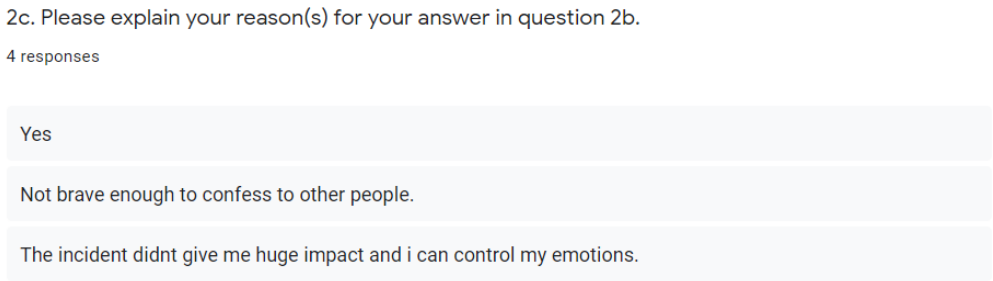


Figure 90: Analysis of Section D – Question 2c

Again, although not much data has been retrieved for the open-ended question above, there are still some insightful information nonetheless including victims afraid of confessing their incidents to other people as well as victims not affected strongly due to minor incident perceived which leads them to not contact the relevant NGOs after being cyberbullying. With the proposed system proactively sending attentive and careful messages to the victims, victims will be more likely to open up and therefore allowing NGOs to assist them and prevent them from sinking into deeper hole, hence the proposed system is determined to be beneficial and useful.

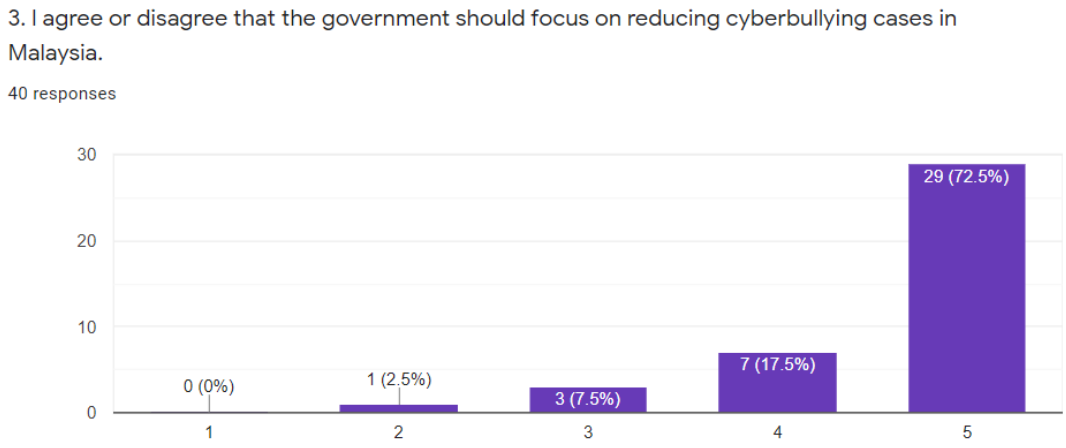


Figure 91: Analysis of Section D – Question 3

From the bar chart depicted above, an overwhelming number of participants of 90% agree that the government should focus on reducing cyberbullying cases. Based on the degree of agreement expressed above, it is clear that the public recognise that cyberbullying as one of the most concerning issues in Malaysia as of current and agree that the government should find ways to effectively mitigate them, which is what the proposed system intended to do.

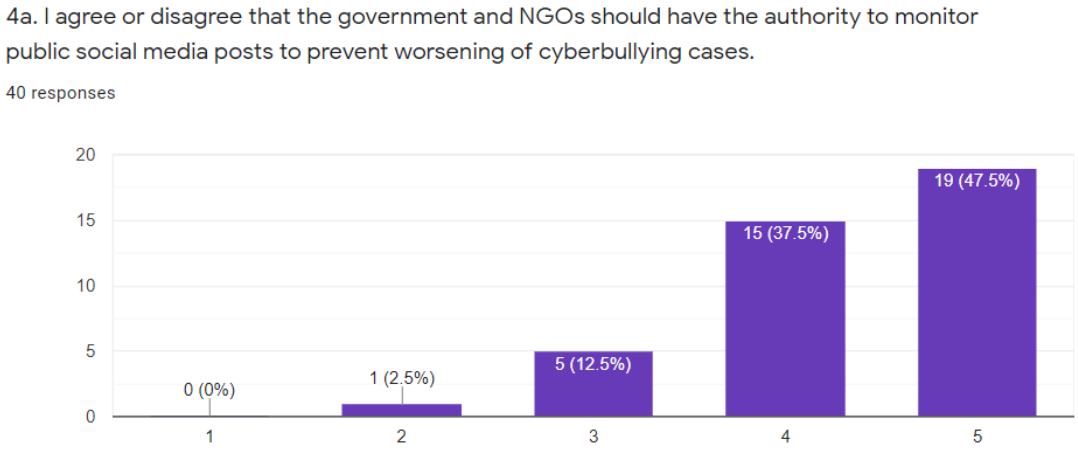


Figure 92: Analysis of Section D – Question 4a

Amongst the 40 participants who partook in the survey, there are as much as 34 (85%) of them agree that the government and NGOs should have the authority to monitor public social media posts to prevent worsening of cyberbullying cases in Malaysia. From the results above, it can be inferred that the general public are mostly comfortable being monitored publicly for the purpose

of controlling cyberbullying incidents in Malaysia. Therefore, the proposed system is legitimised by the public and the implementation plan will be retained.

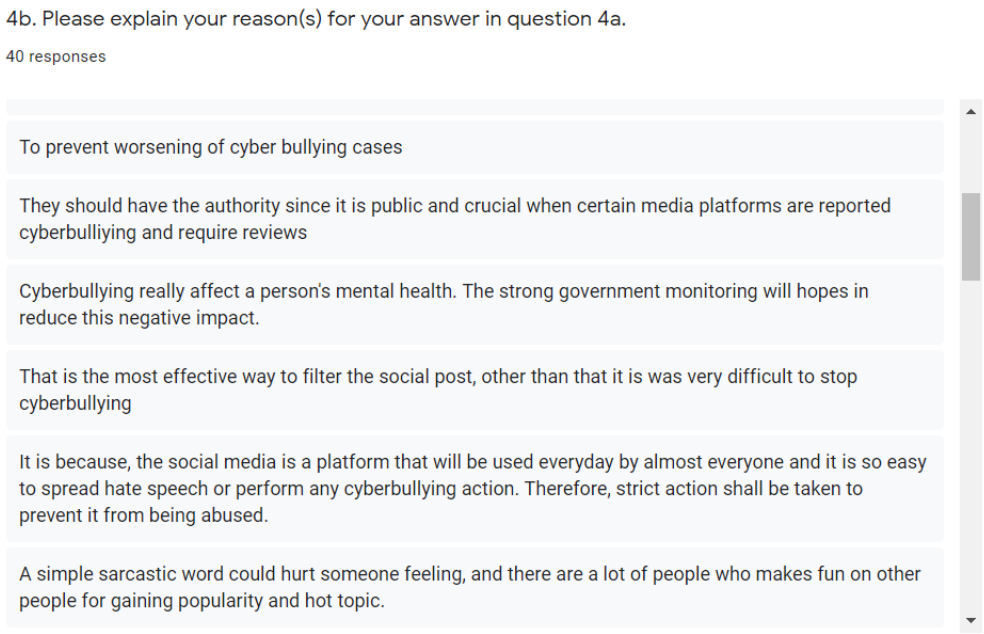


Figure 93: Analysis of Section D – Question 4b

Table 34: Categorised Data of Section D - Question 4b

- Effective. - Protect the wellbeing of the people. - Create a better social media environment. - Proactive and stricter action needs to be taken already. - Should be handled by respective social media platform through reporting. - Slightly invasive.

Based on the qualitative answers gathered on this open-ended question, the data have been categorised. From the categorised data, it can be observed that most think that public monitoring approach will be effective in terms of helping the victims and controlling the cases. There are also participants that mentioned that applying such approach can protect the wellbeing of not just the victims but the individuals who uses social media as well and also creating a better social media

environment. Apart from that, there are participants who commented that a proactive and stricter action needs to be taken already so as to mitigate cyberbullying cases effectively, hence supporting the approach. From the data observed, most participants agree that the approach will bring a significant impact towards alleviating cyberbullying incidents, which legitimise the main functionality of the proposed system to be implemented and executed. Although there are also participants who voice out that these cases should be handled by the respective social media platform instead by having the public reporting seen incidents, the problem regarding this comment is that based on the data observed above, specifically on Section B, there are quite the number of the victims and bystanders who do not report these incidents, hence leaving some cases being unresolved. Plus, the effects of being cyberbullying might still lingers within the victims. Therefore, publicly monitoring social media is deemed very beneficial because it eases system users' effort tremendously in not only identifying cyberbullying incidents occurred but also reaching out the victims who needs help. Furthermore, there are participants who raises the issue that such approach could be slightly invasive in the aspect of privacy. However, based on the statistics gathered above, most people are generally comfortable with them and such approach is nowhere near as intrusive as monitoring private messages, thus the proposed system is still valid to be proceeded.

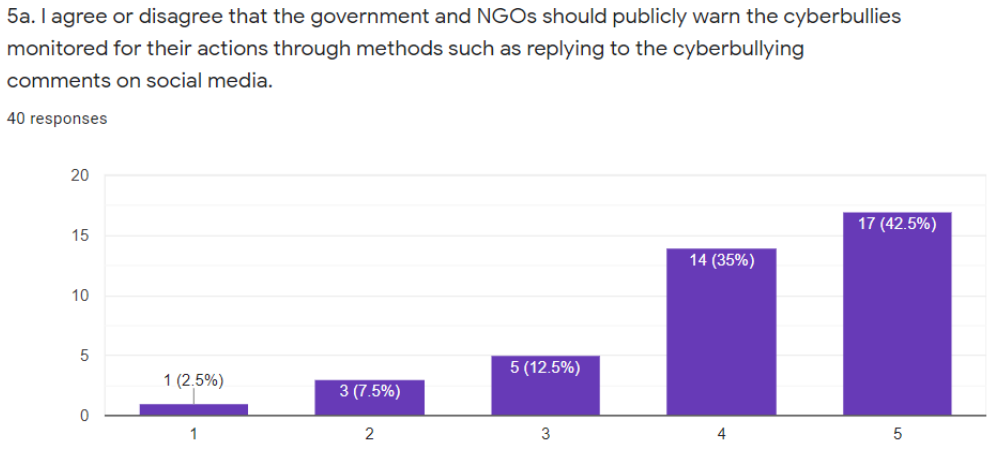


Figure 94: Analysis of Section D – Question 5a

According to the statistics displayed above, majority of the participants agree that the public approach of warning the cyberbullies is practicable, with an overall percentage as high as 77.5% whereby only 10% of the participants oppose to it. Based on the supportive statistics, assumptions

can be made regarding that through public approach, not only will the cyberbully refrained from continuing the harassment to the victim, but the cyberbullying issue will gain more awareness amongst the public or even fending off other cyberbullies as well, which ultimately control the cyberbullying incidents. Although the statistics have proven enough to validate and retain the feature of replying cyberbullying tweets in the proposed system to warn the cyberbullies, a follow-up question is asked to acquire in-depths opinion of the public regarding the approach, thus help identify whether should the feature be tweaked to ensure utmost effectiveness.

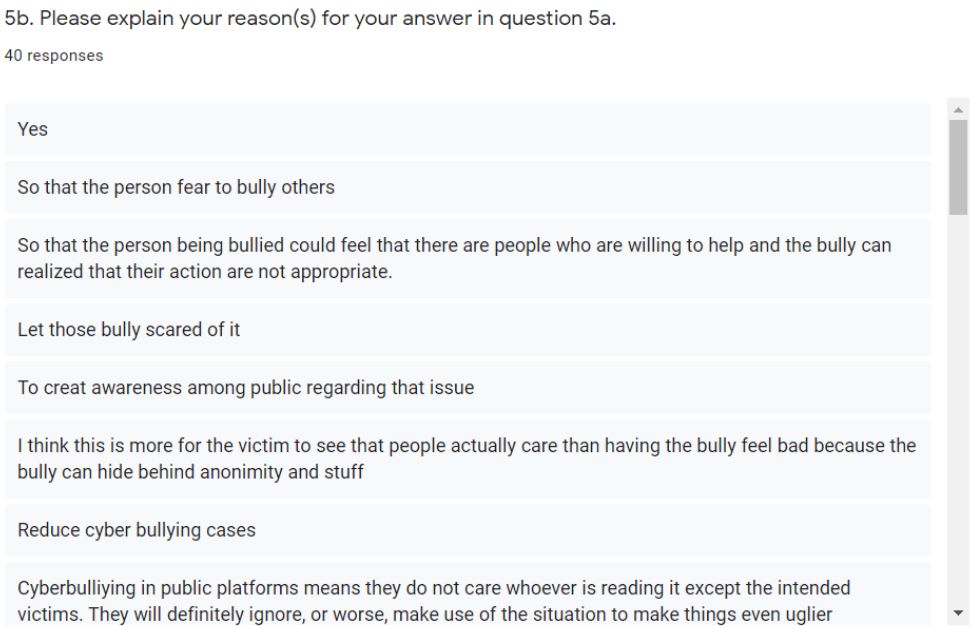


Figure 95: Analysis of Section D – Question 5b

Table 35: Categorised Data of Section D - Question 5b

- Make the cyberbully to stop. - Raise public awareness and attention to cyberbullying issue. - Help victims realise that there are people care for them as well. - Make cyberbullies feel ashamed. - Escalate the situation through private cyberbullying. - Cyberbullies will not listen to warning.

After categorising the qualitative data collected for this question, there are several insights acquired regarding the approach of warning cyberbullies publicly. First and foremost, there are people who believe that such approach can influence the cyberbully to stop their action because they realise their actions have severe repercussions and might even delete their comments. Moreover, some people mentioned that using public approach, it will raise public awareness and attention towards the cyberbullying issue itself. Thus, not only will it fend off the other cyberbullies, but the public will be aware the severity of cyberbullying including its consequences, which ultimately create a better social media environment. These findings have matched the speculation made above.

Other than these findings, there are also unexplored insights including certain individuals perceived that through this approach, it will help the victims realise that there are people care for them during this chaotic occurrence. However, there are also people argue that warning cyberbullies publicly will make them feel ashamed or escalate the situation even further as they proceed to cyberbullying the victims privately instead. Moreover, there are opinions discussed that the cyberbullies will not listen despite the warning given. From the data analysed, it can be concluded that the approach of warning the cyberbullies publicly are generally acceptable and the feature can be retained, which will be developed into the system if time permits. As for the issues in possibly shaming the cyberbullies or worsening the situation, the solution to that would be adding a reminder to the system users to tune the messages sent to the cyberbullies to be as less shameful and less provocative as possible. To minimise the shaming factor to even lesser degree, the feature of allowing system users to create tweets that prevents outsiders' interruption so that warning can be given as privately as possible will be incorporated into the system if time allows. Meanwhile on the issue of the cyberbullies not listening to the warning, if the incident has grown to the state where it is uncontrollable, the authorities themselves might have to take stricter action.

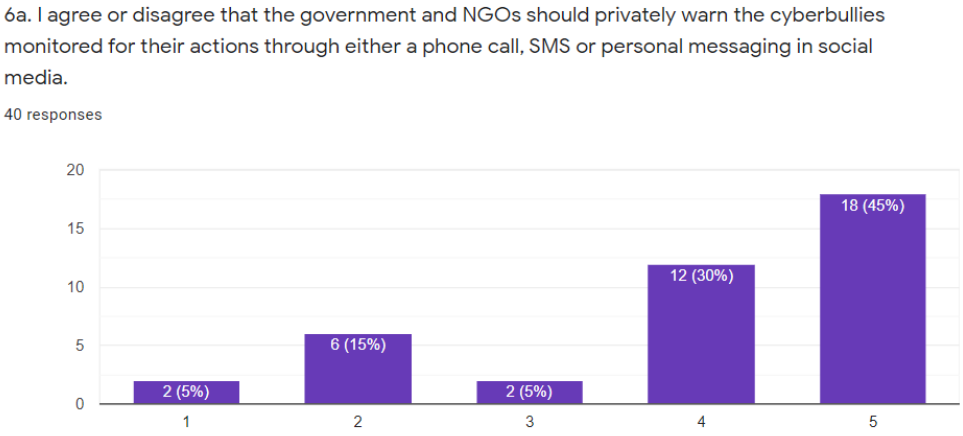


Figure 96: Analysis of Section D – Question 6a

By looking at the bar chart depicted above, it can be clearly seen that most participants with percentage as much as 75% agree that both parties should adapt private approach in warning the cyberbullies. However, there are 20% of the participants disagree with such approach as well. Based on the results received, it could be speculated that yes, private approach will be effective in instilling the consequences of cyberbullying to them, but such approach could be invasive. Even though the statistics are undoubtedly leaning towards agreement as to the approach of warning cyberbullies privately, the follow-up question as shown below was asked to retrieve the public perception regarding this approach in detail, so that the researcher can acquire deeper insights and therefore conclusively determine whether should the feature be retained, modified or even possibly removed from the proposed system.

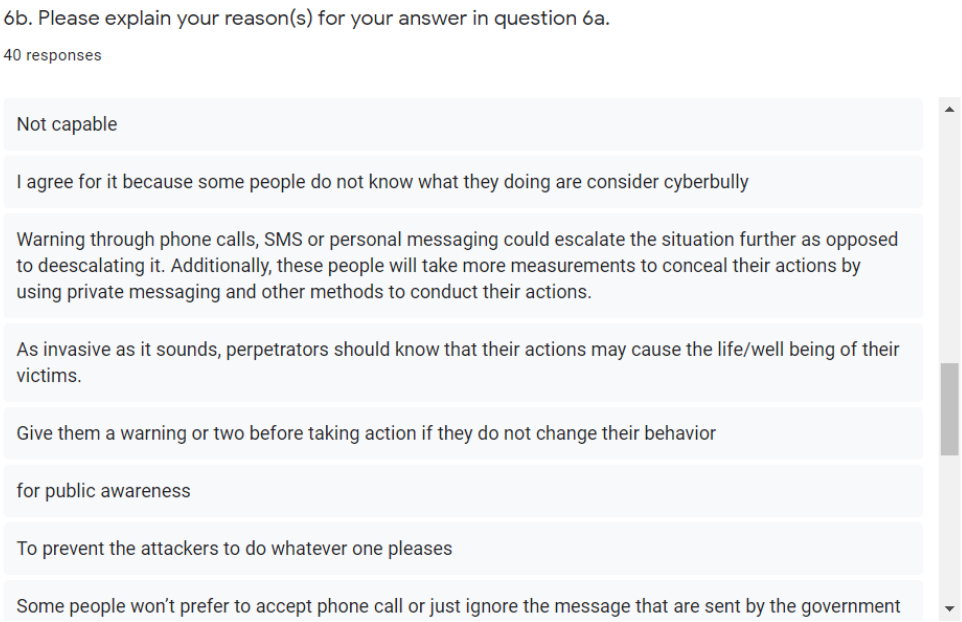


Figure 97: Analysis of Section D – Question 6b

Table 36: Categorised Data of Section D - Question 6b

- Make the cyberbully to stop. - Escalate the situation through private cyberbullying. - Cyberbullies will not listen to the warning. - Invasive and intimidating.

Based on the categorised data derived from the qualitative answers given, the participants believe that warning the cyberbullies privately will influence them to cease their actions as well because they will realise that what they have done is not appropriate. However, same as warning them publicly, the participants have mentioned that even through private warning, the cyberbully will either not heed the warning or exacerbate the situation further. Additionally, the general public expressed that using private approach could be intrusive and intimidating, which could cause adverse effects instead positive ones. Despite the overwhelming approval regarding the approach, the concept of the approach will need to be improved. Therefore, again, adding a reminder in the system to the users to construct the messages sent carefully may help reduce the intimidating factor so that the cyberbullies will receive the message with an open attitude. Furthermore, through the help of the previously proposed feature to identify the cyberbullies' toxicity level based on the

number of tweets they have posted over the past month, the private approach of warning the cyberbullies through either SMS, phone call or personal messaging in social media can be applied when the incidents have gone too far. All in all, the feature of warning the cyberbullies through these methods will still be retained regardless and implemented in the system, except for the SMS and phone call because the feature to extract the contact number of a user was later found to be deprecated by Twitter. Nevertheless, if the API was ever released again, such feature can be considered as future enhancements.

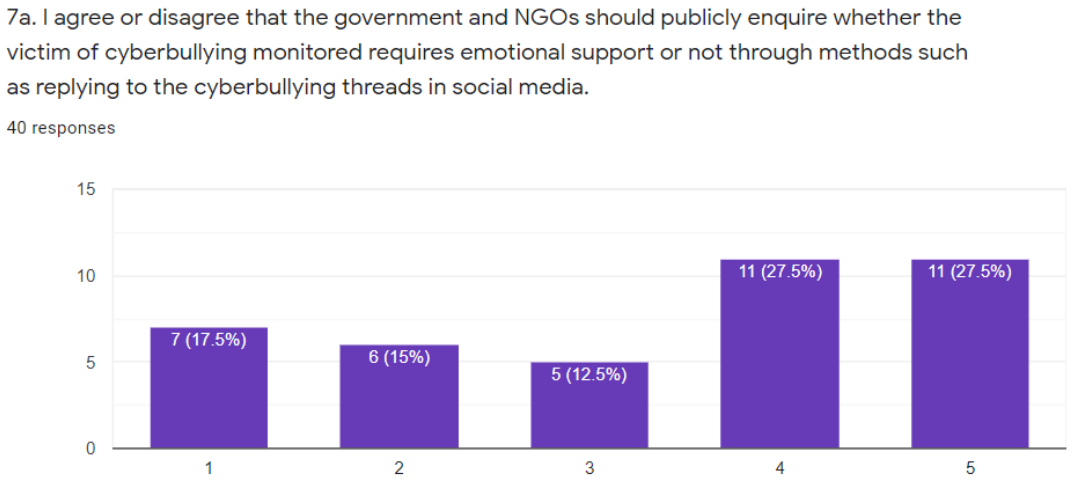


Figure 98: Analysis of Section D – Question 7a

As displayed on the bar chart above, the answers given by the participants regarding this topic are considerably divided. Although 55% of the participants agree that approaching victims publicly is practicable, there are as much as 32.5% who oppose the approach as well, leaving 12.5% of the participants being hesitant regarding the approach. Judging by the polar opposite opinions, it can be speculated that most people think that approaching the victims publicly will make them feel ashamed or made fun of for requiring help, yet some think that offering help publicly will ease the situation regardless. According to the statistics shown, the divided scores indicate that the approach might not be as effective. To assess whether to retain, improve or discard the feature, the answers contributed to the follow-up question below is analysed.

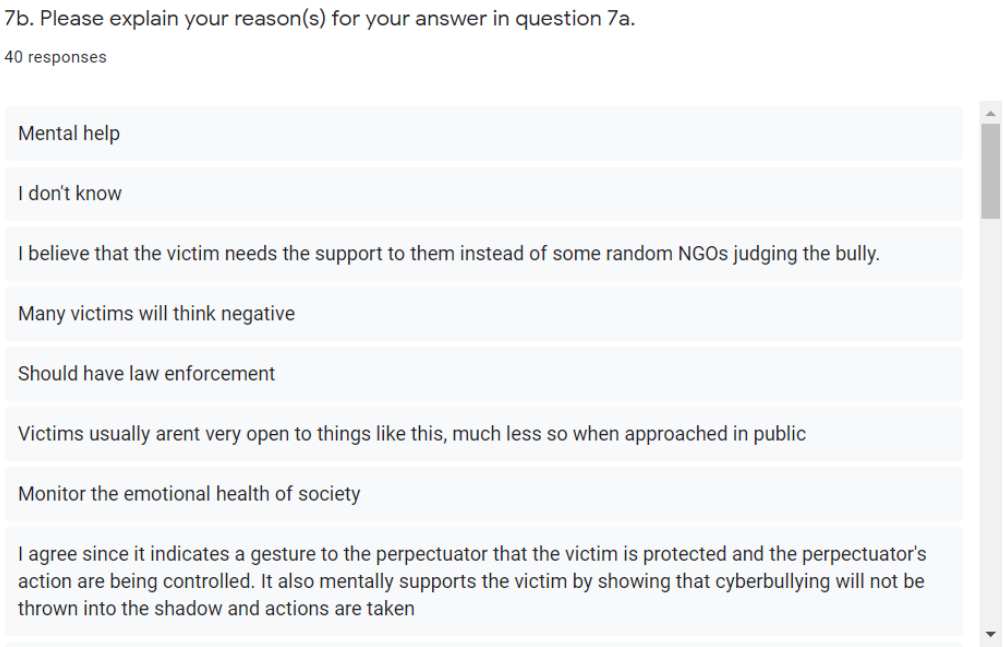


Figure 99: Analysis of Section D – Question 7b

Table 37: Categorised Data of Section D - Question 7b

- Ensure the victim are getting help. - Increase awareness about the support available. - Make victims feel ashamed even more. - Private approach is better.

Based on the data collected and categorised, it can be examined that the participants think offering emotional support publicly will not only ensure the victims are getting mental help if needed, but it also increases awareness to the public and possibly other victims about the support available for them, making the public to feel that the government are actually concerned with these issues. Having said that, many people believe that offering emotional support might make the victims feel ashamed already, yet doing it publicly will make it worse due to people viewing them as weak and the victims will further being made fun of. On top of that, most people who gave the opinion also added upon their sentences that approaching victims privately will be much more effective and most importantly, safer. Due to the fact that the feature of Direct Message (Private approach) has limitation whereby the system users may only approach them when the victims permit “strangers” to DM them, to ensure the victims will get help nonetheless, the feature of replying tweets to offer

emotional support publicly will be retained, but an alternative to approach them as privately as possible will be explored as well. The possible improvement could be allowing the system users to create a tweet that tags the victims meanwhile preventing replies from other people, hence allowing the system users to keep the conversation as private as possible without any interferences. Unfortunately, since the project has limited duration, the improvement will only be considered if time allows. However, another improvement that will be implemented is the inclusion of a reminder to the system users to construct the messages sent attentively so the victims will receive it well.

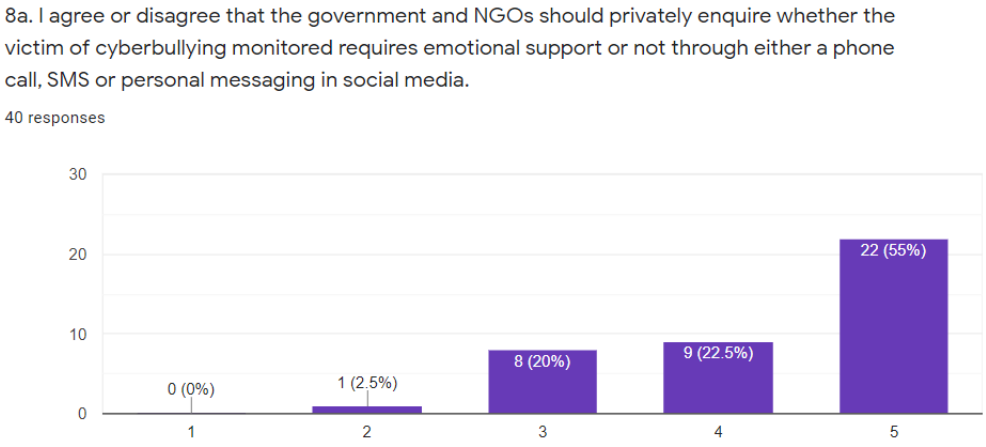


Figure 100: Analysis of Section D – Question 8a

From the bar chart drawn above, majority of the participants with the dominant percentage of 77.5% agree that approaching victims privately when offering emotional support is practicable. However, there are also 20% of the participants who are uncertain regarding the effectiveness of such approach. Through the percentages shown, it can be seen that most agree that such approach will definitely help the victims, however, it can be inferred that some may perceive such approach might be invasive, just like the case of warning the cyberbullies privately. Therefore, in order to decisively determine whether the feature should be maintained, modified or discarded from the proposed system, the answers from the follow-up question regarding their opinion will be analysed.

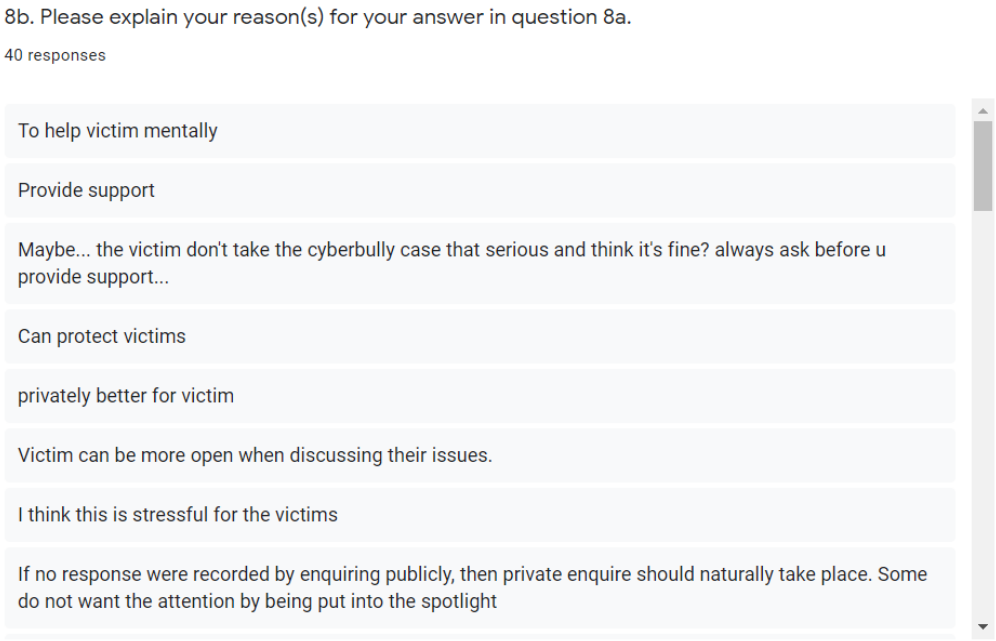


Figure 101: Analysis of Section D – Question 8b

Table 38: Categorised Data of Section D - Question 8b

- Ensure the victims who are afraid or unaware of the counselling help available will be assisted if needed. - Reduces public exposure of victims' incidents as minimal as possible. - Shameful or stressful.

From the answers collected from this question, several insightful themes were identified. First of which is that the participants voiced out that offering emotional support to the victims privately will ensure that the victims who are afraid or unaware of the counselling help available will the necessary receive help if desired. Moreover, as compared to public approach, the general opinion given by the participants is that privately approach reduces the public exposure of the victims' incidents as minimal as possible because some victims do not want their incidents being known, which leads to the third point. There are participants as well expressed that approaching victims proactively will still make the victim feel shameful or stressful. Hence, although the concept of offering emotional support privately will be maintained and developed into the proposed system,

the system will again add a reminder to the system users to ensure the messages sent will be constructed carefully and attentively so that the victims will receive these messages more optimistically rather than feeling shameful. Feature wise however, only Direct Messaging will be kept because as mentioned previously, the API to extract contact information is deprecated. Thus, if the API was ever released again, these features can be considered as future enhancements.

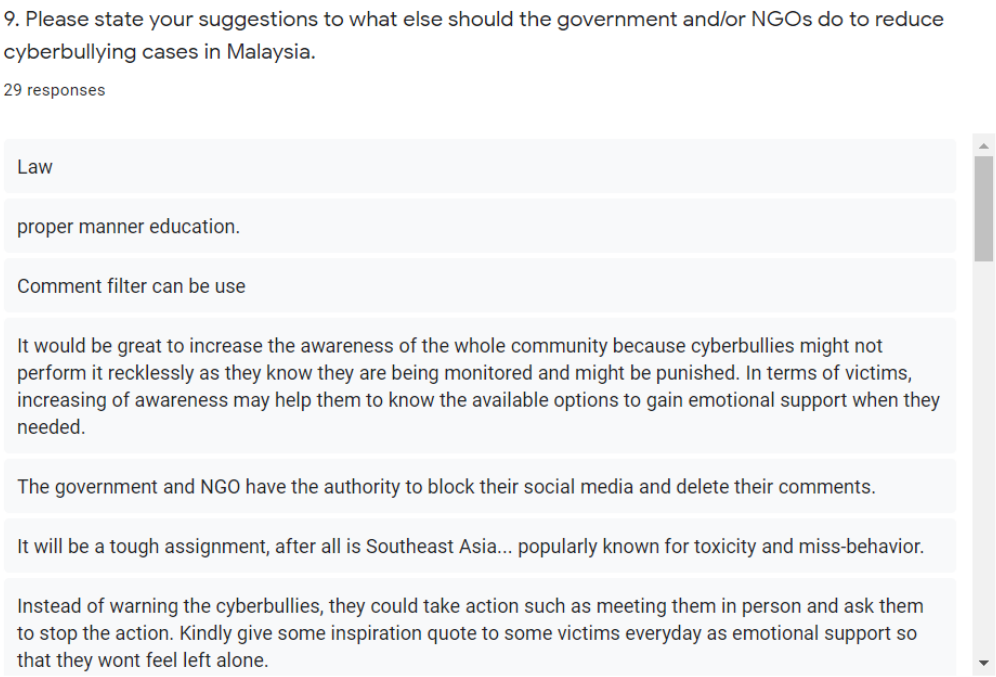


Figure 102: Analysis of Section D – Question 9

Table 39: Categorised Data of Section D - Question 9

- Enforce stricter law. - Awareness of the platform or the cyberbullying issue itself. - Grant the government and NGOs to block their social media and delete comments. - Offer counselling service to cyberbullies.

After categorising the qualitative data collected from this question, it was discovered that many agree to enforce stricter law with penalty involved to anyone who cyberbullies. There are also people who perceive that the awareness regarding the reporting platform or the cyberbullying issue

itself should be largely spread and instilled upon the individuals of all ages through methods such as education or campaigns. These valuable suggestions can be delivered to the government or NGOs so they could change their strategies currently adopted and therefore gradually reduce cyberbullying occurrences in Malaysia. Aside from these suggestions, there are also people who mentioned that the government and NGOs should be granted the authority to block certain individual's social media as well as deleting comments. Although these suggestions cannot be implemented as of current, in the future however, the government could work closely with the particular social media platform, so they are given the authority to perform these operations. Furthermore, some participants have voiced out an interesting comment regarding that the counselling help should be offered to the cyberbullies as well. This comment can be evaluated that cyberbullies themselves might have their own very problems which led them to harm others impulsively. Therefore, in the proposed system, other than being able to send message to the cyberbullies to warn them, the system users should be able to send message to offer counselling support to even the cyberbullies as well.

Based on the analysis of the data gathered through the survey data collection method, it can be conclusively determined that the issue of cyberbullying cannot be overlooked, and the implementation of the proposed system is proceedable. First and foremost, although Section A collects mostly data concerning the participants' demographics that helps determine the coverage of the current research, there were also information that highlights that the social media, Twitter are still fairly popular amongst Malaysians as well as the increase of victims of cyberbullying compared to previous study. The information gathered has not only implicate that the development of the proposed system to monitor Twitter messages can be continued, but it has also indicated that cyberbullying in Malaysia has gone much severe over the years, thus legitimise the urgency to develop the proposed system for the purpose of controlling these cases. This section has also unearthed the fact that Facebook, Instagram and YouTube are widely popular amongst Malaysians. Therefore, the monitoring capability on these social media will be placed as future enhancement to be incorporated into the system. As for Section B, the victims in Malaysia were unveiled to have suffered the same affective disorders as discovered in previous papers. Moreover, the importance of the proposed system is yet again illuminated due to the fact that majority of the victims and numerous bystanders do not report cyberbullying incidents most of the time, with reasons include ignorance on who or where to report. Moving onto Section C, the common patterns and languages

presented in cyberbullying messages in Malaysia are identified and aligned with what the system originally proposed, in which the cyberbullying messages are often conveyed publicly in text-form using code-switching language between English and Malay. However, apparently the occurrence of code-switching cyberbullying messages between English, Malay and Mandarin are almost as frequent, therefore will be considered as future enhancement so that the cyberbullying messages can be detected more comprehensively and accurately. Lastly in Section D, it was analysed that Malaysians in masses are not aware of the available reporting service nor NGOs that provide emotional support. Plus, many people are generally comfortable with the government and NGOs monitoring public social media messages to control cyberbullying incidents as well as having an acceptance attitude towards these parties warning cyberbullies and offering victims emotional support both publicly and privately. These findings have proven that the three main features in the proposed system can be maintained, except with few improvements and additional features comprising adding a reminder to the system users to formulate the messages sent to be as less shameful and less provocative as possible, permitting system users to offer emotional support to even the cyberbullies as well as allowing system users to create tweets that prevents outsiders' interruption so that either cyberbullies or cybervictims can be approached as privately as possible. Although the last feature mentioned will be listed as considered feature due to the project time constraints.

6.1.2 Interview

For the purpose of achieving the objectives identified previously, several individuals were contacted and interviewed. The first party to interview involves cyberbullying-emphasised government agencies. Therefore, Ms. Norlinda, the senior analyst for MyCERT specifically in the Cyber999 unit was interviewed. Although email interview was successfully conducted with MCMC as well, the identity of the interviewee was not revealed to the researcher. As for the emotional support-focused NGOs, Mr. Richie, the operations manager for Childline Foundation as well as Mr. Vidyasagar, the senior child advocate and media manager for Vanguards4Change were successfully interviewed. The data gathered from these interviewees are extremely important to contribute essential information to the current project especially since they are the target users for the proposed system.

Before the interview commence, the purposes of the interview including the proposed system features are explained in detail to the interviewee so that they understand the full context regarding the project.

6.1.2.1 Government Agencies

Table 40: Analysis of Interview for Government Agencies - Question 1

Question #1: Based on your opinion, what are the reasons behind the increase of cyberbullying incidents in Malaysia of more than two times the amount compared to last year?	
MyCERT:	Based on my opinion, the cyberbullying incidents spiked, especially since March of 2020 because that was when the MCO (Movement Control Order) declared. Due to MCO, more people are having more free time to surf through the Internet, therefore cyberbullying cases naturally increases as well. Also, Malaysians' lack of awareness about what is cyberbullying and how to cope with these incidents is believed to fuel the increase of these incidents as well.
MCMC:	Online harassment including cyberbullying is a threat that needs to be addressed by all parties who use social media users. Cyberbully cases are increasing every year and between 2016 to October 2020, MCMC has received 10,806 public complaints in general related to harassment online. The increase in cyberbullying cases occurs due to negativity in society itself. According to research,

	cyberbullying is common among teenagers in their 20s and such groups are difficult to predict. They are not mature enough to think about the consequences of the crimes they commit. Besides, the increase in the use of the internet is growing and the rapidity of technology.

According to the answers given by the MyCERT interviewee, it could imply that once the pandemic is over, the cyberbullying cases will decrease. Nevertheless, the early adoption of technologies amongst the children to study from home as well as the trend of many companies and their respective employees prefer working from home may prove otherwise, which aligns with the answer given by the MCMC interviewee. Moreover, MyCERT interviewee's mention of the lack of awareness towards the issue of cyberbullying amongst the Malaysians insinuated that as long as there are individuals who are unaware to the issue nor the available coping mechanisms, they could very well be the next victims of cyberbullying. Plus, even the ones who were instilled the said knowledge may still not be able to cope properly due to factors including personality and severity of the particular occurrence. In addition to that, the interviewee from MCMC explained that the teenagers are not aware of the repercussions towards their actions which led to the increase of cyberbullying incidents. Clearly, both parties agree that lack of awareness regarding the aspects of cyberbullying has huge influences towards its current numbers. Therefore, the proposed system should be developed to both control the cyberbullying cases but also proactively provide help to the victims.

Table 41: Analysis of Interview for Government Agencies - Question 2

Question #2: Does MyCERT/MCMC currently has methods to identify cyberbullying threats in Malaysia other than the ones reported to your platform?	
MyCERT:	We currently only have the free service Cyber999 which is open to the public, we rely on the public to report the cyberbullying cases to us. There are no methods created specifically in identifying cyberbullying threats in Malaysia.
MCMC	Currently, cyberbully detected based on reports from the public.

A reporting platform heavily relies on the platform awareness and the willingness of the people to report. Based on previous studies conducted, there are quite the numbers of victims and bystanders who do not report the incidents. Unreported occurrences may go horribly wrong. The better

approach would be allowing the relevant parties to monitor and control these incidents instead, thus justifying the importance of the proposed system.

Table 42: Analysis of Interview for Government Agencies - Question 3

Question #3: How do MyCERT/MCMC deal with cyberbullying incidents reported?	
MyCERT:	Upon receiving reports of cyberbullying cases, we provide guidance to the victims. For example, on social media like Facebook or Instagram, we suggest them options of what they can do, such as reporting the incident on that specific platform. Cyberbullying incidents that are reported to the police will be redirected to Cyber999 to investigate as well.
MCMC	All complaints received are actioned by MCMC, including but not limited to providing advice or guidance to affected parties, referral to the social media platform providers involved for further evaluation based on their community terms of service and standards, as well as investigations into content found to violate Section 233 of the Communications and Multimedia Act 1998, which prohibits the disseminations of indecent, obscene, menacing, false and threatening content with the intent to offended, persecute, threaten or harass others. Complaints that are not under MCMC jurisdiction will be referred to the relevant enforcement agencies, and MCMC will provide technical assistance accordingly

Based on the answers given above, the researcher has fully understood on the government agency domain especially for MyCERT and MCMC in terms of how they handle cyberbullying incidents reported.

Table 43: Analysis of Interview for Government Agencies - Question 4

Question #4: Does MyCERT/MCMC provide any form of help to the victims of cyberbullying and how?	
MyCERT:	As explained earlier, we only provide advice to the victims. We currently do not have specialists nor a department to provide emotional support to the victims.
MCMC:	MCMC assistance is based on the nature of the complaints that we receive. Should the complaint is against Section 233 of CMA 1998, our assistance would

	consist of investigation, removal notice and any other necessary actions within our jurisdiction. On top of that, most of the time, MCMC will provide advisories to the victims (complainants) to lodge an abuse report directly to the social media platform provider, to take civil action and, or to consider any other actions.

Aside from having understood the government agency domain more in-depth, it was mentioned by the MyCERT's interviewee that their agency does not have specialists that directly provide emotional support. However, one of the main system features that offer emotional support can still be retained for other government agencies such as MCMC as well as the NGOs to provide emotional support.

At this point of the interview, MyCERT has informed to the researcher that the department will no longer handle cyberbullying issues in the future. Instead, the department will only emphasise on technical cyberthreats such as phishing or malware. Therefore, the rest of the questions that are composed purposely to obtain MyCERT's opinions toward the proposed system will not be inquired.

6.1.2.2 NGOs

Table 44: Analysis of Interview for NGOs - Question 1

Question #1: Based on your experiences and perspective, has cyberbullying incidents in Malaysia increases or decreases over the years?	
Childline Foundation:	Based on our observations so far, we have seen that there is an increase of cyberbullying incidents.
Vanguards4 Change:	Based on my opinion, the cyberbullying incidents in Malaysia have increased.

According to the answers gathered, the interviewees have unanimously agreed that cyberbullying incidents in Malaysia have gone severe over the years. This finding has proven that the proposed system should be implemented to control cyberbullying cases in Malaysia.

Table 45: Analysis of Interview for NGOs - Question 2

Question #2: Based on your opinions and experiences, what are the possible reasons that lead to the increase or decrease of cyberbullying incidents?	
Childline Foundation:	Based on my opinion, the increase happens solely because of the lack of education. A lot of people, even the victims themselves do not see it as cyberbullying, but they attack their own self-worth sometimes.
Vanguards4 Change:	Based on my opinion, the cyberbullying increases because the technology usage have spiked over the years, which lead more and more people having access to the internet and social media.

According to the answers given, it was evident that the proposed system will play a significant role in alleviating cyberbullying incidents because as long as there is lack of cyberbullying awareness amongst the people along with the heavy usage of technologies, cyberbullying will always remain as an issue. Moreover, educating everyone in Malaysia with regards to cyberbullying would be difficult because it takes a huge amount of resources in terms of effort, time and money. On top of that, some of whom that were educated may not be able to handle the actual cyberbullying incidents especially when the incident gone chaotic. Aside from that, since technologies especially social media have brought the masses so much of convenience and entertainment, imagining the downfall of technology usage is almost impossible.

Table 46: Analysis of Interview for NGOs - Question 3

Question #3: Based on your experiences, have any victims of cyberbullying ever expressed reluctancy to report their experiences and why?	
Childline Foundation:	Yes, there are many. Sometimes it is really due to lack of confidence or the fear of being shamed. Depression or the events revolved around their environment such as family issues are also a factor as well.
Vanguards4 Change:	Yes. Victims tend to stay quiet and anonymous.

Based on the findings acquired, it can be confidently concluded that there are definitely victims out there who are afraid to report and would rather suffer alone, which could lead to catastrophic incident. Therefore, this data proves that the implementation of the proposed system whereby it is

capable to identify these victims as well as to offer emotional support is extremely important and beneficial.

Table 47: Analysis of Interview for NGOs - Question 4

Question #4: What are the standard procedures for your NGO when approaching victims of cyberbullying who request counselling session?	
Childline Foundation:	What we usually do is we first reassure the victims that they have taken the right action when talking with us. During the conversation, we typically will not ask the victims to speak about their experiences because it will just exacerbate trauma. We listen carefully until the victims are willing to open up. We also ask questions only to check whether what we have heard is correct and properly understood. We do not want to express personal opinions about the alleged abuser because the victims can feel more frustrated, we purely comfort them and provide advices. After the conversation, we will make a record of the conversation as detailed and as soon as possible, and we will treat the information confidentially. When we proactively approach the victims, we typically just say if you need help, we are here.
Vanguards4 Change:	We listen carefully to their problems and we provide advices regarding what they can do onwards. We generally just avoid imposing on the victims as much as possible.

From the information gathered through this question, the researcher has understood well regarding each of the NGO's domain with respect to their approach when conducting counselling session with the victims. Furthermore, the system feature improvement discovered during the analysis of survey data whereby the system should add a reminder to the users when constructing messages sent to the victims could be enhanced even better. The enhancement would be adding the detail of appropriately engaging a victim delineated by the interviewees as shown above to the reminder feature.

Table 48: Analysis of Interview for NGOs - Question 5

Question #5: Does your NGO provide further check up on the individuals who requested counselling session previously and why?

Childline Foundation:	We do, just to check whether they still are being bothered by the issue and need further counselling or not.
Vanguards4 Change:	No. We only provide help when they approach us. We currently do not have the extra human resources to provide further check-ups.

Based on the answers gathered, it was revealed that it is totally allowed to provide further check up on individuals. Plus, by looking at the benefits such engagement can provide, it is determined that the victims' information can be stored into the system. Additionally, if the considered feature of chatroom was to be developed, the system users can then provide further check up on these victims.

6.1.2.3 Government Agencies & NGOs

Table 49: Analysis of Interview for Government Agencies & NGOs - Question 1

Question #1: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?	
MCMC:	Cyberbullying incidents are depending on how a person reacts to a content affecting him/her. Facebook is also depending on user reports to detect cyberbullying or harassment incidents. However, any detection systems that could detect potential offences could be beneficial, depending on how the system works and its capability.
Childline Foundation:	I believe it would be highly beneficial because it helps us to observe and gain insights regarding the cyberbullying occurrence detected.
Vanguards4 Change:	In my opinion, I think it would be beneficial because it helps us to identify cyberbullying easily. However, in this day and age, some people have concerns about privacy issues even though it is public messages.

Based on the opinions gathered by the targeted system users, all parties are in agreement that the very core functionality proposed in the system would be practical and beneficial, which justifies that it should be maintained. Although the interviewee from Vanguards4Change has expressed that some people may concern about privacy issue, the results gathered from the survey above have unveiled that most people are generally comfortable with their public social media posts being monitored as long as it helps in preventing the cyberbullying cases from worsening.

Table 50: Analysis of Interview for Government Agencies & NGOs - Question 2

Question #2: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?	
MCMC:	That could be another option that could be put into consideration, depending on the policy decision.
Childline Foundation:	I think warning cyberbullies have both good sides and bad sides. Warning the cyberbullies may make them stop cyberbullying, but it might actually make them do more as well. Also, there are also situations where cyberbullies hurt others because they are hurt, so we should also offer emotional support for them. Warning them as of now may not be as effective because Malaysia currently does not criminalise this kind of act, but we could at least try especially for cyberbullies who acts intentionally.
Vanguards4 Change:	If the warning messages being sent to the cyberbullies sounds nice enough, then yes, I think the feature would be useful to potentially stop them from cyberbullying.

Based on the answers gathered above, it can be analysed that all the interviewees are leaning towards the agreement side that this feature will be beneficial because it could potentially cease cyberbullies' inappropriate behaviour. Thus, the feature will be maintained. However, interviewee from Childline Foundation has mentioned that warning them may actually exacerbate the situation while interviewee from Vanguards4Change stated that the messages sent should have pleasant tone. For those reasons, the system will be adding a reminder to the system users to formulate the messages sent to be as less shameful and less provocative as possible, just like what was suggested during the analysis of survey data. Additionally, the interviewee has expressed the importance of offering emotional support to even the cyberbullies. Therefore, it is decided that the system users will be equipped with the option to perform said action as well.

Table 51: Analysis of Interview for Government Agencies & NGOs - Question 3

Question #3: Do you think should the system users approach the cyberbullies publicly, privately or both?	
MCMC:	It will depend on the decision made by the respective authorities i.e. PDRM.

Childline Foundation:	I think both approaches are effective, but I personally believe that warning them privately will be better because the cyberbully may not even aware that they are cyberbullying other people, it could have been just an accident, so contacting them privately may not shame them as much or as fear mongering as warning them publicly.
Vanguards4 Change:	If it is a message that is pre-generated for every cyberbullying post, yes it should be public, if it is customized message, then it should be private. Sending customised warning messages publicly for different cyberbullies may victimised them because other people may join in bullying the cyberbullies instead.

According to the statements acquired, although interviewee from MCMC has mentioned that it also depends on other authorities' decisions, it can be observed that both approaches are viable, except the private approach would be more preferable. Since Direct Message in Twitter may not be possible for every individual, both approaches will still be maintained and developed into the proposed system to ensure the messages at least get across the cyberbullies. Based on the insights given by the interviewee from Vanguards4Change, although minor, the initially proposed feature whereby the system users are able to modify pre-written messages sent will assist in the endeavor of customising private messages sent to the cyberbullies.

Table 52: Analysis of Interview for Government Agencies & NGOs - Question 4

Question #4: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?	
MCMC:	It is up to the system developers to provide all features that they think might be beneficial and to be available in the system.
Childline Foundation:	I think it provides a good insight of the profile for this person, so we know how frequent they cyberbully. That would kind of give us a gauge of how severe this person is regards to being a cyberbully.
Vanguards4 Change:	Yes, I think it is beneficial so it allows us to know which cyberbullies should be paid extra attention.

According to the opinions obtained, despite interviewee from MCMC saying that the feature is up to the developers, the feature of identifying toxicity level is deemed beneficial from the other parties' point of view as it allows them to pinpoint on which cyberbullies to place their focus on, thus the feature will be maintained and implemented into the proposed system.

Table 53: Analysis of Interview for Government Agencies & NGOs - Question 5

Question #5: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?	
MCMC:	It is up to the system developers to provide all features that they think might be beneficial and to be available in the system.
Childline Foundation:	I wholly agree that this feature would be beneficial because it guarantees that the victims will get help if they ever need one, although I would say that the adoption rate may not be as high especially for Chinese because we typically do not rely on others when we encounter problems.
Vanguards4 Change:	Yes, offering counselling support would be very helpful to the victims. How effective would it be depends because some people may not believe in mental care provided by us NGOs.

Based on the valuable responses received, despite interviewee from MCMC saying that the feature is up to the developers, it can be confidently concluded that the feature will be significantly beneficial to them as the system users to be able to offer counselling support to the victims, therefore the said feature will be maintained and implemented.

Table 54: Analysis of Interview for Government Agencies & NGOs - Question 6

Question #6: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?	
MCMC:	It is up to the system developers to provide all features that they think might be beneficial and to be available in the system. The opinions from the support groups available in Malaysia would be crucial as well.
Childline Foundation:	I personally believe privately approaching victims would be the surefire way. However, I would also say that posting publicly would be greatly beneficial as

	well. Despite being a double-edged sword method because approaching victims publicly could make them be viewed as weak and push us away from them, approaching victims publicly could also start a chain of other people posting positive messages as well.
Vanguards4 Change:	I would say private is better because it is more personal. Publicly provide help could make them feel ashamed because the victim will have this thought he or she is weak because they need help. Also, exposure regarding their situations could do more harm than good.

According to the answers acquired above, the interviewee from MCMC has indicated that the decisions should be based on the developers as well as the support groups such as NGOs, and the interviewees from the respective NGOs have expressed that private approach would be better, which aligns with the results gathered from the survey. However, the interviewee from Childline Foundation and survey results have expressed that offering emotional support publicly have its own benefits as well. Hence, the researcher has reached a conclusion that both approaches including publicly offering counselling support to the victim will be maintained nonetheless. For the purpose of minimising the possibility of shaming the victims, as proposed during analysis of survey data, the system will be adding a reminder to the system users to formulate the messages sent to be as less shameful and less provocative as possible.

Table 55: Analysis of Interview for Government Agencies & NGOs - Question 7

Question #7: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?	
MCMC:	It is up to the system developers to provide all features that they think might be beneficial and to be available in the system.
Childline Foundation:	I think this feature would be useful in extrapolating cyberbullying cases in Malaysia, so that we observe the severity of phenomenon over time.
Vanguards4 Change:	Yes definitely, I would be aware of what is going on, usually cyberbullying cases would be not reported. Having this graphical chart could bring greater awareness regarding the issue.

Based on the answers obtained, although interviewee from MCMC saying that the feature is up to the developers, both interviewees from respective NGOs have agreed that the graphical chart will be a great addition to the proposed system. Thence, the feature will be retained and implemented into the proposed system.

Table 56: Analysis of Interview for Government Agencies & NGOs - Question 8

Question #8: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?	
MCMC:	It is up to the system developers to provide all features that they think might be beneficial and to be available in the system.
Childline Foundation:	Yes, I believe that would be useful so that we may act based on how severe the cyberbullying incident detected. But I also think that generating a 24-hour report regarding the cyberbullying incidents detected would be useful as well so that we can observe as a whole, to see whether certain incidents are occurring repeatedly.
Vanguards4 Change:	Yes, I believe this would be beneficial as well so that we are aware of the detected cases.

According to the opinions gathered above, despite interviewee from MCMC saying that the feature is up to the developers, both interviewees from the respective NGOs believe that the alert feature would be beneficial during their usage, thus the feature will be retained and implemented into the proposed system. However, the interviewee from Childline Foundation did mention that generating a 24-hour report regarding cyberbullying incidents occurred would be useful as well so that the users can process what happened during the day before. As for this feature addition, it will be placed under consideration due to the limited project timeline.

Table 57: Analysis of Interview for Government Agencies & NGOs - Question 9

Question #9: What are the main quality attributes concerned do you have in the proposed system?	
MCMC:	Security, data protection and dashboard.
Childline Foundation:	I believe user experiences will be one of the main concerns in the system because there are a large number of social workers, and they are the most active ones, are usually quite old and some may not be as IT-literate as young people.

	Performance could be an issue in my opinion as well because based on what I understand, machine learning can take a huge resource in computing, if the system is slow it could be frustrating to the users. Other than that, I think that security would be an issue as well because some people could be sharing accounts to their colleagues, and their computers might have malware in it and may breach the confidential data stored in the system.
Vanguards4 Change:	For me is definitely the user interface (UI). As long as the UI is intuitive, it helps me do even the basic stuff more efficient.

According to the inputs given to the question above, it can be observed that security, user experiences and user interface are of their greatest concerns to ensure that people of all ages can employ the proposed system intuitively meanwhile preventing potential harm such as privacy breach to all parties including the cyberbullies and the cybervictims. Therefore, the researcher will prioritise in optimising these three elements in the proposed system. Due to the researcher not having a strong cybersecurity background, the researcher will have to perform in-depth research regarding this field during the system development to reduce potential cyberthreats as minimal as possible. As for the performance, the researcher has conducted thorough technical research in order to select the most suitable technical instruments with ensuring good performance in mind. Therefore, as long as the researcher maintain a good coding practice, performance should not be an issue.

Table 58: Analysis of Interview for Government Agencies & NGOs - Question 10

Question #10: Do you have any suggestions to improve the proposed system?	
MCMC:	Nothing at the moment.
Childline Foundation:	I think what you have suggested so far is pretty solid. The only things you have to concern in my opinion is the user experience and the security. I also think that if us users can have two-way communications with the victims will be useful as well.
Vanguards4 Change:	Generally, just the UI needs to be good.

According to the answers given, there are not many suggestions to be implemented into the proposed system except that the system should have satisfactory user experiences, user interface and security. Interviewee from Childline Foundation has also mentioned that having two-way communications will be useful as well. Thus, the considered feature of chatroom will be implemented if there is available time.

Based on the analysis of the data acquired from the interview conducted, the prevalence of cyberbullying, their individual domain specifically in handling cyberbullying incidents as well as their opinions and requirements towards the proposed system were comprehensively and immensely understood. First and foremost, all the interviewees invited have concurred that cyberbullying cases in Malaysia have gone more severe over the years. This finding has justified that the proposed system should be implemented for the purpose of controlling and alleviating the severity of cyberbullying cases in Malaysia. Furthermore, the information collected has shed light over the procedures regarding on how each party deal with cyberbullying incidents reported as well as the lack of effective mechanism amongst the government agency in combatting cyberbullying incidents. These valuable insights have helped the researcher in unveiling the importance of the proposed system along with enhancement or internal specifications the system should equip. Although MyCERT were not asked the rest of the questions concerning the requirements towards the proposed system due to the fact that they are not planning to focus on cyberbullying issue in the future, the proposed system will still be targeted for other cyberbullying-focused government agencies including MCMC based on the opinions gathered by the other interviewees. Speaking of requirements, all the previously proposed functionalities and features will be maintained and developed into the system as the interviewees generally believe that these implementations will be beneficial or useful not only to themselves, but also to the victims and cyberbullies. Despite that, there are several new features that are categorised as prioritised and considered which will be added into the system. The prioritised feature involves allowing the system users to provide emotional support to the cyberbullies as well as including a reminder to the system users to formulate messages sent to either cyberbullies and cybervictims carefully meanwhile the considered feature that will be developed if there is available time will be the ability to generate a 24-hour report regarding the cyberbullying incidents occurred. Apart from that, based on the opinions acquired, the system should also be designed and developed to have intuitive user experiences, beautiful user interface, speedy performance and solid security.

6.2 Summary

In summary, the key takeaway from the analysis of the data gathered using survey and interview is that the implementation of the proposed system will be exceptionally imperative in alleviating the severity of cyberbullying cases in Malaysia. From the data obtained, all the functionalities and features proposed in the system will be maintained as previously stated except with several improvements and future enhancements excavated that could perfectionate the system to better recognise and control cyberbullying phenomenon occurred throughout the social media platform. The feature improvement identified from both techniques were classified as prioritised and considered. Considered features are features that will be incorporated into the system only if there is sufficient time. The prioritised features determined are a reminder displayed to the system users that notifies them to construct the message to be as caring and less offensive as possible along with the ability to offer counselling support to even the cyberbullies as well. On the other hand, the considered features identified are the capability to create tweets that prevent other individuals to reply except for the tagged users (Cyberbully or cybervictim) in addition to the ability to generate a 24-hour report that lists all the cyberbullying occurrences detected. Aside from the features, as concerned by the target users interviewed, the system will be built with optimising user experience, user interface, performance and security in mind. As for the future enhancements, the system could expand its pervasiveness of monitoring capability to other social media that are widely utilised amongst Malaysians found in the survey which include Facebook, Instagram and YouTube. Since the proposed system as of current only detect code-switching cyberbullying messages between English and Malay, another future enhancement that can be incorporated into the system is the capability to detect code-switching cyberbullying messages that exists in between English, Mandarin and Malay, which was found to have high occurrence rate as well.

Chapter 7: System Architecture

7.1 Introduction

Code-Switching Cyberbullying Detection and Communication System is a web-based application that detects code-switching cyberbullying messages from the social media platform, Twitter and allows the government agencies as well as the non-governmental organisations to offer counselling support to both the cyberbullies as well as the cybervictims. The core components of the system include a logistic regression machine learning model that categorises cyberbullying and non-cyberbullying messages, a React-Flask web application that allows the system users to interact with the core features of the proposed system as well as the database management system, MySQL which stores the necessary data.

In regard to the core features, first and foremost, the most important ones would undoubtedly be the constant streaming and identification of the code-switching cyberbullying tweets particularly English and Malay acquired from Twitter. Any traceable information to be stored within the database including the Twitter profiles as well as the cyberbullying messages or simply called incidents are encrypted using the AES (Advanced Encryption Standard) encryption algorithm particularly the CBC (Cipher Blocker Chaining) mode under 256 bits, ultimately for the purpose of protecting their utmost privacy. As the detection process performed in the background, server-side to be specific, the users can log in into the web application to accomplish a variety of operations. Unlike many login functions, the implementation of the function in the current system works differently wherein the users within one organisation shall login the one organisation account only, in terms of the Twitter account as well because operations such as offering emotional support in actuality will be sent from a Twitter account as triggered through the current system, meaning all the employees in the organisation share the same account in the system and in the Twitter. This is predominantly because when offering counselling support, users representing one single organisation emanates more legitimacy compared to using their personal account. One of the main accessible features would be the dashboard that comprises diverse statistics such as last week's average cyberbullying incidents identified, total cyberbullying incidents unearthed, total cyberbullies detected and the state with the highest cyberbullying occurrences. On top of that, the dashboard also provides another interactive statistic wherein the system users can view the number of cyberbullying incidents with multitude of format including daily or monthly and even bar chart

or map view, therefore grants the users with comprehensive information from different perspective. Along with the statistics, the notifications of new cyberbullying incidents detected that helps alert the system users will be refreshed every five minutes to maintain satisfactory performance and smooth user experience.

Additionally, when encountering the page filled with profiles that are detected as cyberbullies and cybervictims, the system users shall be able to notice that different colours were assigned to the respective cyberbullies. These colours represent the toxicity level of each cyberbully in the past month; Five cyberbullying incidents involved will be assigned the toxicity level of low with the colour yellow; Ten cyberbullying incidents involved will be designated the toxicity of medium with the colour orange meanwhile twenty or more cyberbullying incidents involved will be delegated the toxicity of high with the colour red. Through these colours, the system users will be aware immediately on which profiles should be monitored heavily in a single glance.

As mentioned, one of the most vital elements in the system consists of offering counselling support to the cyberbullies as well as to the cybervictims. Thence, the system has been equipped with two mechanisms for the users to provide the pre-written support messages including replying to the tweet publicly or direct messaging to the Twitter profile privately. Needless to say, different organisations have distinct messages to be sent or perhaps different conversations or profile status might require tweaking in the pre-written messages. Thus, the system users shall have the capability to modify these pre-written messages as well. On a side note, each role and messaging method within the system including cyberbully, cybervictim as well as cyberbully-victim[4] and reply tweet as well as direct message respectively will have individual pre-written messages, hence allowing the system users to send different messages based on the roles of the profiles and messaging method with ease. In addition to that, the support message offered previously will be viewable to other organisations as well so as to see and learn how each organisation approach them. Similar to storing the Twitter profiles and the respective incidents, these messages are encrypted using identical AES encryption algorithm to avoid these messages from being leaked.

[4] Someone who cyberbully but also a victim.

Due to the fact that the system permits only recognised organisations to access the system, only the system users from the governmental organisations shall be able to add new organisations for the purpose of authorising them to access the system.

Apart from that, despite the machine learning model integrated within the system capable of distinguishing cyberbullying messages, there could be times where some messages detected were misclassified as cyberbullying. Hence, the system users during the access shall have the ability to remove these misclassified messages whenever. Lastly, it goes without saying that the system users shall be able to log out of the system as well.

7.2 Abstract Architecture

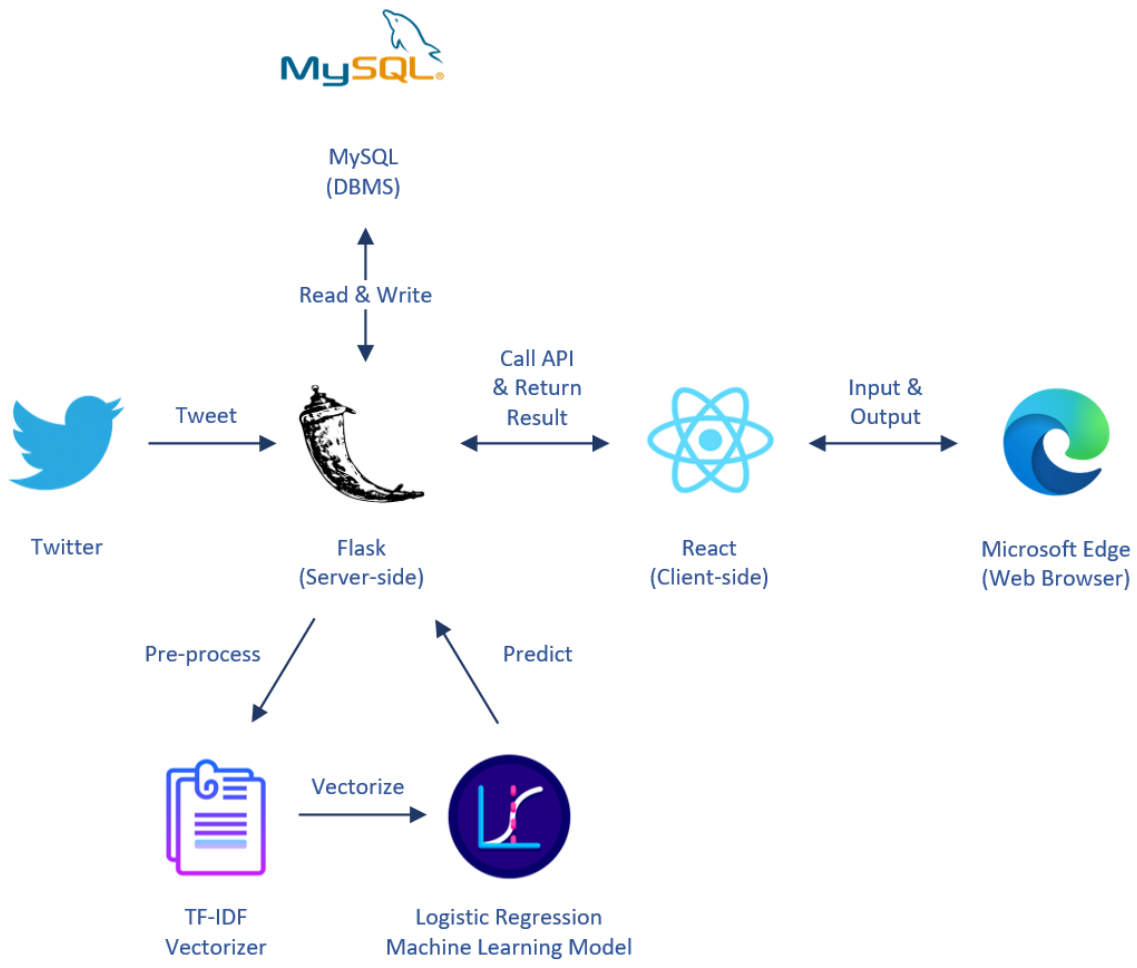


Figure 103: Code-Switching Cyberbullying Detection and Communication System - System Architecture

The diagram shown above displays the proposed system architecture wherein it demonstrates the data flow as well as how the components communicate with each other. First and foremost, the tweets specifically with a location tag in Malaysia will be constantly streamed from the social media platform Twitter. Subsequently, once the tweet has been identified to have a username tag, pre-processed from the Python-based server-side web framework, Flask as well as vectorized using the TF-IDF vectorizer, the logistic regression machine learning model will be responsible in predicting whether the individual tweet message contains any cyberbullying connotation or not. As for the cyberbullying messages identified, the application server will then store the relevant messages alongside the involved profiles into the database under the MySQL database management system. In the meantime, whenever the system users access the system from a web

browser, preferably Microsoft Edge, the client-side JavaScript library, React will construct the web pages based on the URL routes. Apart from that, the input triggered by the system users such as removing incident or changing password will as well be handled by React as in it will call the API endpoint with the information provided to the server-side, the server then executes the necessary processing such as retrieving or updating data within the database and return back a proper response back to the client-side, and finally back to the system users.

7.2.1 System Design

Within the system design phase, the system design methodology, object-oriented analysis and design (OOAD) methodology was employed to describe the proposed system architecture in different diagrams including use case diagram, use case specification, activity diagram and sequence diagram. The class diagram was not illustrated within the system design phase as the object-oriented paradigm was not utilised during the system development, the system in overall was structured more alike to model-view-controller due to the client-side and server-side communication. However, the other diagrams formulated will without a doubt be abundantly effective in conveying the system architecture and its flow of communication from multitude perspective.

7.2.1.1 Use Case Diagram

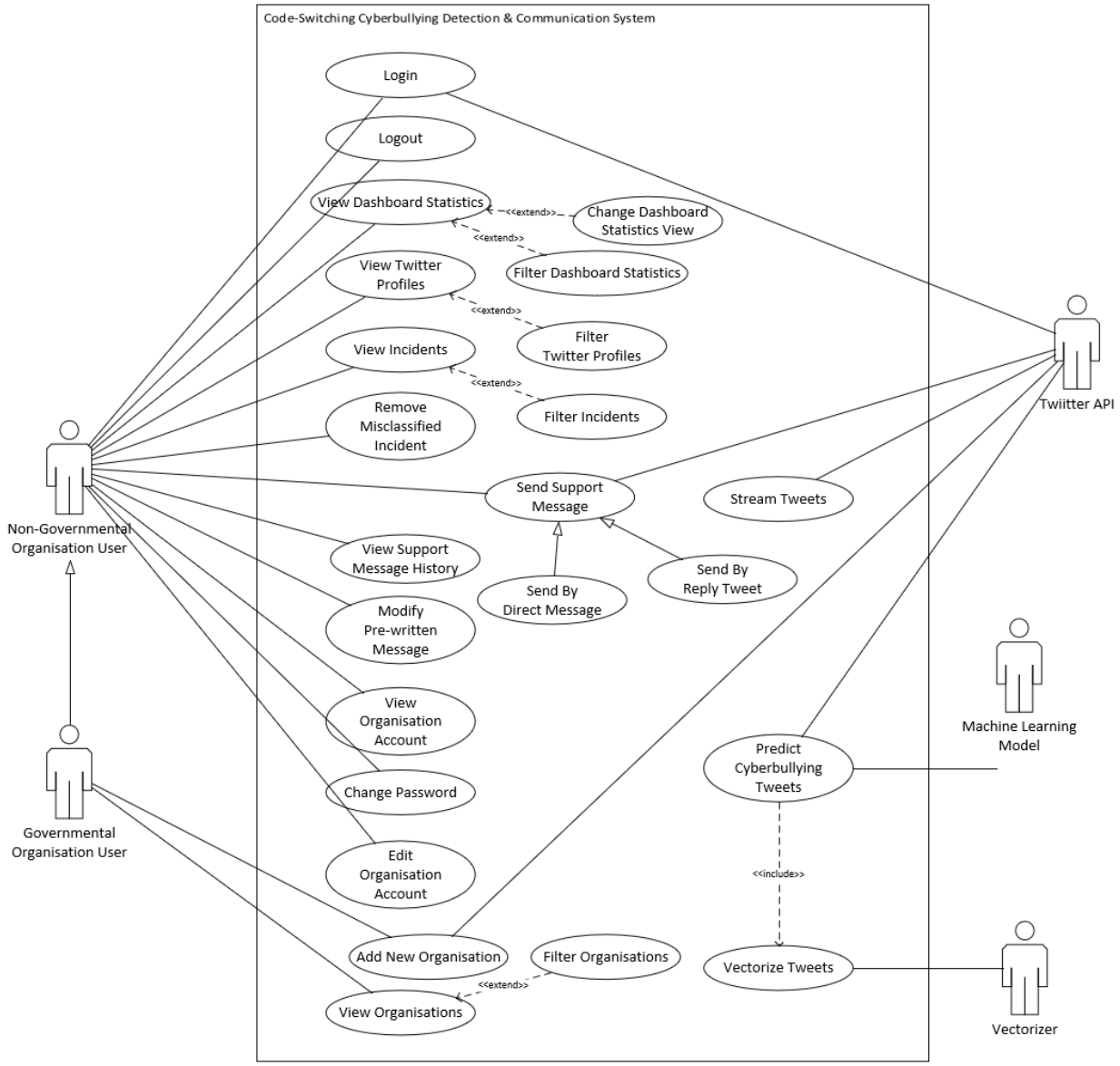


Figure 104: Use Case Diagram

7.2.1.2 Use Case Specification

7.2.1.2.1 Stream Tweets

Table 59: Use Case Specification - Stream Tweets

ID:	UC001	
Name:	Stream Tweets	
Actor(s):	Twitter API	
Description:	Represent the process of retrieving tweets from Twitter into the system.	
Pre-conditions:	The system has authenticated and connected with the Twitter Stream API service.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor encounters a tweet with location tag in Malaysia from Twitter. 2. The actor send the tweet to the system.	3. The system pre-process the given tweet such as removing punctuation and stop words.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	**Identified tweet with no location tag or not from Malaysia.**	
	Actor	**System**
	1. The actor encounters a tweet with no location tag or not from Malaysia.	-

	2. The actor does not send the tweet to the system.	
	Lost connection to Twitter Stream API.	
	Actor	**System**
		1. The system will not receive tweets until it has successfully connected back to the Twitter Stream API.
Post-conditions:	The Malaysia-based tweets, one after another will be constantly streamed into the system before being pre-processed.	

7.2.1.2.2 Vectorize Tweets

Table 60: Use Case Specification - Vectorize Tweets

ID:	UC002	
Name:	Vectorize Tweets	
Actor(s):	Vectorizer	
Description:	Represent the process of vectorizing pre-processed tweets in the system.	
Pre-conditions:	The incoming tweets are pre-processed beforehand.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor vectorize, essentially converting the tweet message into vector of real numbers.	-

Alternative Sequence of Events:	-
Exception Sequence of Events:	-
Post-conditions:	The pre-processed tweets are successfully vectorized.

7.2.1.2.3 Predict Cyberbullying Tweets

Table 61: Use Case Specification - Predict Cyberbullying Tweets

ID:	UC003		
Name:	Predict Cyberbullying Tweets		
Actor(s):	Machine Learning Model, Twitter API		
Description:	Represent the process of categorising tweets to be either cyberbullying or non-cyberbullying.		
Pre-conditions:	The incoming tweets are vectorized beforehand.		
Main Sequence of Events:	**Machine Learning Model**	**System**	**Twitter API**
	1. The machine learning model takes the vectorized tweet and give a prediction value indicating the tweet containing cyberbullying connotation.	3. The system encrypt the profile's Twitter ID and username as well as the tweet's message and its Twitter ID using the AES encryption algorithm	2. The Twitter API retrieves mentioned Twitter profiles information.

		under CBC mode of 256 bits on the server-side. 4. The system save the involved profiles, the relevant messages alongside the location specifically the district and the state the tweet was posted from into the database.	
Alternative Sequence of Events:	**The tweet was replying to another tweet.**		
	Machine Learning Model	**System**	**Twitter API**
	1. The machine learning model takes the vectorized tweet and give a prediction value indicating the tweet containing cyberbullying connotation.	4. The system encrypt the profile's Twitter ID and username as well as the tweet's message and its Twitter ID using the AES encryption algorithm under CBC mode of 256 bits on the server-side. 5. The system save the involved profiles, the	2. The Twitter API retrieves replied tweet and Twitter profiles information. 3. The Twitter API retrieves mentioned Twitter profiles information.

		relevant messages alongside the location specifically the district and the state the tweet was posted from into the database.	
	The profile has already been existed within the database.		
	Machine Learning Model	**System**	**Twitter API**
	1. The machine learning model takes the vectorized tweet and give a prediction value indicating the tweet containing cyberbullying connotation.	3. The system encrypt the tweet's message and its Twitter ID using the AES encryption algorithm under CBC mode of 256 bits. 4. The system update the existing profiles and save the relevant messages alongside the location specifically the district and the state the tweet was posted from into the database.	2. The Twitter API retrieves mentioned Twitter profiles information.

	The tweet message was predicted to not have cyberbullying intention.	
	Machine Learning Model	**System**
	1. The machine learning model takes the vectorized tweet and give a prediction value indicating the tweet does not contain any cyberbullying connotation.	2. The system neglects the tweet.
Exception Sequence of Events:	-	
Post-conditions:	The cyberbullying tweet message together with other relevant message as well as the involved profile are newly updated within the database successfully.	

7.2.1.2.4 Login

Table 62: Use Case Specification - Login

ID:	UC004
Name:	Login
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User, Twitter API
Description:	Represent the process of authenticating into the system through entering registered credentials.
Pre-conditions:	The user is currently on the login page.

<table>
<tr><td rowspan="2">Main Sequence of Events:</td><td>Non-Governmental Organisation User, Governmental Organisation User</td><td>System</td></tr>
<tr><td>1. The user enters the correct credentials on the respective fields.

2. The user selects the “Login” option to confirm login process.</td><td>3. The system confirms the existence of the entered username within the database.

4. The system confirms the decrypted password matches the hashed password stored within the database.

5. The system redirects the actor to the dashboard page.</td></tr>
<tr><td rowspan="3">Alternative Sequence of Events:</td><td colspan="3">First time login.</td></tr>
<tr><td>Non-Governmental Organisation User, Governmental Organisation User</td><td>System</td><td>Twitter API</td></tr>
<tr><td>1. The user enters the correct credentials on the respective fields.

2. The user selects the “Login” option to confirm login process.</td><td>3. The system confirms the existence of the entered username within the database.

4. The system confirms the decrypted password matches the</td><td>6. The Twitter API provide authorisation link.

10. The Twitter API identifies valid pin code.</td></tr>
</table>

	8. The user enters the pin code received from logging into the organisation's Twitter account from the link given. 9. The user selects the "Submit" option.	hashed password stored within the database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal with the authorisation hyperlink to permit the system to access the organisation's Twitter account. 11. The system updates the organisation account's Twitter tokens in the database. 12. The system redirects the actor to the dashboard page.	

Exception Sequence of Events:	**Invalid input(s).**	
	Non-Governmental Organisation User, Governmental Organisation User	**System**

	1. The user enters invalid input on the respective fields. 2. The user selects the "Login" option to confirm login process.	3. The system highlights the invalid fields with red and triggers the respective tooltip indicating the valid input for the corresponding fields.
	Wrong username and password.	
	Non-Governmental Organisation User, Governmental Organisation User	**System**
	1. The user enters the wrong username and password. 2. The user selects the "Login" option to confirm login process.	3. The system confirms there is no organisation account with the username. 4. The system displays an error message stating that either the username or the password is wrong.
	Correct username but wrong password.	
	Non-Governmental Organisation User, Governmental Organisation User	**System**
	1. The user enters the correct username but wrong password on the respective fields.	3. The system confirms the existence of the entered username within the database.

	2. The user selects the "Login" option to confirm login process.	4. The system displays an error message stating that the password is wrong.	
	First time login but the user cancels authorising the system to access the organisation's Twitter account.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user enters the correct credentials on the respective fields. 2. The user selects the "Login" option to confirm login process. 8. The user selects the "Cancel" option. 10. The user selects the "Continue" option in the pop-up modal.	3. The system confirms the existence of the entered username within the database. 4. The system confirms the decrypted password matches the hashed password stored within the database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal with the authorisation hyperlink to permit the	6. The Twitter API provides authorisation link.

		system to access the organisation's Twitter account. 9. The system displays a response message stating the authorisation process was unsuccessful due to it being cancelled on a pop-up modal. 11. The system closes the pop-up modal.	
	First time login but the user uses a wrong Twitter account that contradicts to the Twitter ID saved in the database during authorisation process.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user enters the correct credentials on the respective fields. 2. The user selects the "Login" option to confirm login process. 7. The user enters the pin code received from	3. The system confirms the existence of the entered username within the database. 4. The system confirms the decrypted password matches the	6. The Twitter API provides authorisation link. 9. The Twitter API identifies valid pin code.

	logging into a random Twitter account from the link given. 8. The user selects the "Submit" option. 11. The user selects the "Continue" option in the pop-up modal.	hashed password stored within the database. 5. The system requests authorisation link from Twitter API. 6. The system displays a Twitter login modal with the authorisation hyperlink to permit the system to access the organisation's Twitter account. 10. The system displays a response message stating the authorisation process was unsuccessful due to the usage of a wrong Twitter account on a pop-up modal. 12. The system closes the pop-up modal.	
	First time login but the user enters the wrong pin code during authorisation process.		
	Non-Governmental Organisation User,	**System**	**Twitter API**

	Governmental Organisation User		
	1. The user enters the correct credentials on the respective fields. 2. The user selects the “Login” option to confirm login process. 8. The user enters the wrong pin code. 9. The user selects the “Submit” option. 12. The user selects the “Continue” option in the pop-up modal.	3. The system confirms the existence of the entered username within the database. 4. The system confirms the decrypted password matches the hashed password stored within the database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal with the authorisation hyperlink to permit the system to access the organisation’s Twitter account. 11. The system displays a response message stating the	6. The Twitter API provides authorisation link. 10. The Twitter API identifies invalid pin code.

		authorisation process was unsuccessful due to the submission of a wrong pin code. 13. The system closes the pop-up modal.	
Post-conditions:	The user is successfully authenticated into the system and redirected to the dashboard page.		

7.2.1.2.5 Logout

Table 63: Use Case Specification - Logout

ID:	UC005	
Name:	Logout	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of logging out of the system.	
Pre-conditions:	The actor must be authenticated into the system.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Logout" option from the navigation bar.	2. The system redirects the actor to the login page.
Alternative Sequence of Events:	-	

Exception Sequence of Events:	-
Post-conditions:	The actor is successfully logged out of the system and redirected to the login page.

7.2.1.2.6 View Dashboard Statistics

Table 64: Use Case Specification - View Dashboard Statistics

ID:	UC006	
Name:	View Dashboard Statistics	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of viewing the statistics within the dashboard page.	
Pre-conditions:	The actor must be authenticated into the system.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Dashboard" option from the navigation bar.	2. The system enables date selections within the calendar based on the earliest date of records saved in the database till the current date. 3. The system enables year selections based on the distinct years of records saved in the database.

		4. The system displays the overall statistics from last week alongside bar chart-based monthly statistics regarding cyberbullying incidents.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	-	
Post-conditions:	The statistics are successfully displayed onto the dashboard page.	

7.2.1.2.7 Change Dashboard Statistics View

Table 65: Use Case Specification - Change Dashboard Statistics View

ID:	UC007	
Name:	Change Dashboard Statistics View	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of changing the statistics view within the dashboard page.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the dashboard page.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the “Map” option.	2. The system enables date selections within the calendar

		based on the earliest date of records saved in the database till the current date. 3. The system enables month and year selections based on the distinct years and months of records saved in the database. 4. The system displays map-based monthly statistics regarding cyberbullying incidents.
Alternative Sequence of Events:	**Switch to bar chart view.**	
	Actor	**System**
	1. The actor selects the "Bar Chart" option.	2. The system enables date selections within the calendar based on the earliest date of records saved in the database till the current date. 3. The system enables year selections based on the distinct years of records saved in the database. 4. The system displays bar chart-based monthly statistics regarding cyberbullying incidents.
Exception Sequence of Events:	-	

Post-conditions:	The statistics are successfully displayed onto the dashboard page in chosen view.

7.2.1.2.8 Filter Dashboard Statistics

Table 66: Use Case Specification - Filter Dashboard Statistics

ID:	UC008	
Name:	Filter Dashboard Statistics	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of filtering the statistics within the dashboard page.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the dashboard page.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor switch to the "Day" option on the time filter during bar chart view.	2. The system displays the bar chart-based daily statistics specifically throughout seven dates of records beginning from the current date regarding cyberbullying incidents.
Alternative Sequence of Events:	**Filter by selected date during bar chart view.**	
	Actor	**System**

	1. The actor selects a date from the available dates in the calendar.	2. The system displays the bar chart-based daily statistics specifically throughout seven dates of records beginning from the selected date regarding cyberbullying incidents.
	Switch to the "Month" option during bar chart view.	
	Actor	**System**
	1. The actor switch to the "Month" option on the time filter during bar chart view.	2. The system displays the bar chart-based monthly statistics specifically throughout the months from the latest year of records regarding cyberbullying incidents.
	Filter by selected year during bar chart view.	
	Actor	**System**
	1. The actor selects a year from the available year options.	2. The system displays the bar chart-based monthly statistics specifically throughout the months from the selected year of records regarding cyberbullying incidents.
	Switch to "Day" option during map view.	
	Actor	**System**
	1. The actor switch to the "Day" option on the time filter during map view.	2. The system displays the map-based daily statistics specifically

		based on the current date regarding cyberbullying incidents.
	Filter by selected date during map view.	
	Actor	**System**
	1. The actor selects a date from the available dates in the calendar.	2. The system displays the map-based daily statistics specifically based on the selected date regarding cyberbullying incidents.
	Switch to the "Month" option during map view.	
	Actor	**System**
	1. The actor switch to the "Month" option on the time filter during map view.	2. The system displays the map-based monthly statistics specifically based on the latest month and year of records regarding cyberbullying incidents.
	Filter by selected month and/or year during bar chart view.	
	Actor	**System**
	1. The actor selects a month and/or year from the available month and year options.	2. The system displays the map-based monthly statistics specifically based on the selected month and/or year of records regarding cyberbullying incidents.
Exception Sequence of Events:	-	

Post-conditions:	The statistics are successfully filtered and displayed onto the dashboard page.

7.2.1.2.9 View Twitter Profiles

Table 67: Use Case Specification - View Twitter Profiles

ID:	UC009	
Name:	View Twitter Profiles	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of viewing the twitter profiles on the twitter profiles page.	
Pre-conditions:	The actor must be authenticated into the system.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Twitter Profiles" option from the navigation bar.	2. The system displays a list of Twitter profiles that have involved in cyberbullying or cybervictim incidents.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	**There are no twitter profiles with incidents involved saved within the database.**	
	Actor	**System**

	1. The actor selects the "Twitter Profiles" option from the navigation bar.	2. The system displays a message stating there were no profiles found.
Post-conditions:	A list of Twitter profiles is successfully displayed on the Twitter profiles page.	

7.2.1.2.10 Filter Twitter Profiles

Table 68: Use Case Specification - Filter Twitter Profiles

ID:	UC0010	
Name:	Filter Twitter Profiles	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of filtering the Twitter profiles on the Twitter profiles page.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the Twitter profiles page.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor enters a username onto the search field.	2. The system displays the filtered list of Twitter profiles based on the Twitter username entered that have involved in cyberbullying or cybervictim incidents.
	Filter Twitter profiles by support status.	

Alternative Sequence of Events:	**Actor**	**System**
	1. The actor selects the “Not Yet”, “Offered” and/or “Offered Yet Continues” support status options.	2. The system displays the filtered list of Twitter profiles based on the support status options that have involved in cyberbullying or cybervictim incidents.
	Filter Twitter profiles by roles.	
	Actor	**System**
	1. The actor selects the “Cyberbully”, “Cybervictim” and/or “Cyberbully-Victim” role options.	2. The system displays the filtered list of Twitter profiles based on the role options that have involved in cyberbullying or cybervictim incidents.
	Filter Twitter profiles by toxicity level.	
	Actor	**System**
	1. The actor selects the “Low”, “Medium” and/or “High” toxicity level options.	2. The system displays the filtered list of Twitter profiles based on the toxicity level options that have involved in cyberbullying or cybervictim incidents.
	Filter Twitter profiles by page number.	
	Actor	**System**
	1. The actor selects the next page, previous page or a page number.	2. The system displays the filtered list of Twitter profiles based on the

		page number options that have involved in cyberbullying or cybervictim incidents.
Exception Sequence of Events:	**There are no Twitter profiles with incidents involved saved within the database according to the filter(s) given.**	
	Actor	**System**
	1 The actor provides a combination of filters.	2. The system displays a message stating there were no profiles found.
Post-conditions:	The filtered list of Twitter profiles is successfully displayed on the twitter profiles page.	

7.2.1.2.11 View Incidents

Table 69: Use Case Specification - View Incidents

ID:	UC011	
Name:	View Incidents	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of viewing selected profile's incidents on the profile details modal.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the Twitter profiles page.	
	Actor	**System**

Main Sequence of Events:	1. The actor selects the "View Incidents" option of a particular profile on the Twitter profiles page.	2. The system displays the incident filters based on profile's role. 3. The system displays the list of incidents involved.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	-	
Post-conditions:	The selected profile's incidents are successfully displayed on the profile details modal.	

7.2.1.2.12 Filter Incidents

Table 70: Use Case Specification - Filter Incidents

ID:	UC012	
Name:	Filter Incidents	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of filtering selected profile's incidents on the profile details modal.	
Pre-conditions:	The actor must be authenticated into the system and is currently opening the profile details modal.	
	Actor	**System**

Main Sequence of Events:	1. The actor selects the "Cyberbully" option on the incidents filter.	2. The system displays the filtered list of profile's incidents based on the cyberbullying incidents involved.
Alternative Sequence of Events:	**Filter incidents by cybervictims incidents involved.**	
	Actor	**System**
	1. The actor selects the "Cybervictim" option on the incidents filter.	2. The system displays the filtered list of profile's incidents based on the cybervictim incidents involved.
Exception Sequence of Events:	-	
Post-conditions:	The selected profile's incidents are successfully filtered and displayed on the profile details modal.	

7.2.1.2.13 Remove Misclassified Incident

Table 71: Use Case Specification - Remove Misclassified Incident

ID:	UC013
Name:	Remove Misclassified Incident
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User
Description:	Represent the process of removing a profile's incident on the profile details modal.

Pre-conditions:	The actor must be authenticated into the system and is currently opening the profile details modal.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Remove Incident" option on a particular incident. 4. The actor selects the "Continue" option in the pop-up modal.	2. The system deletes the incident record from the database. 3. The system displays a response message stating the incident has been successfully removed on a pop-up modal. 5. The system closes the pop-up modal. 6. The system refreshes the list of profile's incidents in the profile details modal.
Alternative Sequence of Events:	**The profile has no cyberbullying incidents left.**	
	Actor	**System**
	1. The actor selects the "Remove Incident" option on a particular cyberbullying incident. 4. The actor selects the "Continue" option in the pop-up modal.	2. The system deletes the incident record from the database. 3. The system displays a response message stating the incident has been successfully removed on a pop-up modal. 5. The system closes the pop-up modal.

		6. The system refreshes the list of profile's incidents in the profile details modal. 7. The system removes the "Cyberbully" option within the incidents filter.
	The profile has no cybervictim incidents left.	
	Actor	**System**
	1. The actor selects the "Remove Incident" option on a particular cybervictim incident. 4. The actor selects the "Continue" option in the pop-up modal.	2. The system deletes the incident record from the database. 3. The system displays a response message stating the incident has been successfully removed on a pop-up modal. 5. The system closes the pop-up modal. 6. The system refreshes the list of profile's incidents in the profile details modal. 7. The system removes the "Cybervictim" option within the incidents filter.
	The profile has no incidents left.	
	Actor	**System**

	1. The actor selects the "Remove Incident" option on a particular cybervictim incident. 4. The actor selects the "Continue" option in the pop-up modal.	2. The system deletes the incident record and updates the profiles' role within the database. 3. The system displays a response message stating the incident as well as the related profiles has been successfully removed on a pop-up modal. 5. The system closes the pop-up modal along with the profile details modal. 6. The system refreshes the list of Twitter profiles in the Twitter profiles page.
Exception Sequence of Events:	-	
Post-conditions:	The incident is successfully removed and the actor would be displayed a pop-up message before dismissing and be redirected back to the profile details modal.	

7.2.1.2.14 Send Support Message By Reply Tweet

Table 72: Use Case Specification - Send Support Message By Reply Tweet

ID:	UC014
Name:	Send Support Message By Reply Tweet

Actor(s):	Non-Governmental Organisation User, Governmental Organisation User, Twitter API		
Description:	Represent the process of sending support message on the support message modal through replying to a tweet publicly.		
Pre-conditions:	The user must be authenticated into the system and is currently opening the profile details modal.		
Main Sequence of Events:	**Non-Governmental Organisation User, Governmental Organisation User**	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user selects the "Continue" option in the pop-up modal.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's Twitter account stored within database. 6. The system saves the sending instance including the current date, the profile	5. The Twitter API sends the support message to the chosen tweet/incident using organisation's Twitter account.

		alongside its role during that moment into the database. 7. The system displays a response message stating the support message has been successfully sent on a pop-up modal. 9. The system closes the pop-up modal.	
Alternative Sequence of Events:	-		
Exception Sequence of Events:	**The organisation account's Twitter tokens have been expired or became invalid. The user successfully authorises the system to access the organisation's Twitter account.**		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown.	6. The Twitter API provides authorisation link. 10. The Twitter API identifies valid pin code.

	8. The user enters the pin code received from logging into the organisation's Twitter account from the link given. 9. The user selects the "Submit" option. 13. The user selects the "Continue" option.	4. The system failed to establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system updates the organisation account's Twitter tokens in the database.	

		12. The system displays a response message stating the authorisation have been successful and attempt to send the support message again on a pop-up modal. 14. The system closes the pop-up modal.	
	The organisation account's Twitter tokens have been expired or became invalid. The user cancels authorising the system to access the organisation's Twitter account.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user selects the "Cancel" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system failed to establish connection to the Twitter API using	6. The Twitter API provides authorisation link.

	10. The user selects the "Continue" option.	organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 9. The system displays a response message stating the authorisation process was unsuccessful due to it being cancelled on a pop-up modal.	

		11. The system closes the pop-up modal.	
	The organisation account's Twitter tokens have been expired or became invalid. The user uses a wrong Twitter account that contradicts to the Twitter ID saved in the database during authorisation process.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user enters the pin code received from logging into a random Twitter account from the link given. 9. The user selects the "Submit" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system failed to establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API.	6. The Twitter API provides authorisation link. 10. The Twitter API identifies valid pin code.

	12. The user selects the "Continue" option.	7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system displays a response message stating the authorisation process was unsuccessful due to the usage of a wrong Twitter account on a pop-up modal. 13. The system closes the pop-up modal.	
	The organisation account's Twitter tokens have been expired or became invalid. The user enters the wrong pin code during authorisation process.		

	Non-Governmental Organisation User, Governmental Organisation User	System	Twitter API
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user enters the wrong pin code. 9. The user selects the "Submit" option. 12. The user selects the "Continue" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation	6. The Twitter API provides authorisation link. 10. The Twitter API identifies invalid pin code.

		hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system displays a response message stating the authorisation process was unsuccessful due to the submission of a wrong pin code. 13. The system closes the pop-up modal.	
	The same message sent to the same tweet twice.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown.	5. The Twitter API failed to send the support message to the chosen tweet/incident using organisation's Twitter account.

	7. The user selects the "Continue" option.	4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system displays a response message stating that the status is a duplicate and the same message cannot be sent to the same tweet twice on a pop-up modal. 8. The system closes the pop-up modal.	
	The tweet has been deleted in Twitter. The profile still has both cyberbullying and cybervictim incidents involved.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option.	2. The system displays support message modal with the decrypted support message according to	5. The Twitter API failed to send the support message to the chosen tweet/incident using organisation's Twitter account.

	8. The user selects the "Continue" option.	the profile's role shown. 4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system deletes the tweet/incident record from the database. 7. The system displays a response message stating that the tweet has been deleted in Twitter and the incident will be removed from the system on a pop-up modal. 9. The system closes the pop-up modal. 10. The system refreshes the list of profile's incidents in the profile details modal.	

	The tweet has been deleted in Twitter. The profile has no cyberbullying incidents left.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user selects the "Continue" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system deletes the tweet/incident record from the database. 7. The system displays a response message stating that the tweet has been deleted in Twitter and the	5. The Twitter API failed to send the support message to the chosen tweet/incident using organisation's Twitter account.

		incident will be removed from the system on a pop-up modal. 9. The system closes the pop-up modal. 10. The system refreshes the list of profile's incidents in the profile details modal. 11. The system removes the "Cyberbully" option within the incidents filter.	
	The tweet has been deleted in Twitter. The profile has no cybervictim incidents left.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident.	2. The system displays support message modal with the decrypted support message according to	5. The Twitter API failed to send the support message to the chosen tweet/incident

	3. The user selects the “Send” option. 8. The user selects the “Continue” option.	the profile’s role shown. 4. The system establish connection to the Twitter API using organisation’s account stored within database. 6. The system deletes the tweet/incident record from the database. 7. The system displays a response message stating that the tweet has been deleted in Twitter and the incident will be removed from the system on a pop-up modal. 9. The system closes the pop-up modal. 10. The system refreshes the list of profile’s incidents in the profile details modal.	using organisation’s Twitter account.

		11. The system removes the "Cyberbully" option within the incidents filter.	
	The tweet has been deleted in Twitter. The profile has no incidents left.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Reply Tweet" option on a particular incident. 3. The user selects the "Send" option. 8. The user selects the "Continue" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system deletes the tweet/incident record from the database.	5. The Twitter API failed to send the support message to the chosen tweet/incident using organisation's Twitter account.

		7. The system displays a response message stating that the tweet has been deleted in Twitter and the incident will be removed from the system on a pop-up modal. 9. The system closes the pop-up modal along with the profile details modal. 10. The system refreshes the list of Twitter profiles in the Twitter profiles page.	
Post-conditions:	The support message is successfully sent to the particular tweet through replying to it publicly.		

7.2.1.2.14 Send Support Message By Direct Message

Table 73: Use Case Specification - Send Support Message By Direct Message

ID:	UC015
Name:	Send Support Message By Direct Message

Actor(s):	Non-Governmental Organisation User, Governmental Organisation User, Twitter API		
Description:	Represent the process of sending support message on the support message modal through direct messaging to a profile on Twitter privately.		
Pre-conditions:	The user must be authenticated into the system and is currently opening the profile details modal.		
Main Sequence of Events:	**Non-Governmental Organisation User, Governmental Organisation User**	**System**	**Twitter API**
	1. The user selects the "Direct Message" option. 3. The user selects the "Send" option. 8. The user selects the "Continue" option in the pop-up modal.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's Twitter account stored within database. 6. The system saves the sending instance including the current	5. The Twitter API sends the support message to the particular profile on Twitter using organisation's Twitter account.

		date, the profile alongside its role during that moment into the database. 7. The system displays a response message stating the support message has been successfully sent on a pop-up modal. 9. The system closes the pop-up modal.	
Alternative Sequence of Events:	-		
Exception Sequence of Events:	**The organisation account's Twitter tokens have been expired or became invalid. The user successfully authorises the system to access the organisation's Twitter account.**		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Direct Message". 3. The user selects the "Send" option.	2. The system displays support message modal with the decrypted support message according to	6. The Twitter API provides authorisation link. 10. The Twitter API identifies valid pin code.

	8. The user enters the pin code received from logging into the organisation's Twitter account from the link given. 9. The user selects the "Submit" option. 13. The user selects the "Continue" option.	the profile's role shown. 4. The system failed to establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system updates the organisation account's	

		Twitter tokens in the database. 12. The system displays a response message stating the authorisation have been successful and attempt to send the support message again on a pop-up modal. 14. The system closes the pop-up modal.	
	The organisation account's Twitter tokens have been expired or became invalid. The user cancels authorising the system to access the organisation's Twitter account.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Direct Message". 3. The user selects the "Send" option. 8. The user selects the "Cancel" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown.	6. The Twitter API provides authorisation link.

	10. The user selects the "Continue" option.	4. The system failed to establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 9. The system displays a response message stating the authorisation process was unsuccessful due	

		to it being cancelled on a pop-up modal. 11. The system closes the pop-up modal.	
	The organisation account's Twitter tokens have been expired or became invalid. The user uses a wrong Twitter account that contradicts to the Twitter ID saved in the database during authorisation process.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Direct Message". 3. The user selects the "Send" option. 8. The user enters the pin code received from logging into a random Twitter account from the link given. 9. The user selects the "Submit" option. 12. The user selects the "Continue" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system failed to establish connection to the Twitter API using organisation's Twitter account stored within database.	6. The Twitter API provides authorisation link. 10. The Twitter API identifies valid pin code.

		5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system displays a response message stating the authorisation process was unsuccessful due to the usage of a wrong Twitter account on a pop-up modal. 13. The system closes the pop-up modal.	

	The organisation account's Twitter tokens have been expired or became invalid. The user enters the wrong pin code during authorisation process.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Direct Message". 3. The user selects the "Send" option. 8. The user enters the wrong pin code. 9. The user selects the "Submit" option. 12. The user selects the "Continue" option.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's Twitter account stored within database. 5. The system requests authorisation link from Twitter API. 7. The system displays a Twitter login modal included with a message stating that	6. The Twitter API provides authorisation link. 10. The Twitter API identifies invalid pin code.

		the tokens have been expired or became invalid and an authorisation hyperlink has been provided in order to permit the system to access the organisation's Twitter account. 11. The system displays a response message stating the authorisation process was unsuccessful due to the submission of a wrong pin code. 13. The system closes the pop-up modal.	
	The profile disables direct messaging from outsiders on Twitter.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Direct Message" option.	2. The system displays support message modal with the decrypted support	5. The Twitter API failed to send the support message to the particular profile

	3. The user selects the "Send" option. 7. The user selects the "Continue" option.	message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system displays a response message stating that the user on Twitter did not allow direct messaging from outsiders on a pop-up modal. 8. The system closes the pop-up modal.	on Twitter using organisation's Twitter account.
	The profile on Twitter has been deactivated.		
	Non-Governmental Organisation User, Governmental Organisation User	**System**	
	1. The user selects the "Direct Message" option.	2. The system displays support message modal with	5. The Twitter API failed to send the support message to

	3. The user selects the "Send" option. 8. The user selects the "Continue" option.	the decrypted support message according to the profile's role shown. 4. The system establish connection to the Twitter API using organisation's account stored within database. 6. The system updates the profile's role within the database. 7. The system displays a response message stating that the user on Twitter has been deactivated and the profile will be removed from the system on a pop-up modal. 9. The system closes the pop-up modal along with the profile details modal. 10. The system refreshes the list of	the particular profile on Twitter using organisation's Twitter account.

		Twitter profiles in the Twitter profiles page.	
Post-conditions:	The support message is successfully sent to the profile on Twitter through direct messaging privately.		

7.2.1.2.16 View Support Message History

Table 74: Use Case Specification - View Support Message History

ID:	UC016	
Name:	View Support Message History	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of viewing support message sent to the profile by organisations previously.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the profile details page.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Message History" option from the navigation bar.	2. The system displays the support message sent by the organisations previously with the profile's role at the support instance.
Alternative Sequence of Events:	-	

Exception Sequence of Events:	-
Post-conditions:	The support message history of the profile is successfully displayed.

7.2.1.2.17 Modify Pre-written Message

Table 75: Use Case Specification - Modify Pre-written Message

ID:	UC017	
Name:	Modify Pre-written Message	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of modifying the pre-written support message.	
Pre-conditions:	The actor must be authenticated into the system and is currently opening the profile details modal.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Reply Tweet" option on a particular incident. 3. The actor selects the "Modify" option. 5. The actor enters valid support message input.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system enables modification on the pre-written message input field. 7. The system saves the encrypted support message in the database.

	6. The actor selects the “Save” option. 9. The actor selects the “Continue” option.	8. The system displays a response message stating the support message has been successfully saved on a pop-up modal. 10. The system closes the pop-up modal. 11. The system disables the modification on the pre-written message input field.
Alternative Sequence of Events:	**Modify pre-written message during direct message.**	
	Actor	**System**
	1. The actor selects the “Direct Message” option. 3. The actor selects the “Modify” option. 5. The actor enters valid support message input. 6. The actor selects the “Save” option. 9. The actor selects the “Continue” option.	2. The system displays support message modal with the decrypted support message according to the profile’s role shown. 4. The system enables modification on the pre-written message input field. 7. The system saves the encrypted support message in the database. 8. The system displays a response message stating the support message has been successfully saved on a pop-up modal.

		10. The system closes the pop-up modal. 11. The system disables the modification on the pre-written message input field.
Exception Sequence of Events:	**Invalid support message input.**	
	Actor	**System**
	1. The actor selects the "Direct Message" option. 3. The actor selects the "Modify" option. 5. The actor enters invalid support message input.	2. The system displays support message modal with the decrypted support message according to the profile's role shown. 4. The system enables modification on the pre-written message input field. 6. The system triggers the tooltip indicating the valid input for support message.
Post-conditions:	The pre-written support message was successfully modified.	

7.2.1.2.18 View Organisation Account

Table 76: Use Case Specification - View Organisation Account

ID:	UC018
Name:	View Organisation Account

Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of viewing information on own organisation account.	
Pre-conditions:	The actor must be authenticated into the system.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Organisation" option from the navigation bar.	2. The system displays the organisation's information including the email address, phone number as well as its Twitter account's username.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	-	
Post-conditions:	The personal organisation information is successfully displayed.	

7.2.1.2.19 Change Password

Table 77: Use Case Specification - Change Password

ID:	UC019
Name:	Change Password
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User

Description:	Represent the process of changing the organisation's password within the system.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the organisation page.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Change Password" option. 3. The actor enters the current password, the new password and the matching new password. 4. The actor selects the 'Save" option to confirm password modification. 9. The actor selects the "Continue" option on the pop-up modal.	2. The system displays the change password modal with multiple input fields. 5. The system confirms the new passwords entered matches. 6. The system confirms decrypted current password matches the password saved within the database. 7. The system updates the decrypted and bcrypt-based hashed password according to the organisation into the database. 8. The system displays a response message stating that the password has been successfully changed. 10. The system closes the pop-up modal.
Alternative Sequence of Events:	-	

Exception Sequence of Events:	**Invalid password input.**	
	Actor	**System**
	1. The actor selects the "Change Password" option. 3. The actor enters invalid input in either password fields. 4. The actor selects the 'Save" option to confirm password modification.	2. The system displays the change password modal with multiple input fields. 5. The system highlights the invalid fields with red and triggers the tooltip indicating valid input for the password field.
	Wrong current password.	
	Actor	**System**
	1. The actor selects the "Change Password" option. 3. The actor enters the current password, the new password and the matching new password. 4. The actor selects the 'Save" option to confirm password modification.	2. The system displays the change password modal with multiple input fields. 5. The system confirms the new passwords entered matches. 6. The system confirms decrypted current password does not match the password saved within the database. 7. The system displays an error message stating the current password entered is wrong.
	Unmatching new passwords.	

	Actor	System
	1. The actor selects the "Change Password" option. 3. The actor enters the current password, the new password and the unmatching new password. 4. The actor selects the 'Save" option to confirm password modification.	2. The system displays the change password modal with multiple input fields. 5. The system confirms the new passwords entered does not match.
Post-conditions:	The organisation's password is successfully modified.	

7.2.1.2.20 Edit Organisation Account

Table 78: Use Case Specification - Edit Organisation Account

ID:	UC020	
Name:	Edit Organisation Account	
Actor(s):	Non-Governmental Organisation User, Governmental Organisation User	
Description:	Represent the process of modifying organisation's account information.	
Pre-conditions:	The actor must be authenticated into the system and is currently on the organisation page.	
	Actor	**System**

Main Sequence of Events:	1. The actor selects the "Edit Organisation" option. 3. The actor enters updated information on the respective fields. 4. The actor selects the 'Save" option to confirm organisation modification. 7. The actor selects the "Continue" option on the pop-up modal.	2. The system displays the edit organisation modal with multiple input fields. 5. The system updates the new organisation information into the database. 6. The system displays a response message stating that the organisation has been successfully edited on a pop-up modal. 8. The system closes the pop-up modal.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	**Invalid input(s).**	
	Actor	**System**
	1. The actor selects the "Edit Organisation" option. 3. The actor enters invalid input on the respective fields. 4. The actor selects the 'Save" option to confirm organisation modification.	2. The system displays the change password modal with multiple input fields. 5. The system highlights the invalid fields with red and triggers the respective tooltip indicating the valid input for the corresponding fields.

	Entered the same name as other organisations registered within the database.	
	Actor	**System**
	1. The actor selects the "Edit Organisation" option. 3. The actor enters updated information on the respective fields including the same name as another organisation registered within the database. 4. The actor selects the 'Save" option to confirm organisation modification.	2. The system displays the edit organisation modal with multiple input fields. 5. The system displays an error message stating that there is already organisation with the same name registered.
Post-conditions:	The organisation's information is successfully modified.	

7.2.1.2.21 View Organisations

Table 79: Use Case Specification - View Organisations

ID:	UC021
Name:	View Organisations
Actor(s):	Governmental Organisation User
Description:	Represent the process of viewing information of all the organisations registered into the system.

Pre-conditions:	The actor must be authenticated into the system.	
Main Sequence of Events:	**Actor**	**System**
	1. The actor selects the "Management" option from the navigation bar.	2. The system displays all the organisation's information including the email address as well as the phone number.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	-	
Post-conditions:	All the organisations' information registered into the system was successfully displayed.	

7.2.1.2.22 Filter Organisations

Table 80: Use Case Specification - Filter Organisations

ID:	UC022
Name:	Filter Organisations
Actor(s):	Governmental Organisation User
Description:	Represent the process of filtering the organisations on the management page.
Pre-conditions:	The actor must be authenticated into the system and is currently on the management page.

Main Sequence of Events:	**Actor**	**System**
	1. The actor enters an organisation name onto the search field.	2. The system displays the filtered list of organisations based on the organisation name entered that have registered into the system.
	Filter Twitter profiles by page number.	
	Actor	**System**
	1. The actor selects the next page, previous page or a page number.	2. The system displays the filtered list of organisations based on the page number options given that have registered into the system.
Alternative Sequence of Events:	-	
Exception Sequence of Events:	**There are no organisations saved within the database according to the filter(s) given.**	
	Actor	**System**
	1 The actor provides a combination of filters.	2. The system displays a message stating there were no organisations found.
Post-conditions:	The filtered list of organisations is successfully displayed on management page.	

7.2.1.2.23 Add New Organisation

Table 81: Use Case Specification - Add New Organisation

ID:	UC023		
Name:	Add New Organisation		
Actor(s):	Governmental Organisation User, Twitter API		
Description:	Represent the process of adding new organisation on the management page.		
Pre-conditions:	The user must be authenticated into the system and is currently on the management page.		
Main Sequence of Events:	**Governmental Organisation User**	**System**	**Twitter API**
	1. The user selects the "Add New Organisation" option. 3. The user enters new organisation information on the respective fields. 4. The user selects "Save" option to confirm adding new organisation. 12s. The user selects the "Continue" option in the pop-up modal.	2. The system displays the add organisation modal with multiple input fields. 5. The system request the Twitter ID based on entered Twitter username from Twitter API. 7. The system confirms that there is no organisation registered with the same name in the database.	6. The Twitter API provide the Twitter ID.

		8. The system confirms that there is no organisation registered with the same system username in the database. 9. The system confirms that there is no organisation registered with the same Twitter account in the database. 10. The system saves the new organisation information within the database. 11. The system displays a response message stating the new organisation has been added successfully including an automatically generated password on a pop-up modal. 13. The system closes the pop-up modal.	

<table>
<tr><td>Alternative Sequence of Events:</td><td colspan="3">-</td></tr>
<tr><td rowspan="6">Exception Sequence of Events:</td><td colspan="3">Invalid input(s).</td></tr>
<tr><td colspan="2">Governmental Organisation User</td><td>System</td></tr>
<tr><td colspan="2">1. The user selects the “Add New Organisation” option.

3. The user enters invalid input on the respective fields.

4. The user selects “Save” option” to confirm adding new organisation.</td><td>2. The system displays the add new organisation modal with multiple input fields.

5. The system highlights the invalid fields with red and triggers the respective tooltip indicating the valid input for the corresponding fields.</td></tr>
<tr><td colspan="3">The entered Twitter username does not exist on Twitter.</td></tr>
<tr><td>Governmental Organisation User</td><td>System</td><td>Twitter API</td></tr>
<tr><td>1. The user selects the “Add New Organisation” option.

3. The user enters new organisation information on the respective fields.

4. The user selects “Save” option to</td><td>2. The system displays the add organisation modal with multiple input fields.

5. The system request the Twitter ID based on entered Twitter username from Twitter API.</td><td>6. The Twitter API provide the Twitter ID.</td></tr>
</table>

	confirm adding new organisation.	7. The system displays an error message stating that the username did not exist on Twitter.	
	There is already an organisation with the same name registered within the database.		
	Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Add New Organisation" option. 3. The user enters new organisation information on the respective fields including the same name as another organisation registered within the database. 4. The user selects "Save" option" to confirm adding new organisation.	2. The system displays the add organisation modal with multiple input fields. 5. The system request the Twitter ID based on entered Twitter username from Twitter API. 7. The system confirms that there is already an organisation registered with the same name in the database. 8. The system displays an error message	6. The Twitter API provide the Twitter ID.

		stating that an organisation with the same name has already been registered within the system.	
	There is already an organisation with the same system username registered within the database.		
	Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Add New Organisation" option. 3. The user enters new organisation information on the respective fields including the same system username as another organisation's account registered within the database. 4. The user selects "Save" option" to confirm adding new organisation.	2. The system displays the add organisation modal with multiple input fields. 5. The system request the Twitter ID based on entered Twitter username from Twitter API. 7. The system confirms that there is no organisation registered with the same name in the database. 8. The system confirms that there is	6. The Twitter API provide the Twitter ID.

		already an organisation registered with the same system username in the database. 9. The system displays an error message stating that an organisation with the same system username has already been registered within the system.	
	There is already an organisation with the same Twitter account registered within the database.		
	Governmental Organisation User	**System**	**Twitter API**
	1. The user selects the "Add New Organisation" option. 3. The user enters new organisation information on the respective fields including the same Twitter account as another organisation	2. The system displays the add organisation modal with multiple input fields. 5. The system request the Twitter ID based on entered Twitter username from Twitter API.	6. The Twitter API provide the Twitter ID.

	registered within the database. 4. The user selects “Save” option” to confirm adding new organisation.	7. The system confirms that there is no organisation registered with the same name in the database. 8. The system confirms that there is no organisation registered with the same system username in the database. 9. The system confirms that there is already an organisation registered with the same Twitter account in the database. 10. The system displays an error message stating that an organisation with the same Twitter account has already been registered within the system.	

Post-conditions:	The new organisation is successfully added into the system.

7.2.1.3 Activity Diagram

7.2.1.3.1 Stream Tweets

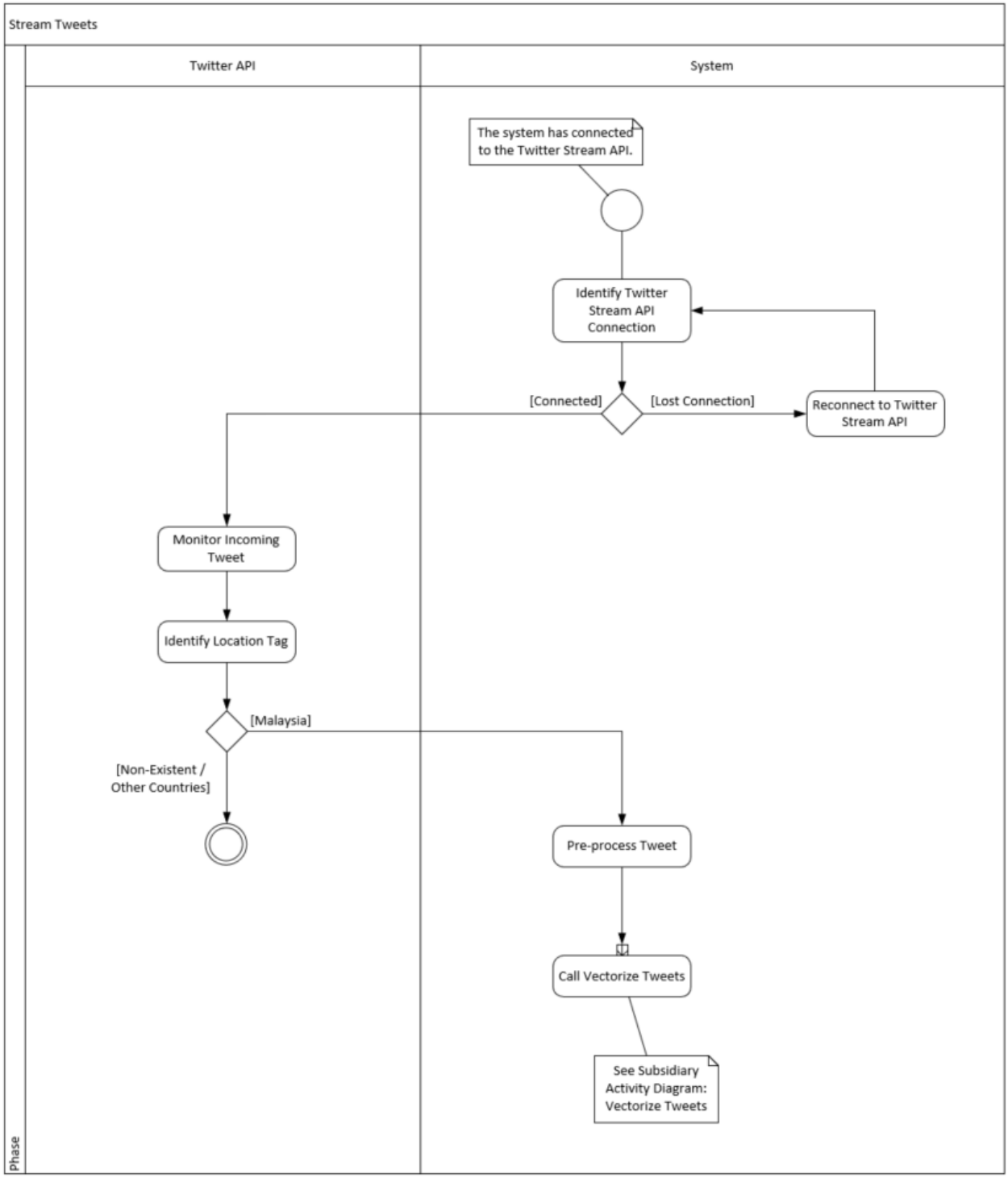


Figure 105: Activity Diagram - Stream Tweets

7.2.1.3.2 Vectorize Tweets

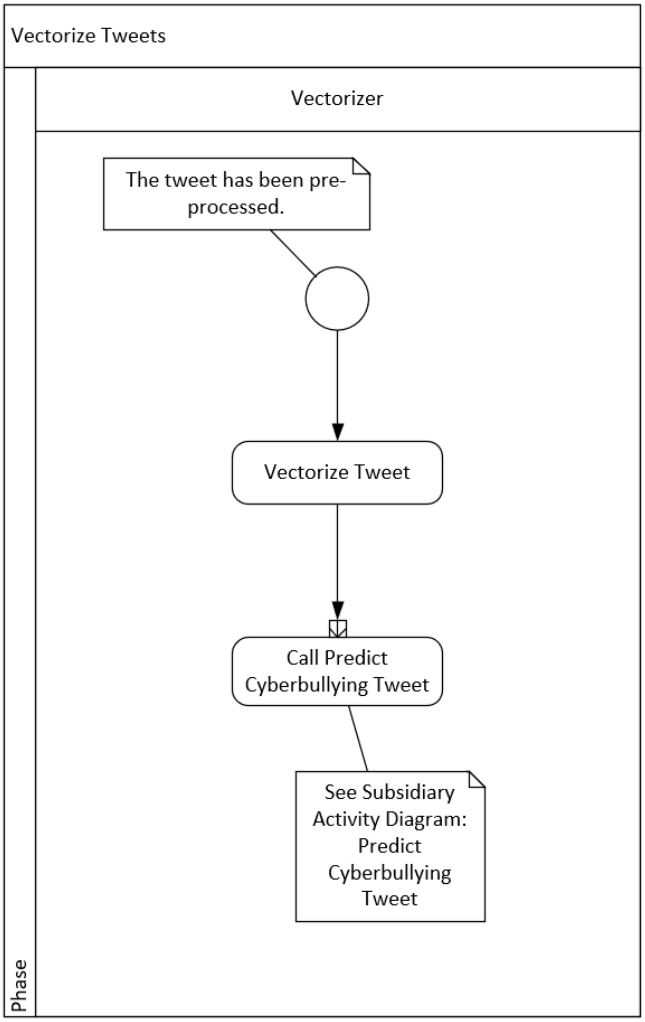


Figure 106: Activity Diagram - Vectorize Tweets

7.2.1.3.3 Predict Cyberbullying Tweets

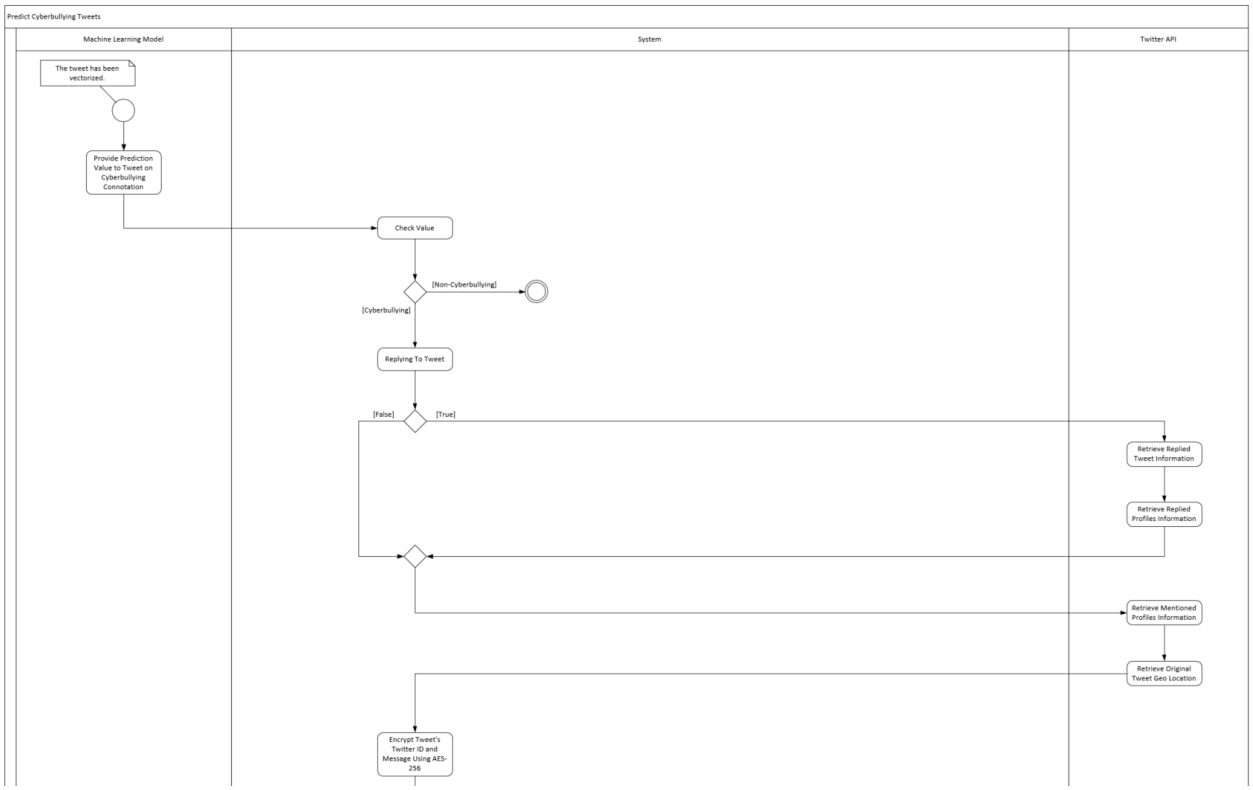


Figure 107: Activity Diagram - Predict Cyberbullying Tweets - Part 1

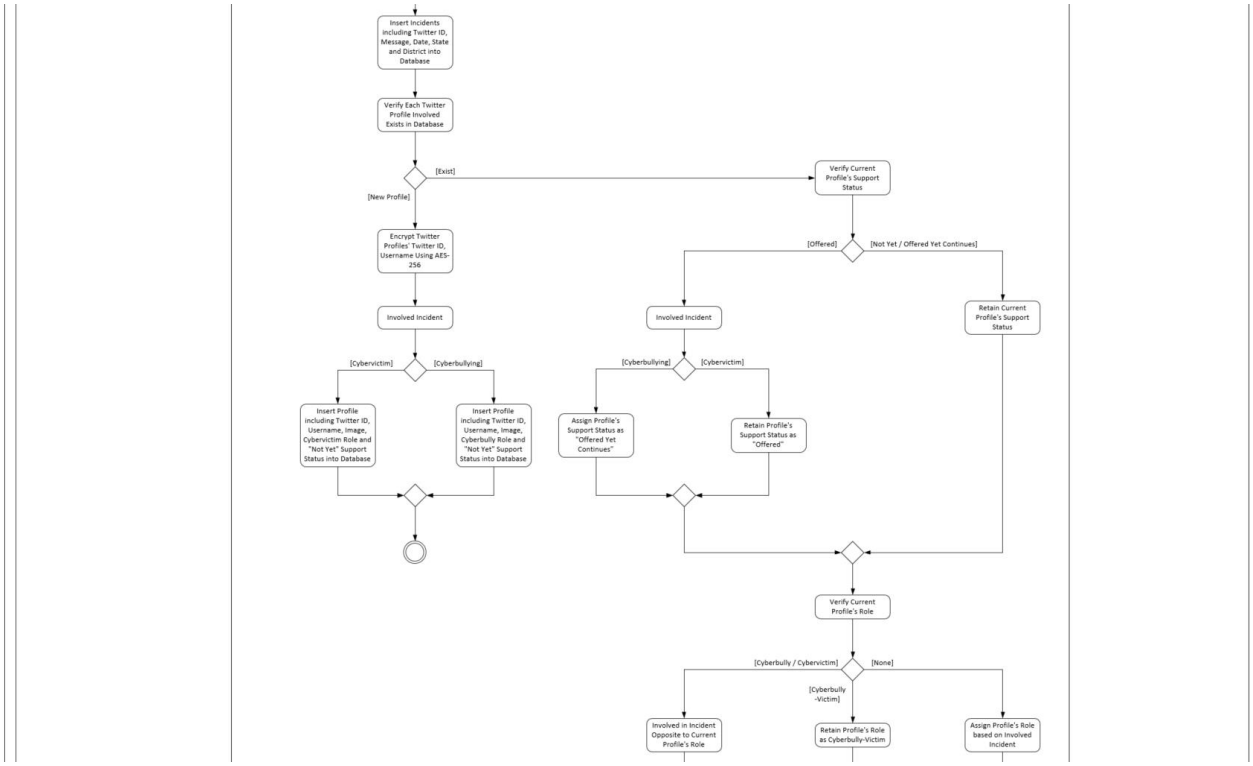


Figure 108: Activity Diagram - Predict Cyberbullying Tweets - Part 2

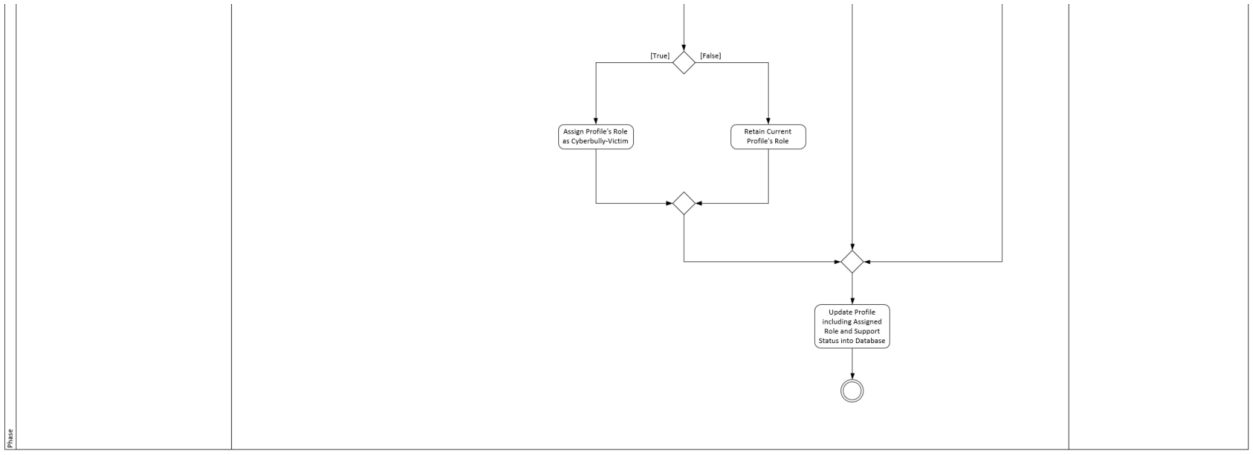


Figure 109: Activity Diagram - Predict Cyberbullying Tweets - Part 3

7.2.1.3.4 Login

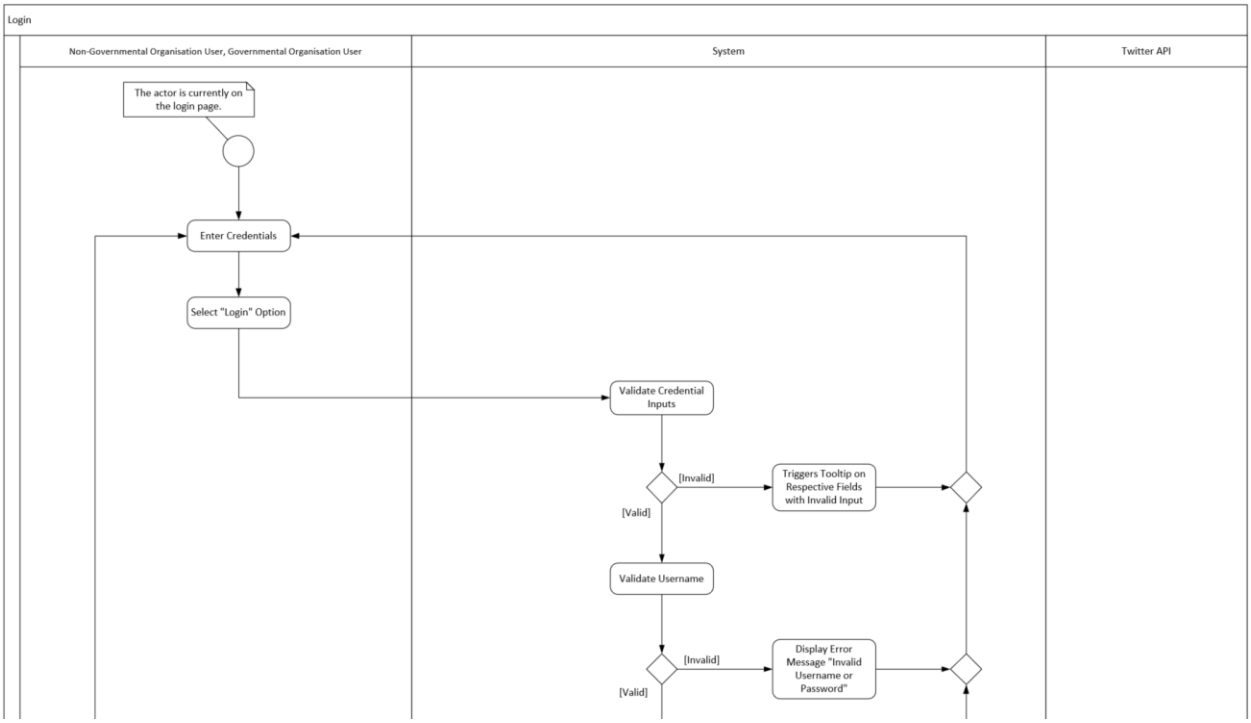


Figure 110: Activity Diagram - Login - Part 1

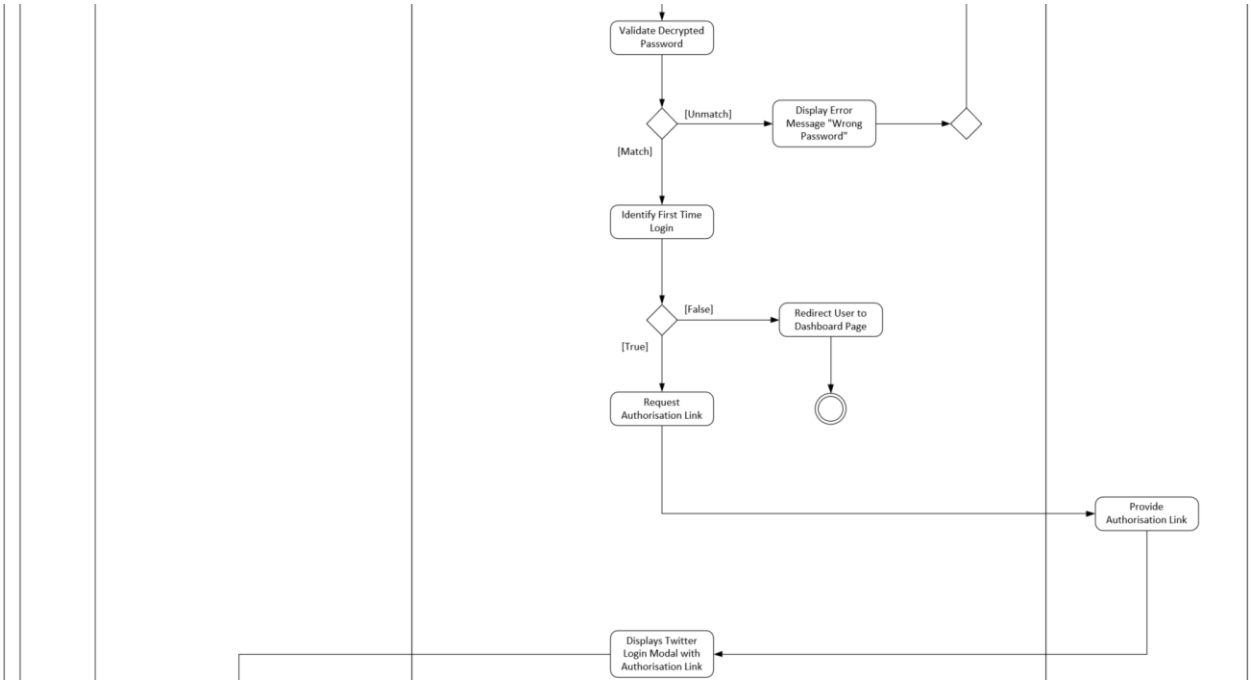


Figure 111: Activity Diagram - Login - Part 2

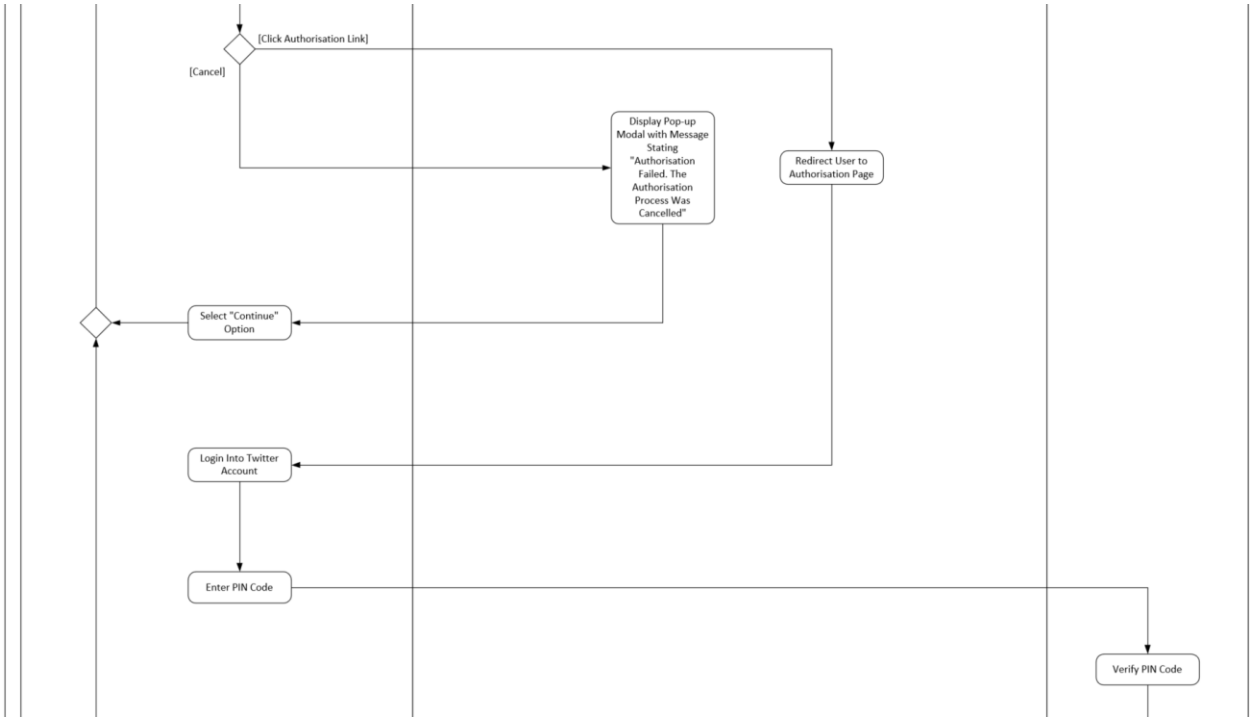


Figure 112: Activity Diagram - Login - Part 3

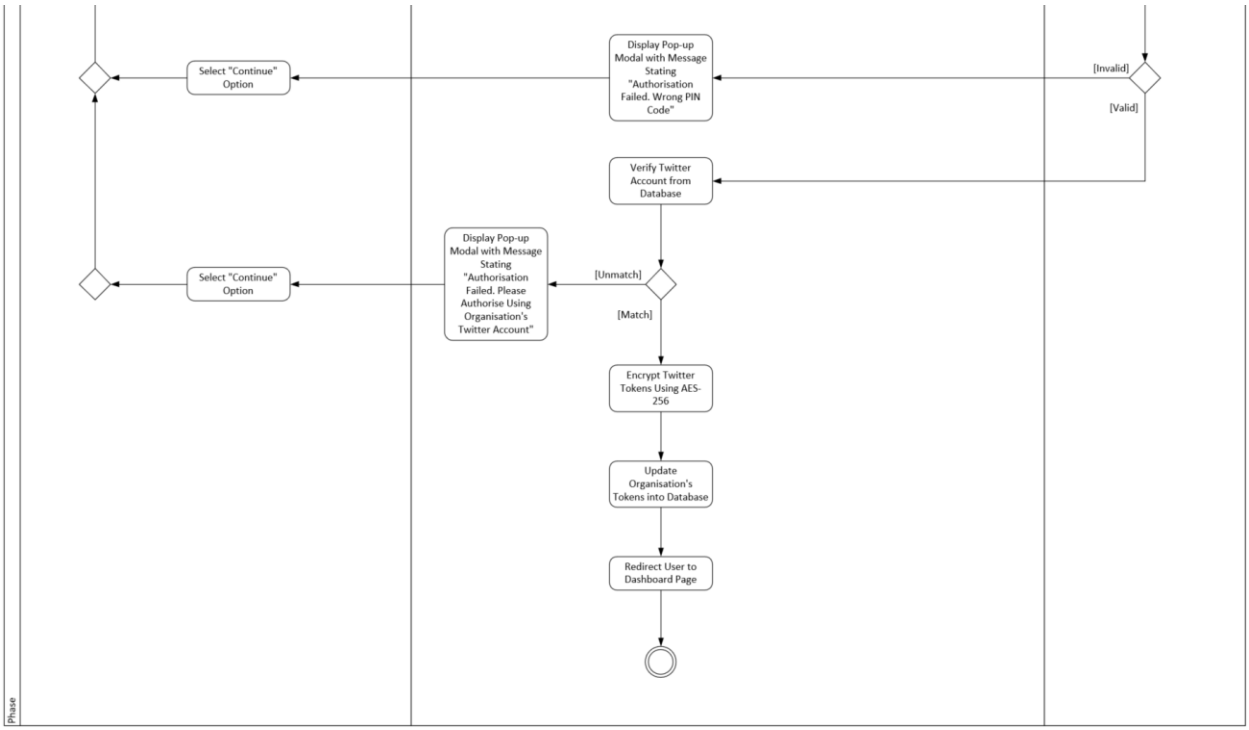


Figure 113: Activity Diagram - Login - Part 4

7.2.1.3.5 Logout

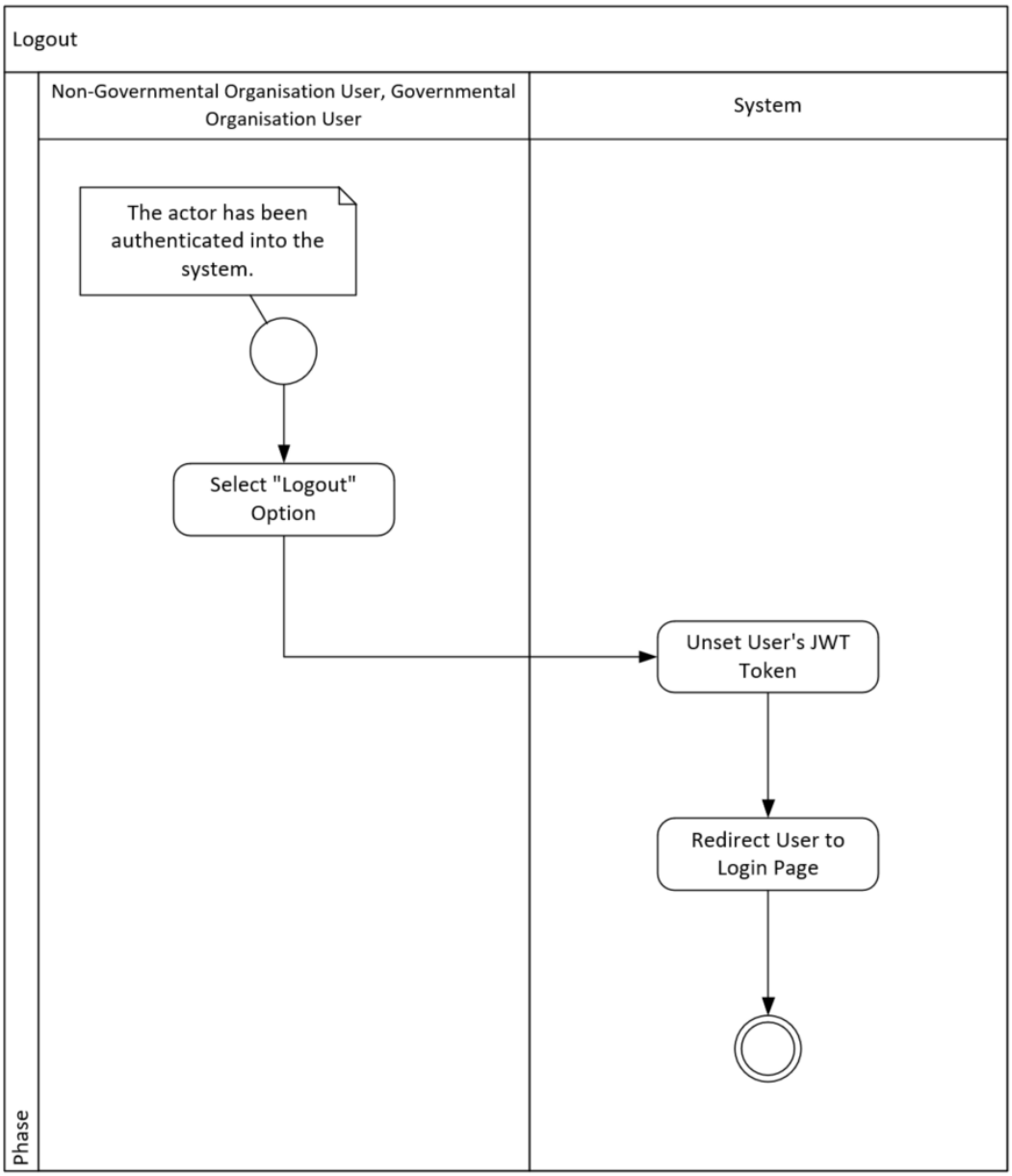


Figure 114: Activity Diagram - Logout

7.2.1.3.6 View Dashboard Statistics

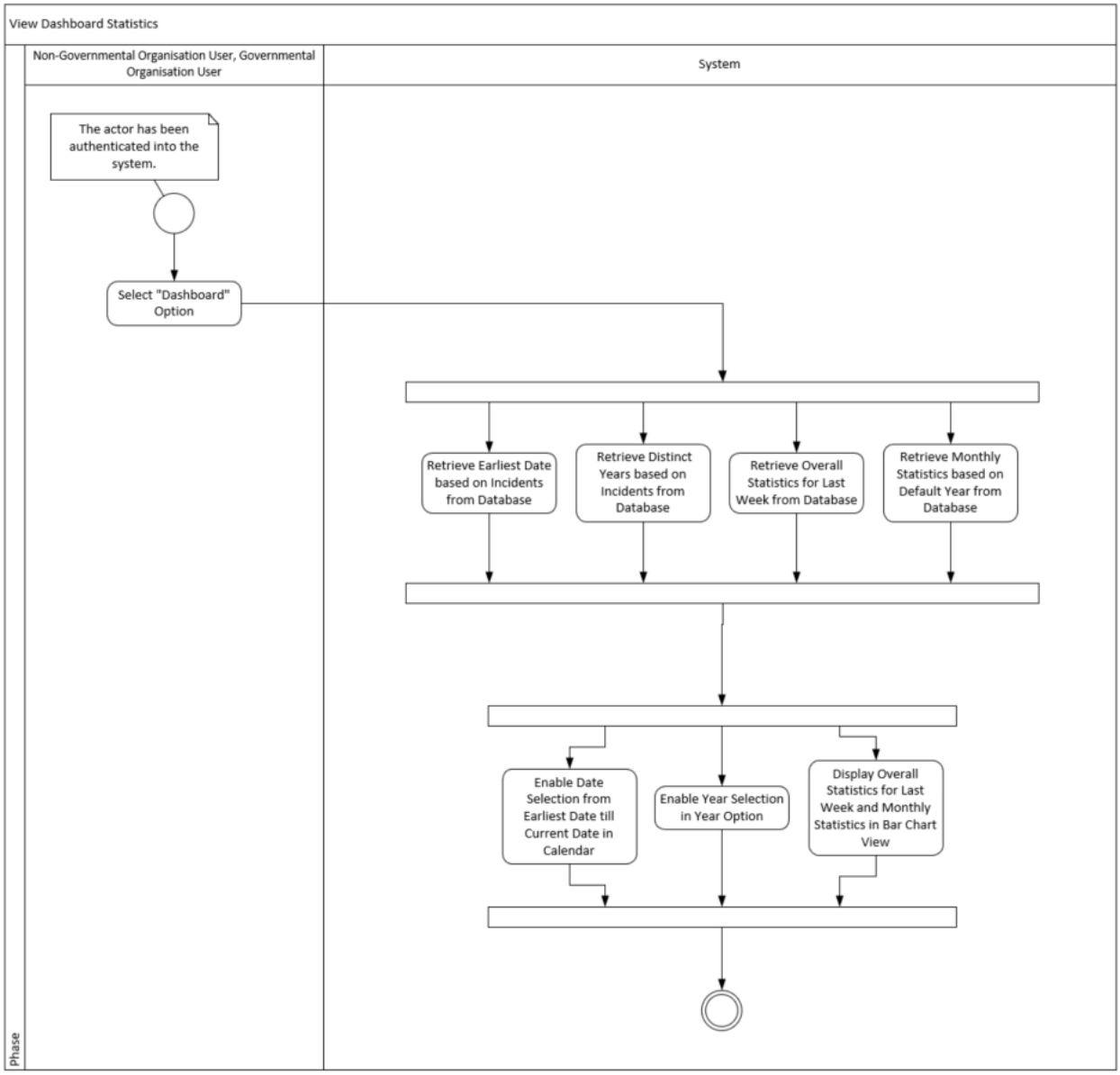


Figure 115: Activity Diagram - View Dashboard Statistics

7.2.1.3.7 Change Dashboard Statistics View

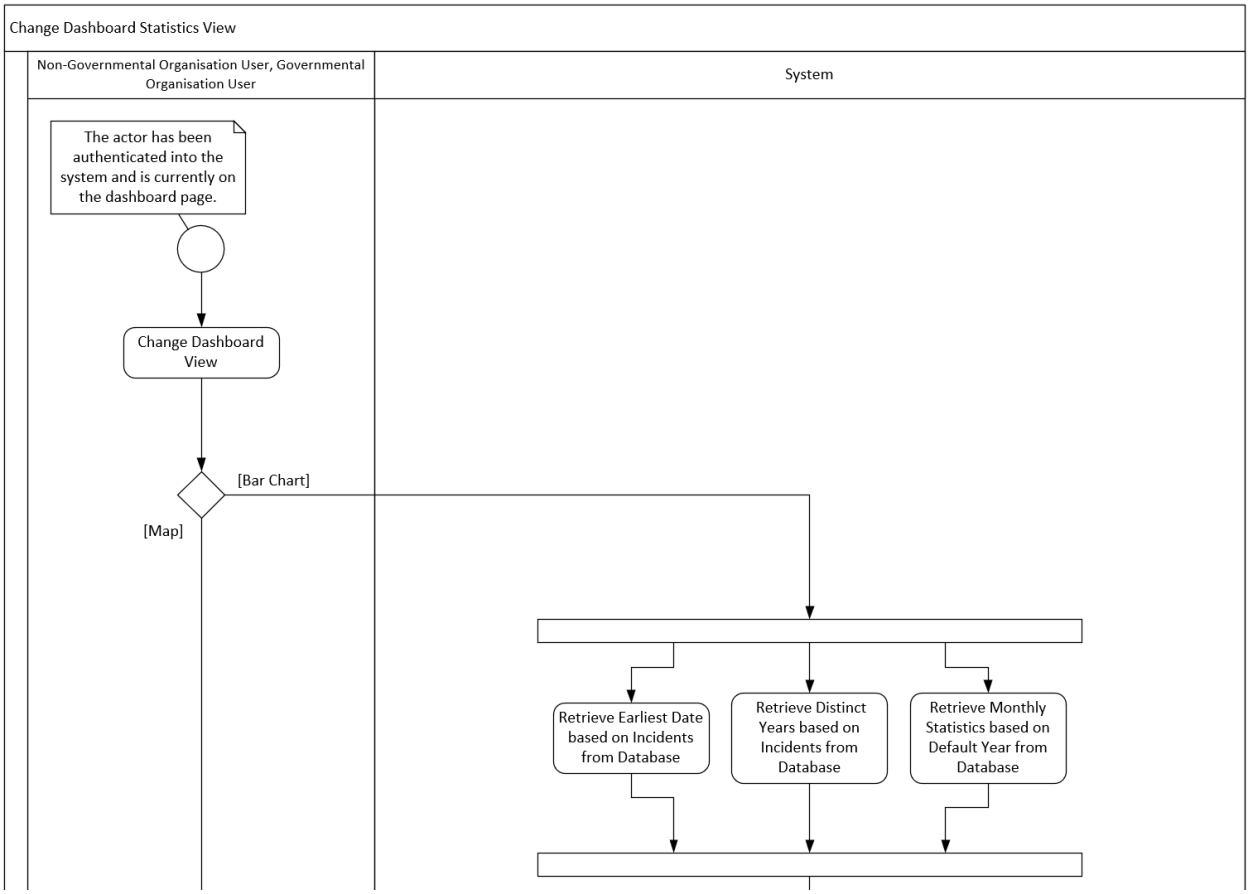


Figure 116: Activity Diagram - Change Dashboard Statistics View - Part 1

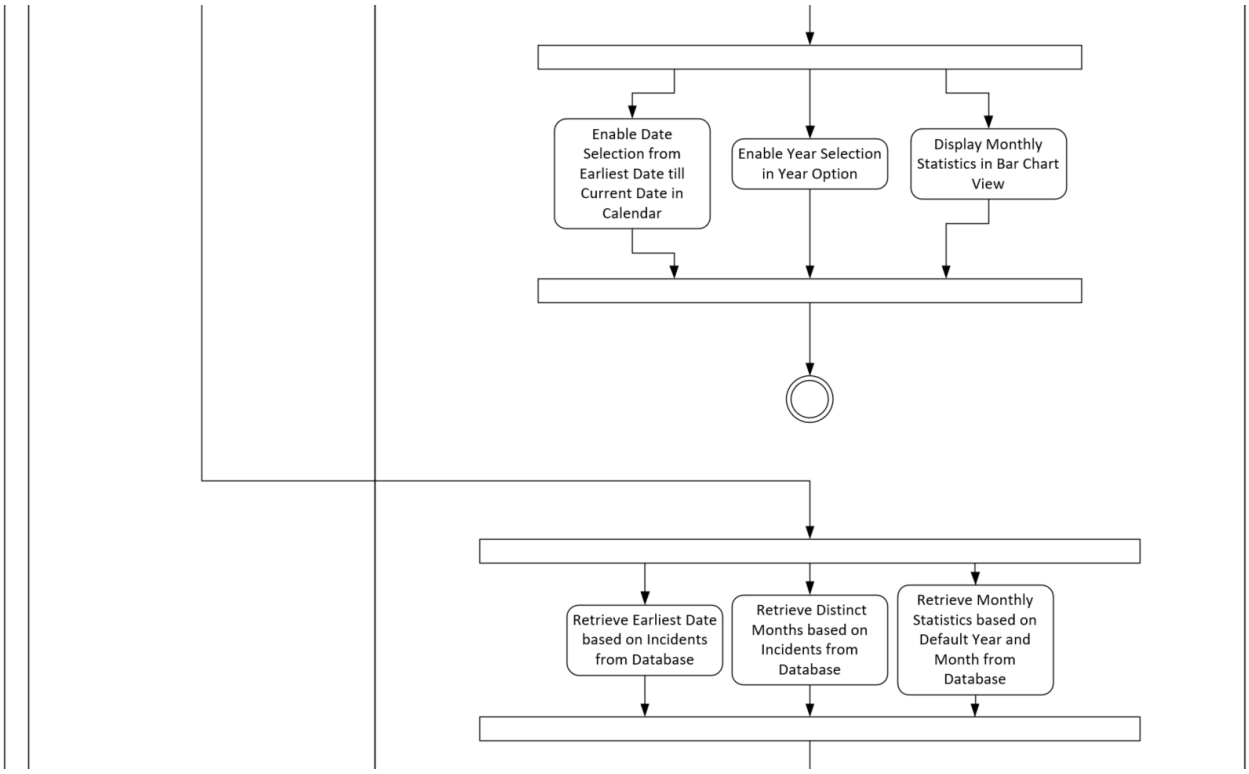


Figure 117: Activity Diagram - Change Dashboard Statistics View - Part 2

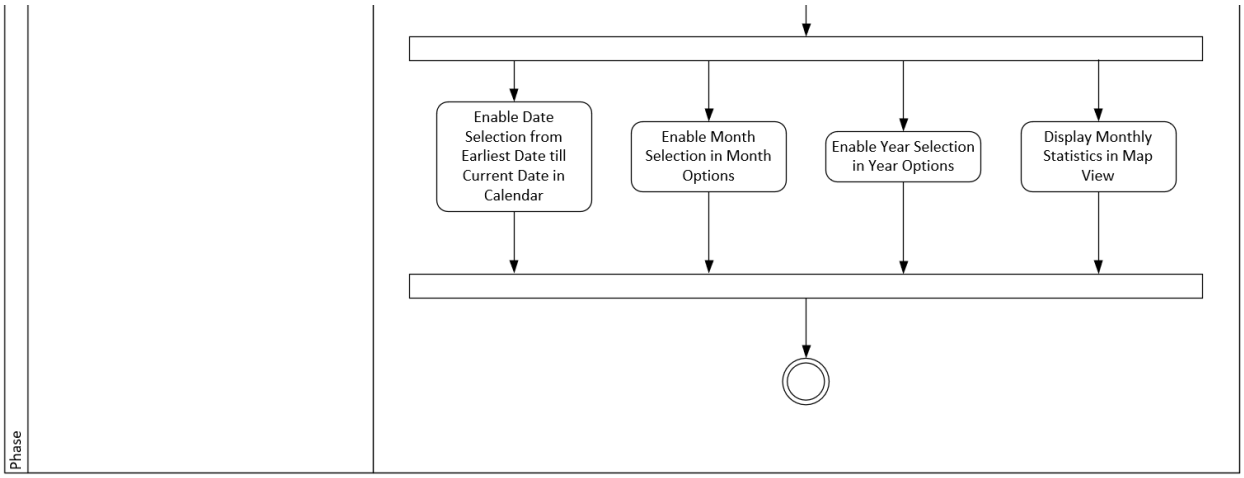


Figure 118: Activity Diagram - Change Dashboard Statistics View - Part 3

7.2.1.3.8 Filter Dashboard Statistics

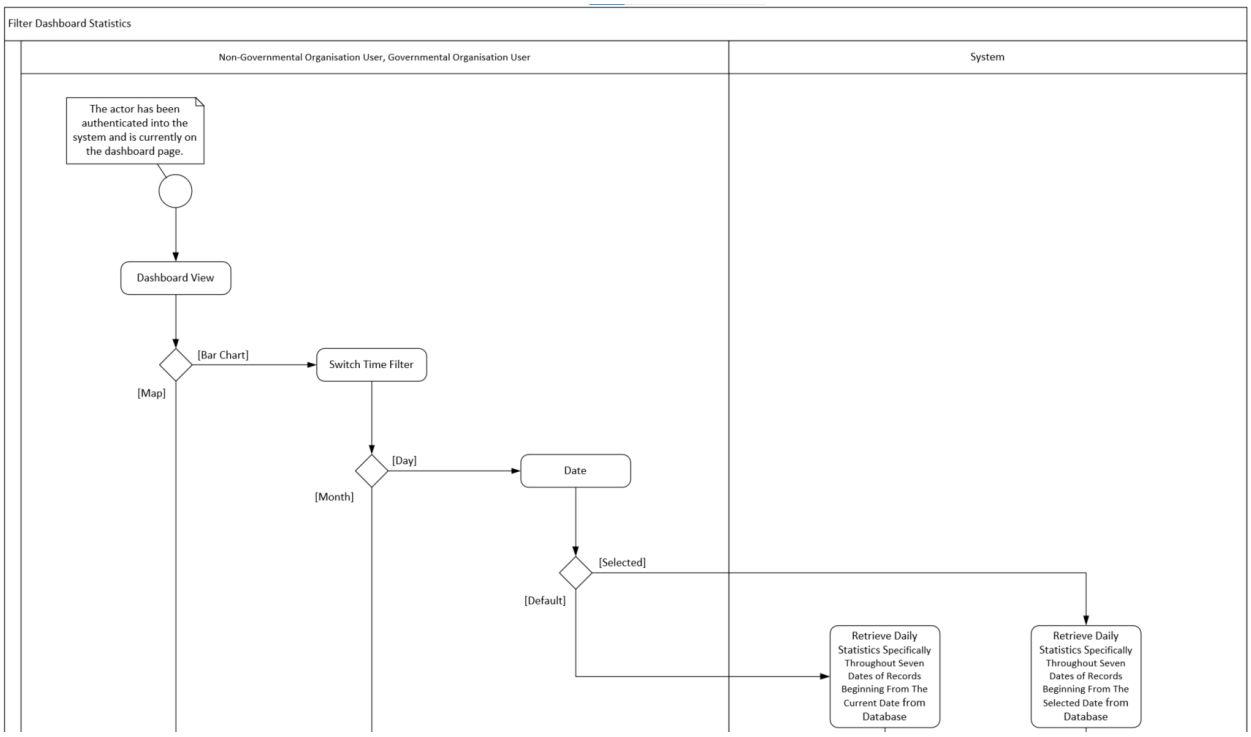


Figure 119: Activity Diagram - Filter Dashboard Statistics - Part 1

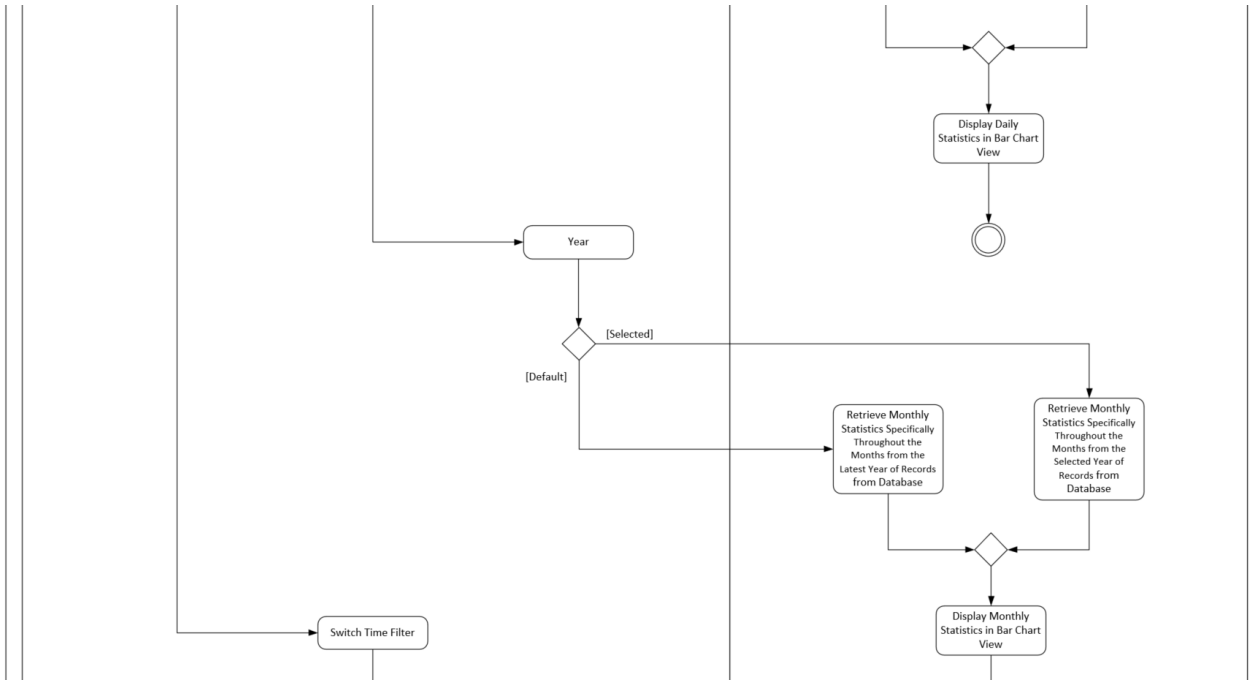


Figure 120: Activity Diagram - Filter Dashboard Statistics – Part 2

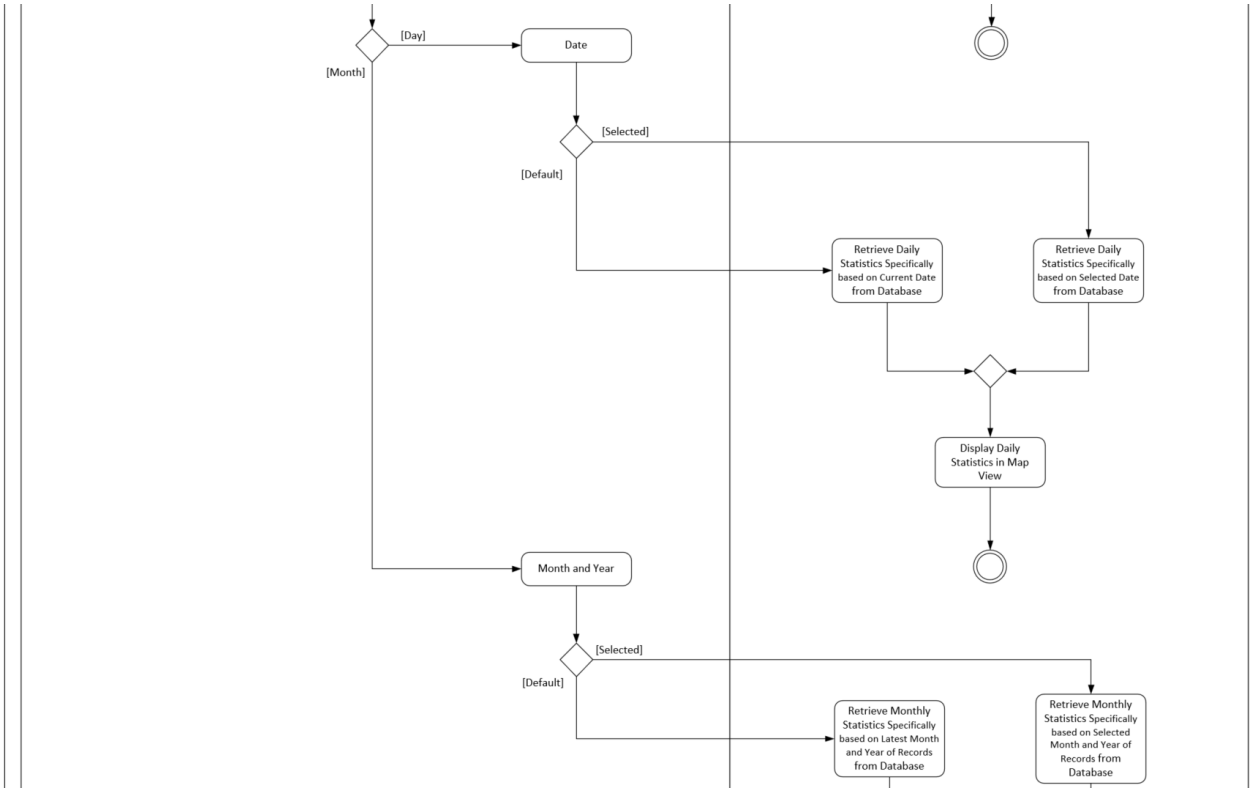


Figure 121: Activity Diagram - Filter Dashboard Statistics - Part 3

Figure 122: Activity Diagram - Filter Dashboard Statistics - Part 4

7.2.1.3.9 View Twitter Profiles

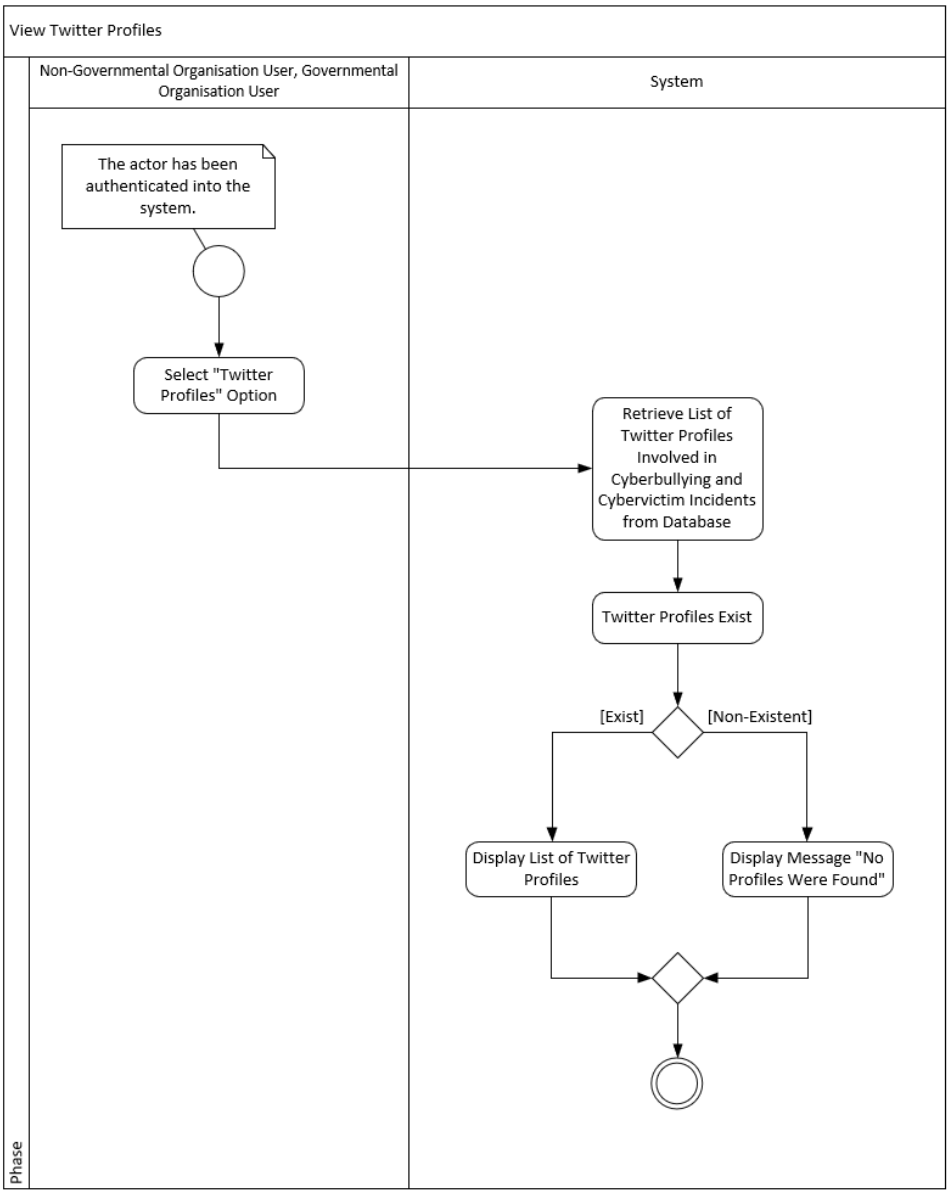


Figure 123: Activity Diagram - View Twitter Profiles

7.2.1.3.10 Filter Twitter Profiles

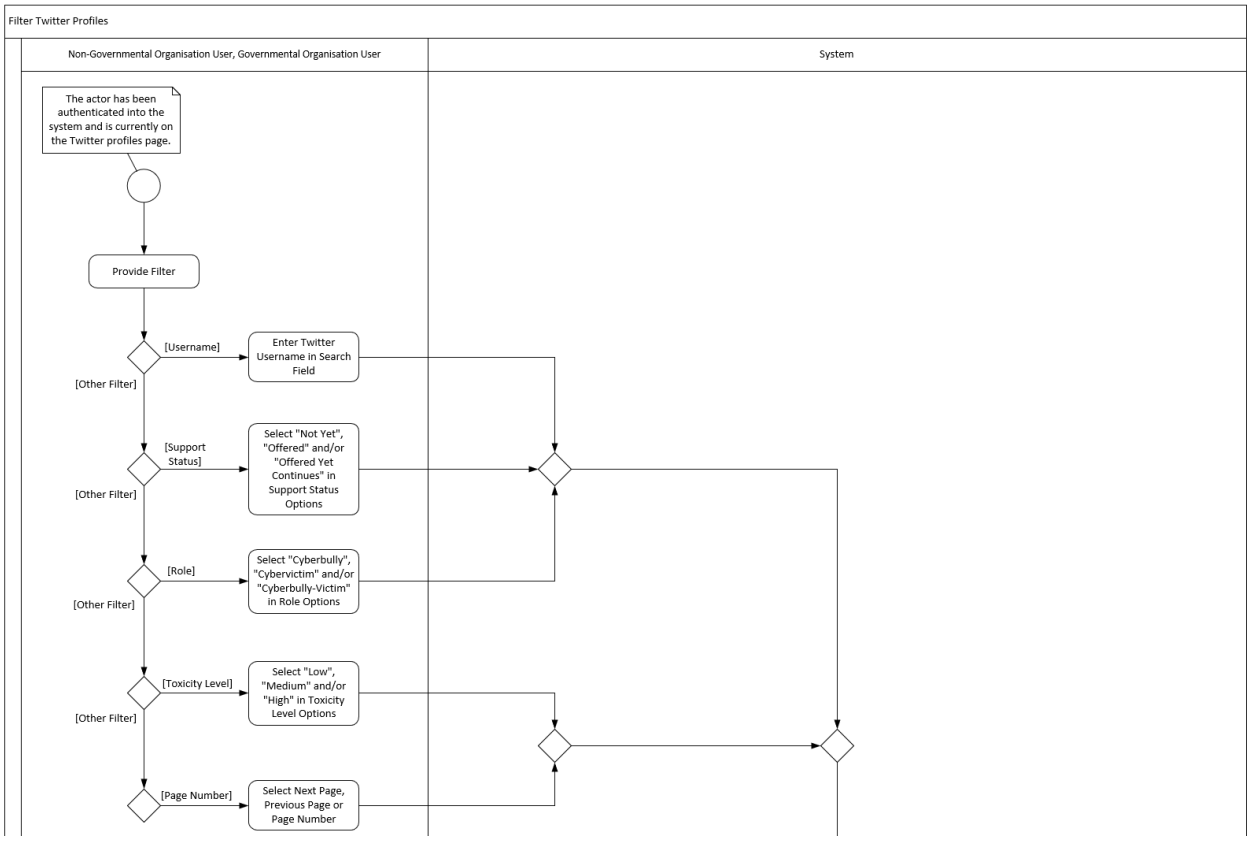


Figure 124: Activity Diagram - Filter Twitter Profiles - Part 1

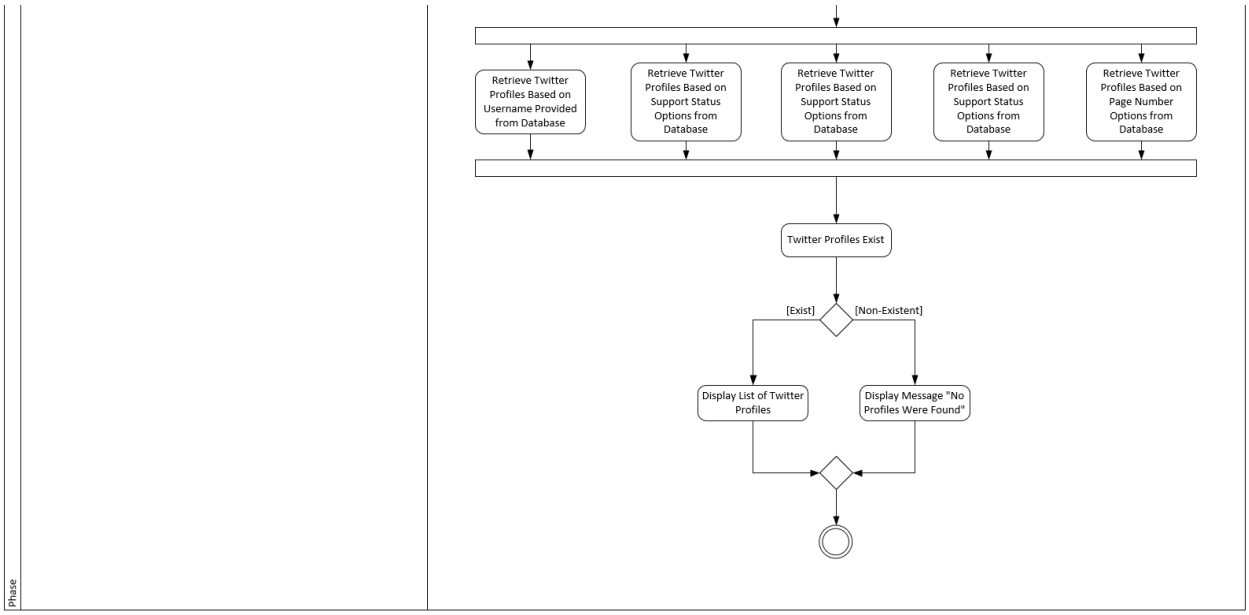


Figure 125: Activity Diagram - Filter Twitter Profiles - Part 2

7.2.1.3.11 View Incidents

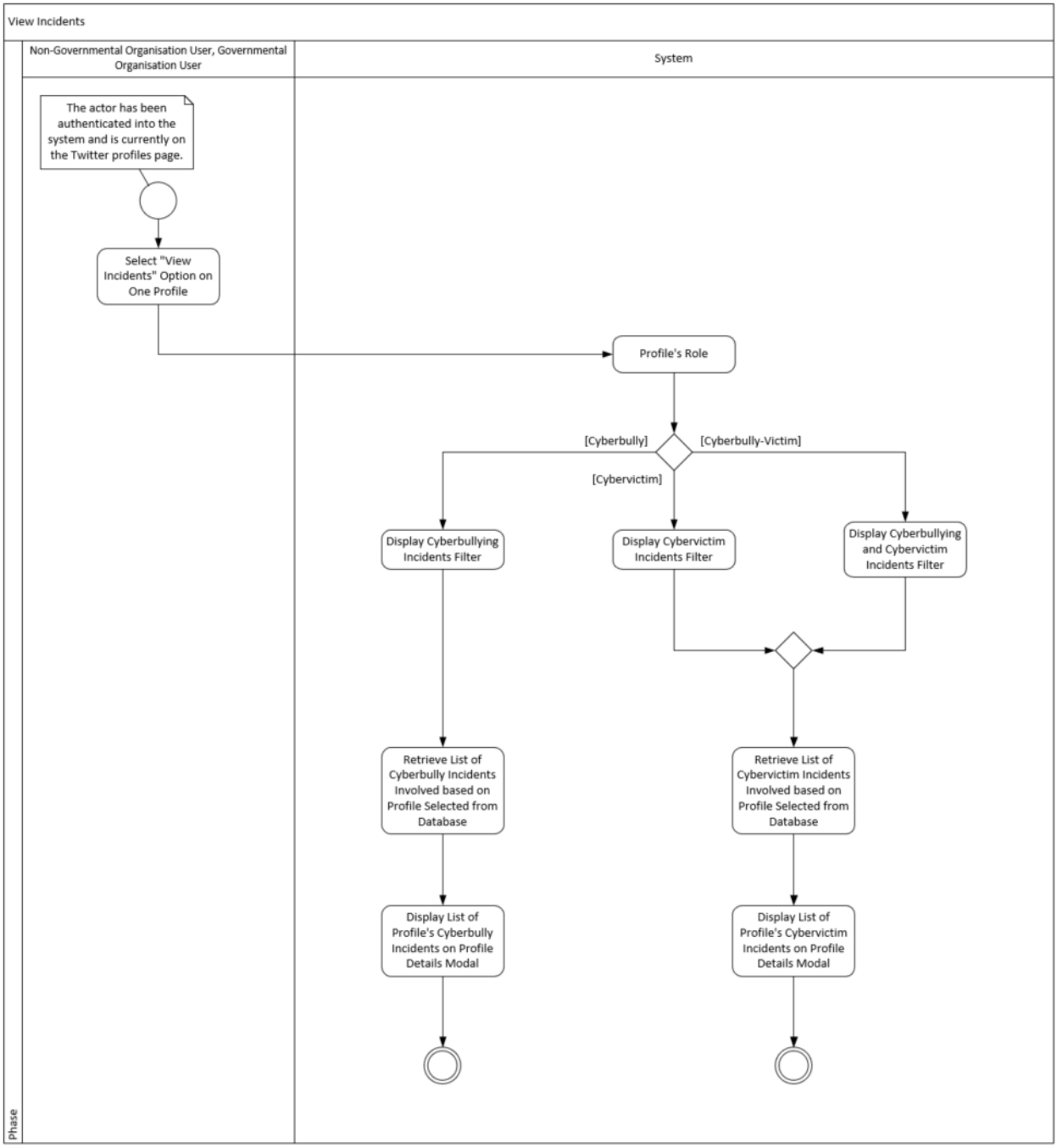


Figure 126: Activity Diagram - View Incidents

7.2.1.3.12 Filter Incidents

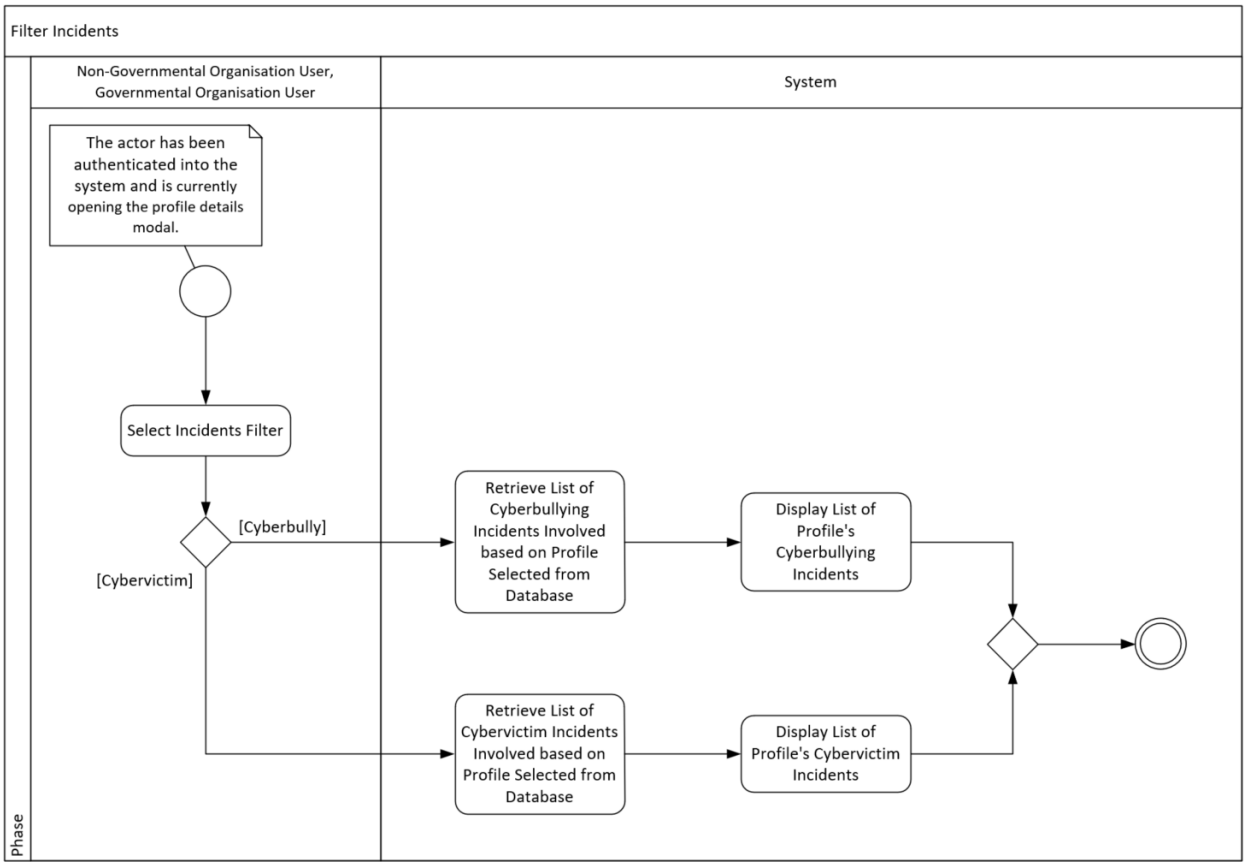


Figure 127: Activity Diagram - Filter Incidents

7.2.1.3.13 Remove Misclassified Incident

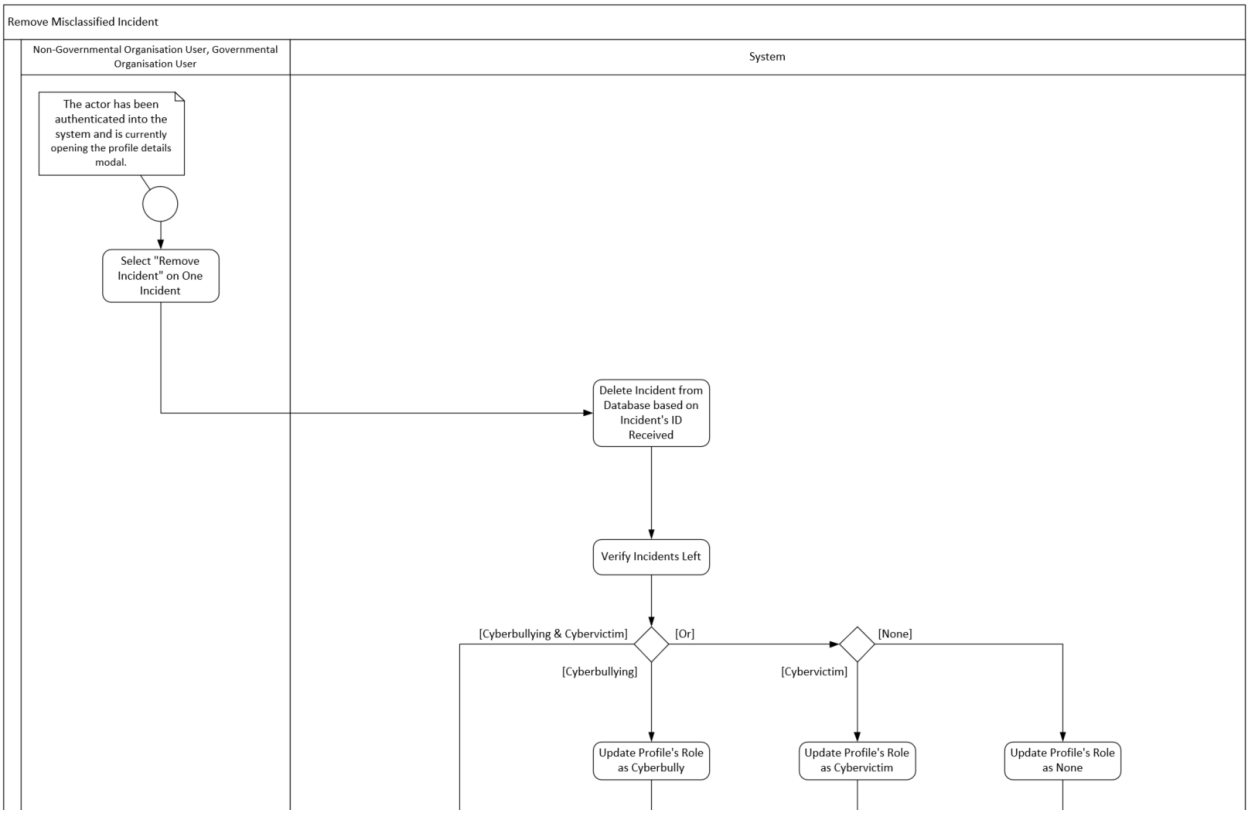


Figure 128: Activity Diagram - Remove Misclassified Incident – Part 1

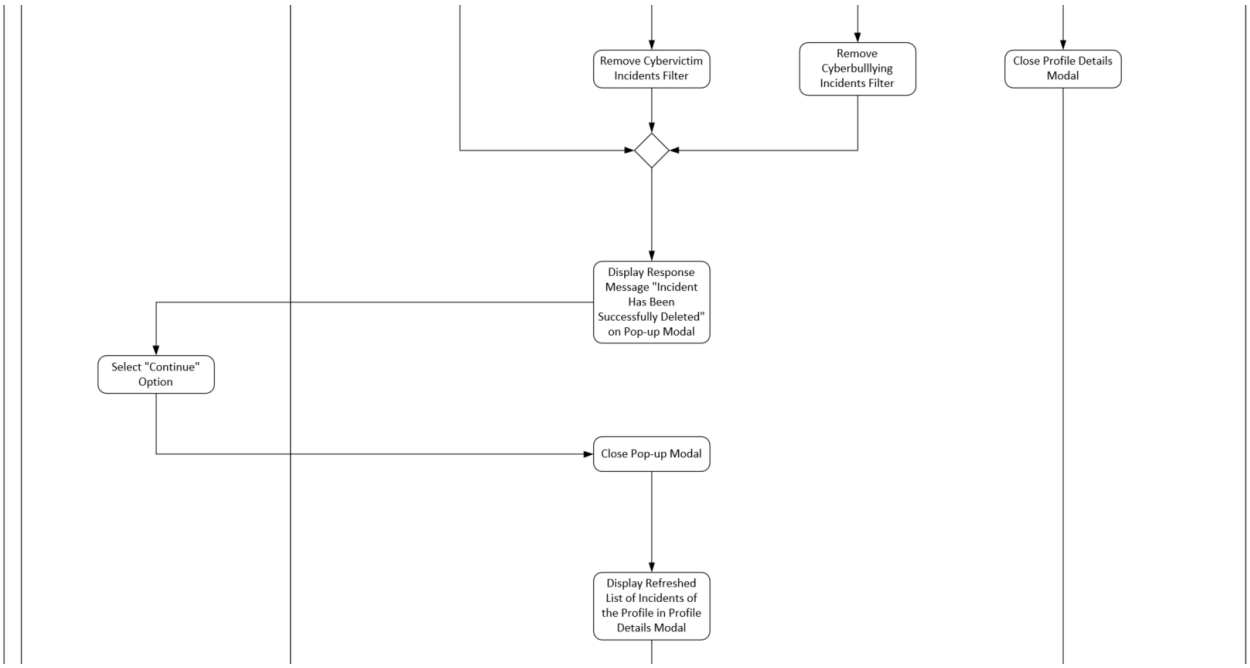


Figure 129: Activity Diagram - Remove Misclassified Incident – Part 2

Figure 130: Activity Diagram - Remove Misclassified Incident – Part 3

7.2.1.3.14 Send Support Message By Reply Tweet

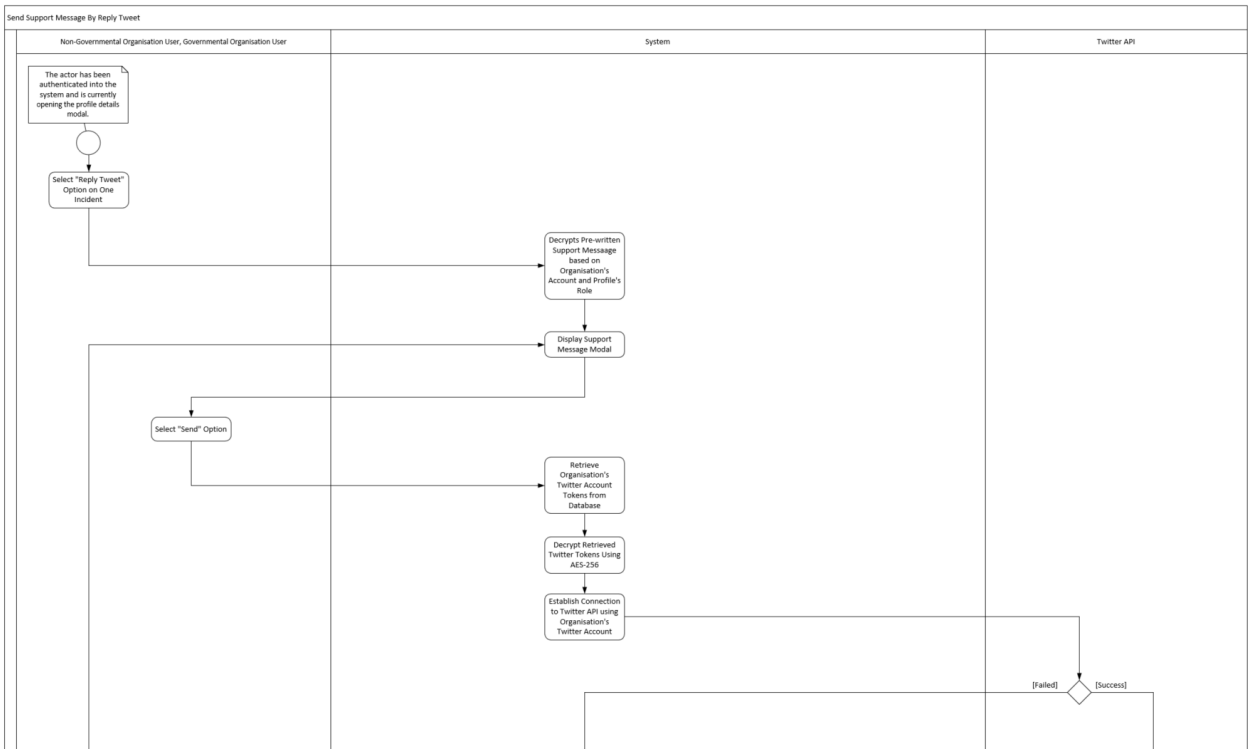


Figure 131: Activity Diagram - Send Support Message By Reply Tweet - Part 1

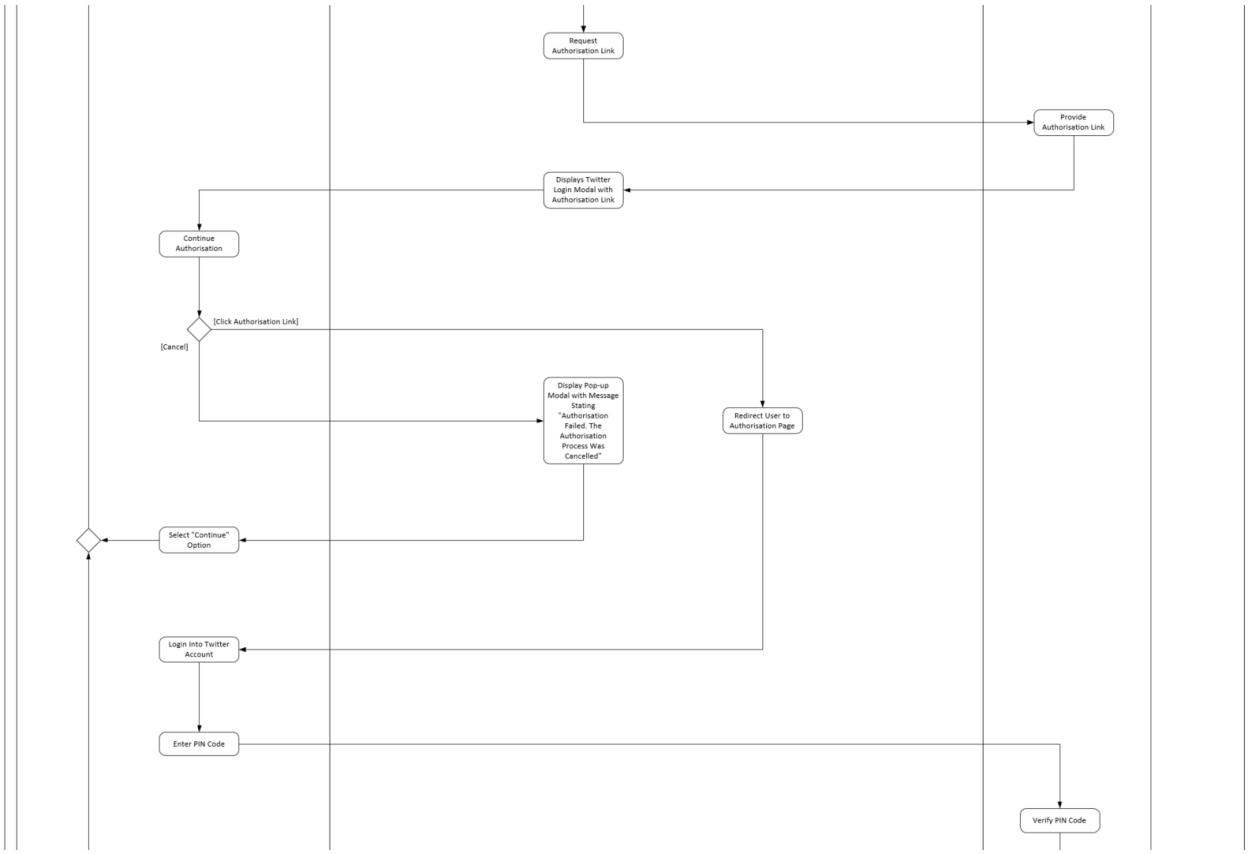


Figure 132: Activity Diagram - Send Support Message By Reply Tweet - Part 2

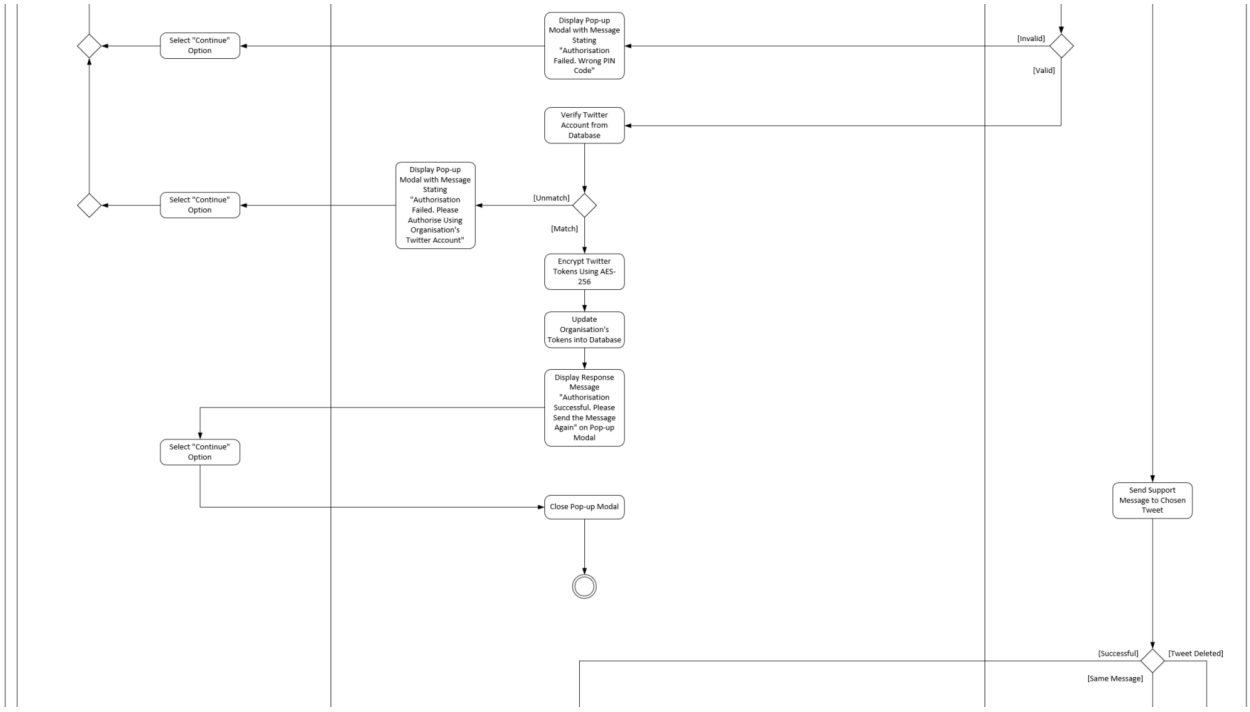


Figure 133: Activity Diagram - Send Support Message By Reply Tweet - Part 3

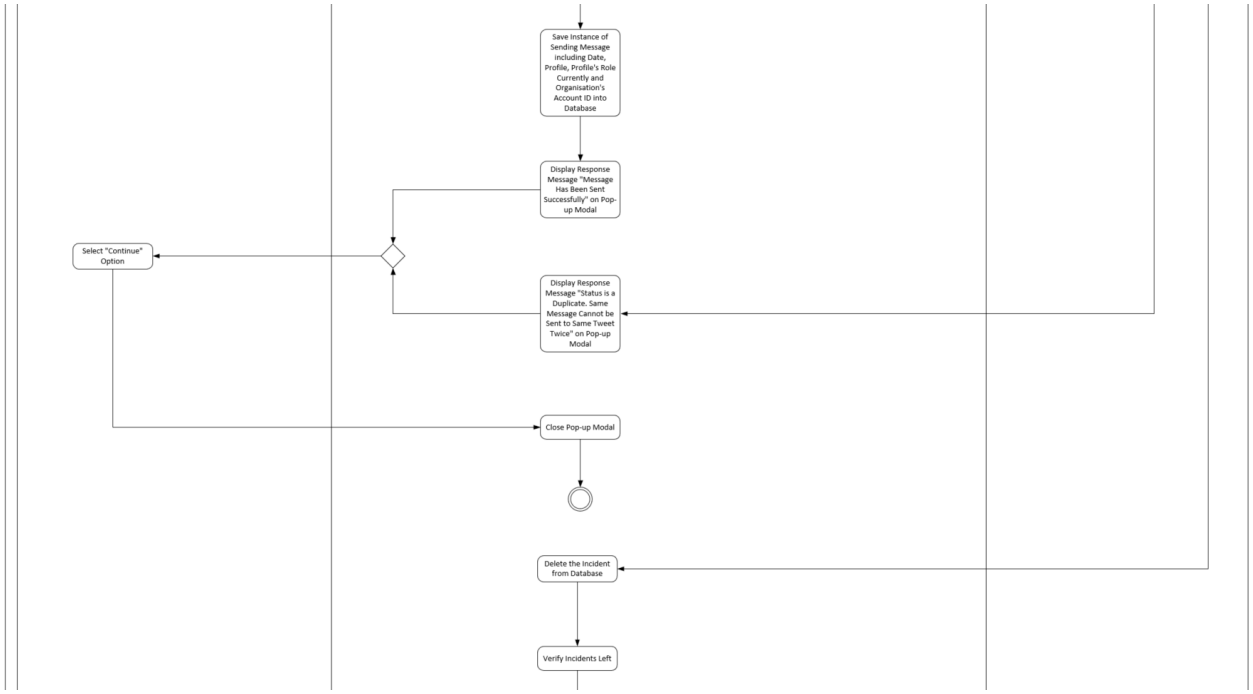


Figure 134: Activity Diagram - Send Support Message By Reply Tweet - Part 4

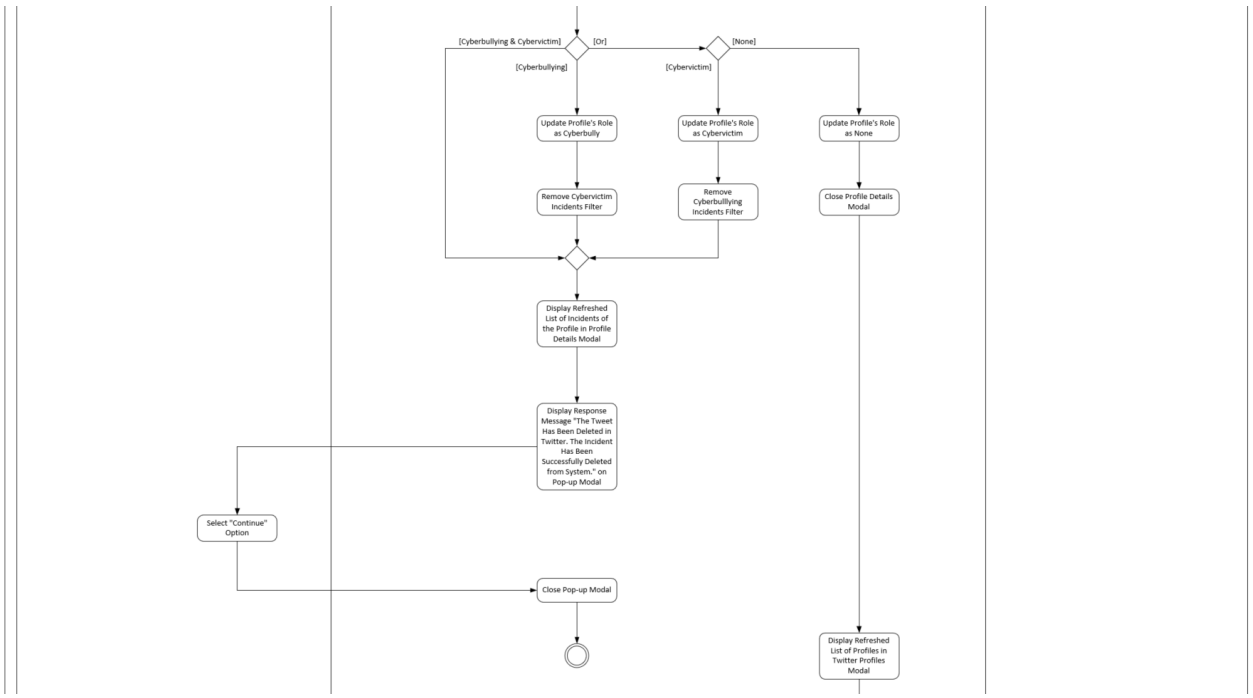


Figure 135: Activity Diagram - Send Support Message By Reply Tweet - Part 5

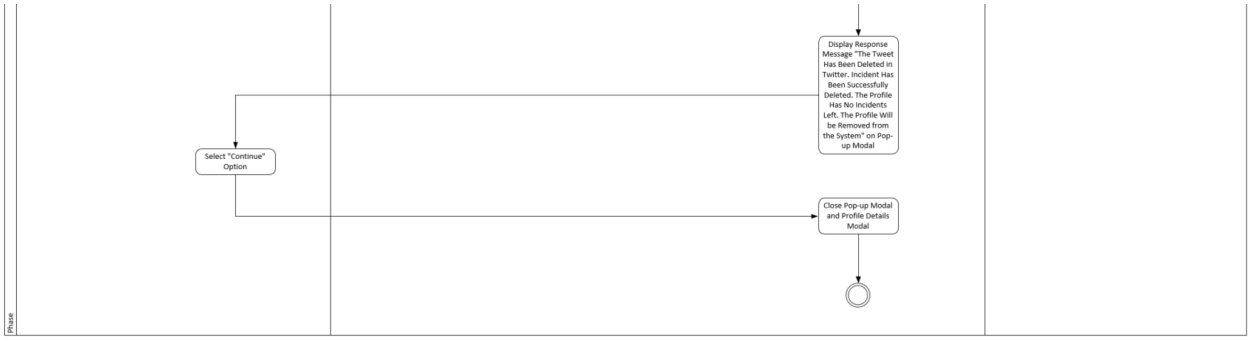


Figure 136: Activity Diagram - Send Support Message By Reply Tweet - Part 6

7.2.1.3.15 Send Support Message By Direct Message

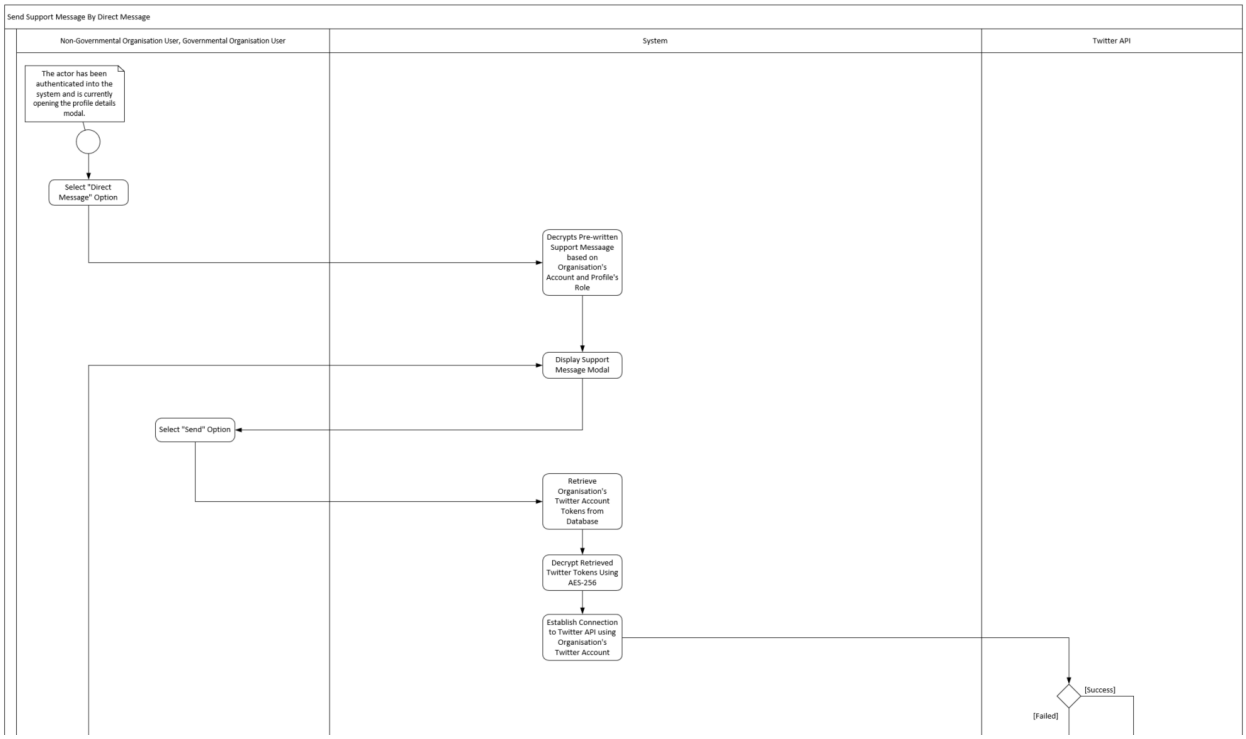


Figure 137: Activity Diagram - Send Support Message By Direct Message - Part 1

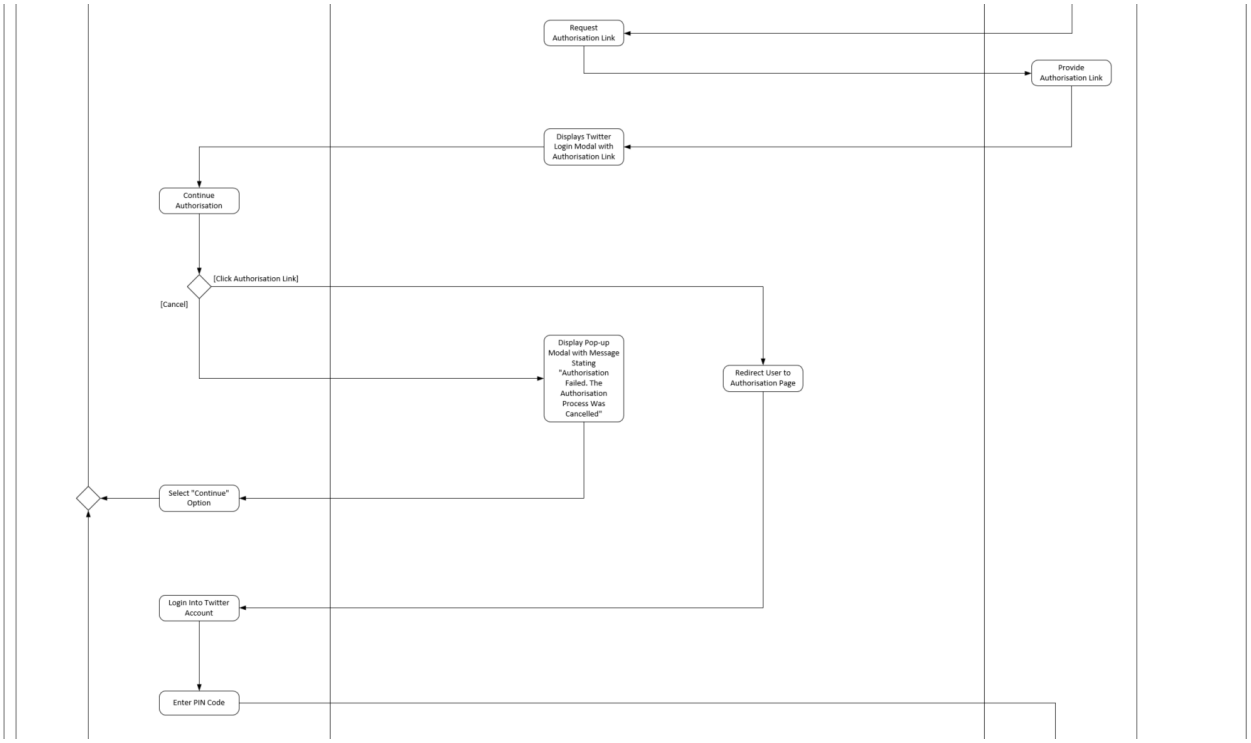


Figure 138: Activity Diagram - Send Support Message By Direct Message - Part 2

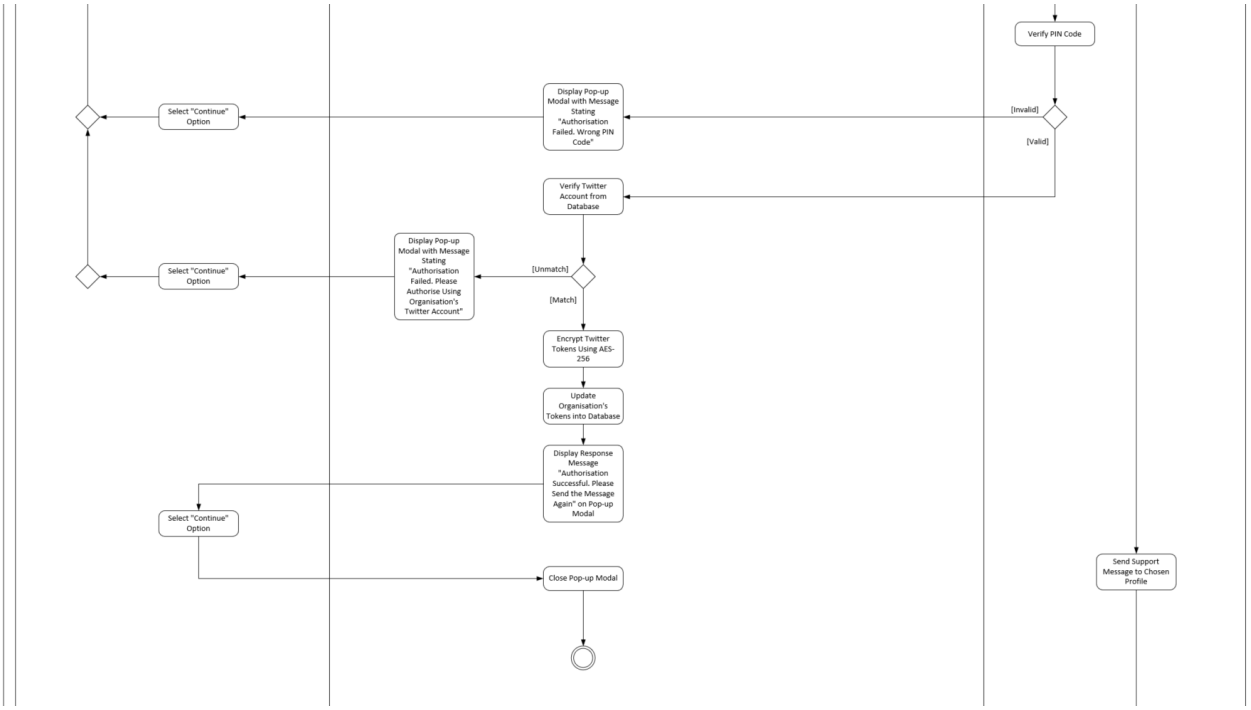


Figure 139: Activity Diagram - Send Support Message By Direct Message - Part 3

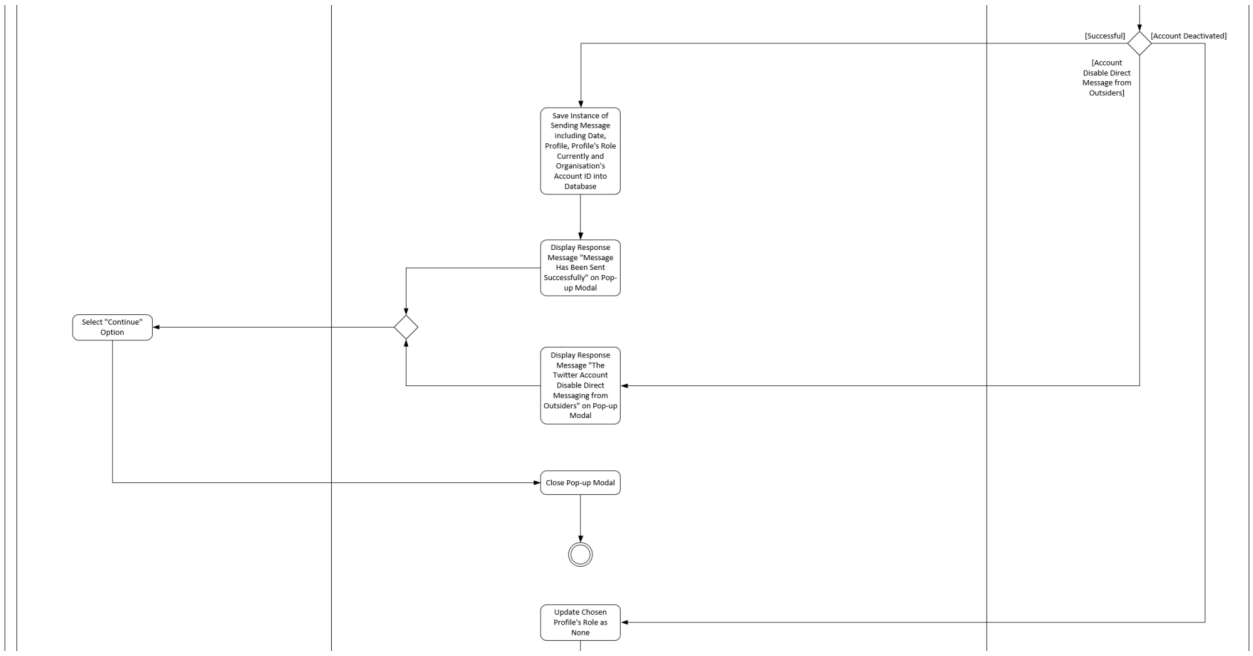


Figure 140: Activity Diagram - Send Support Message By Direct Message - Part 4

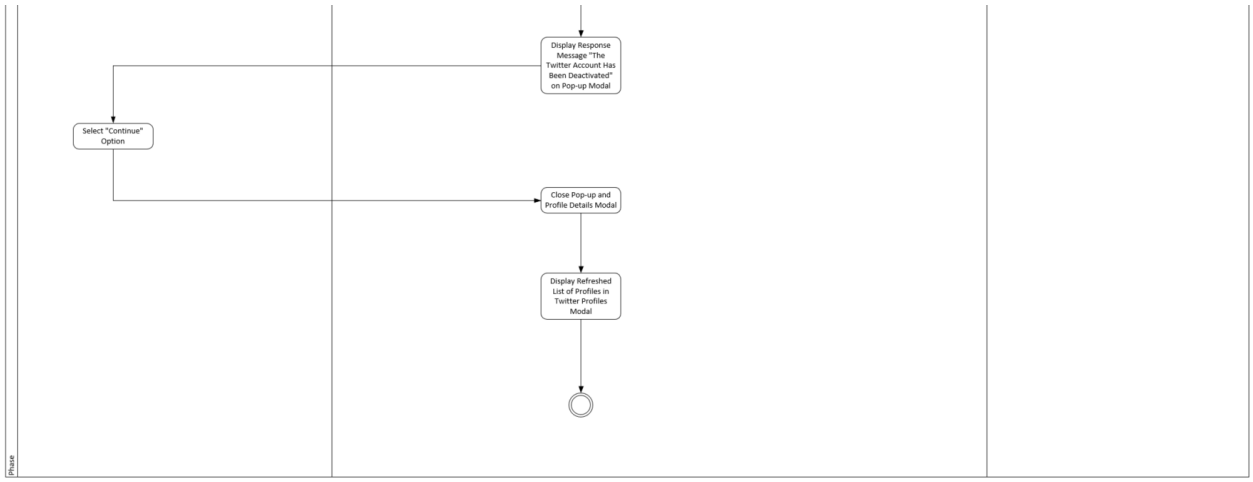


Figure 141: Activity Diagram - Send Support Message By Direct Message - Part 5

7.2.1.3.16 View Support Message History

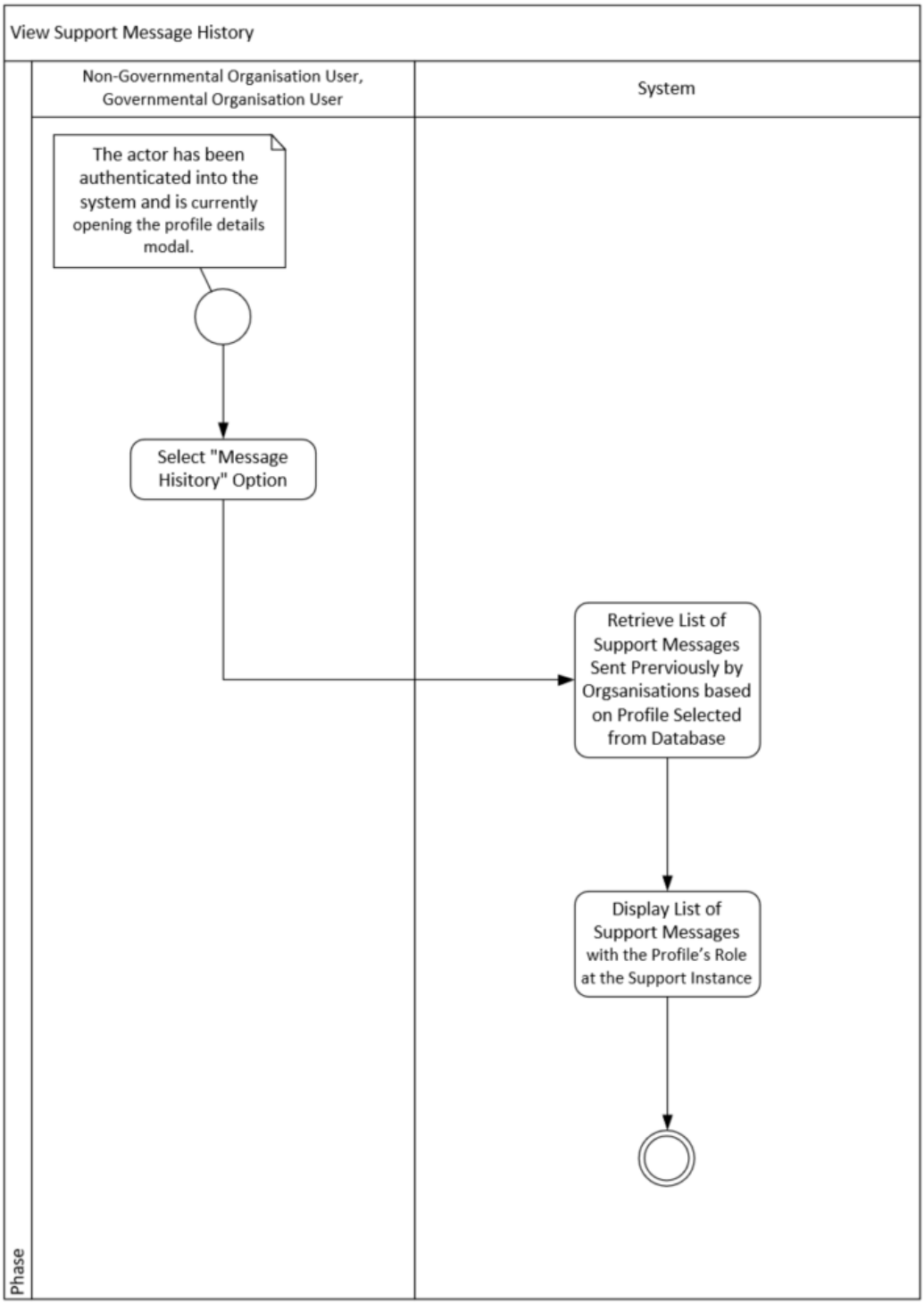


Figure 142: Activity Diagram - View Support Message History

7.2.1.3.17 Modify Pre-written Message

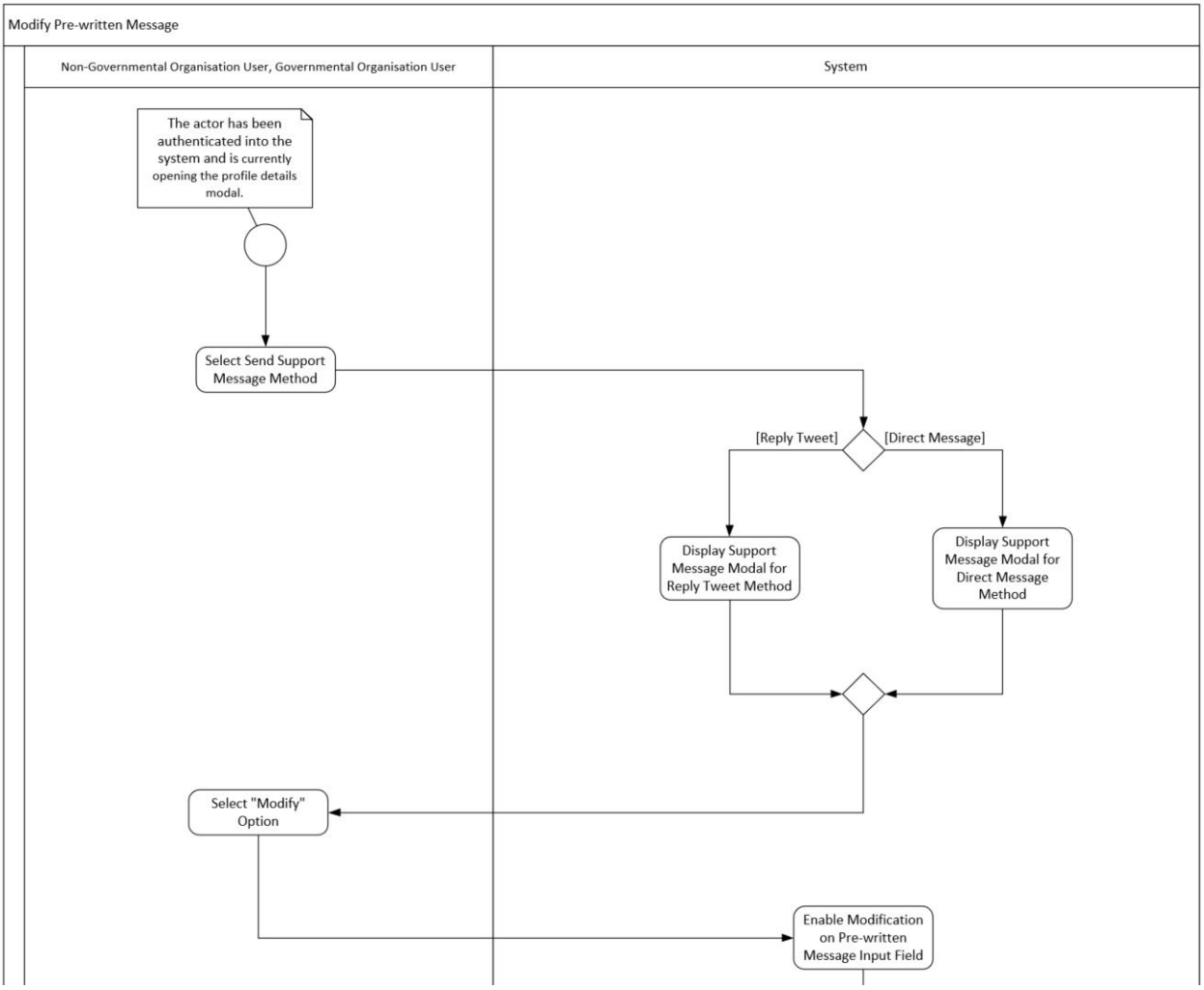


Figure 143: Activity Diagram - Modify Pre-written Message - Part 1

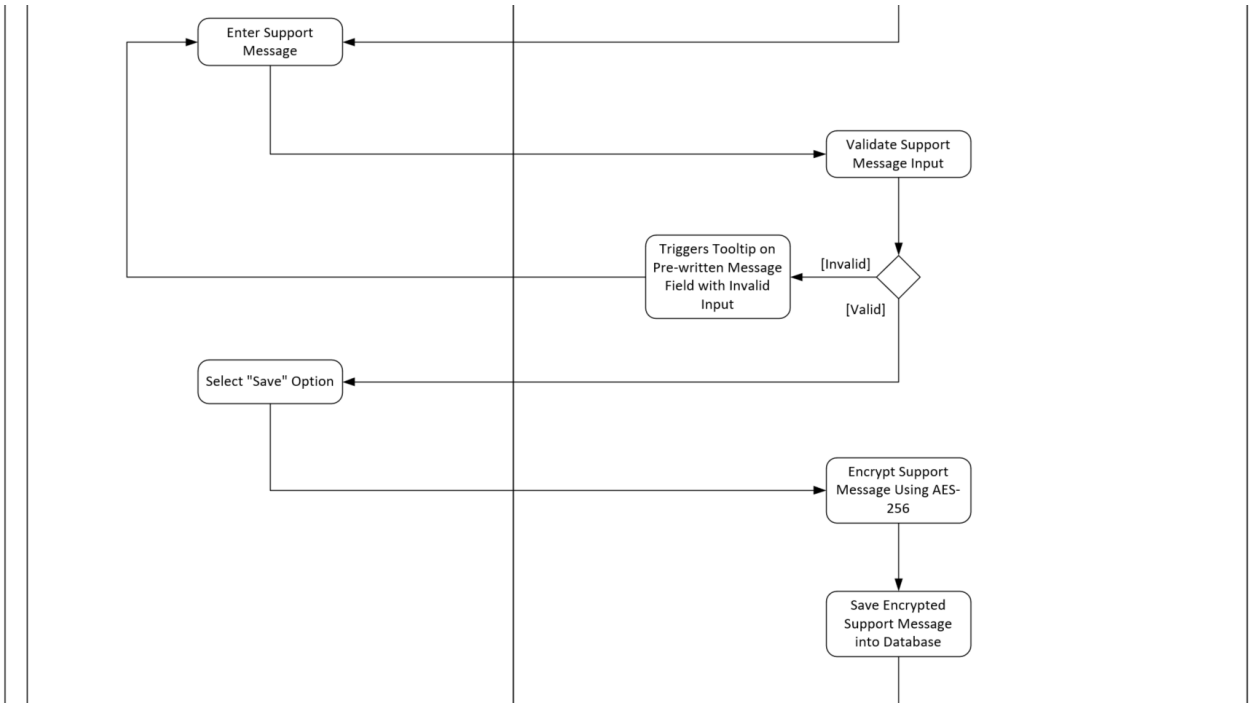


Figure 144: Activity Diagram - Modify Pre-written Message - Part 2

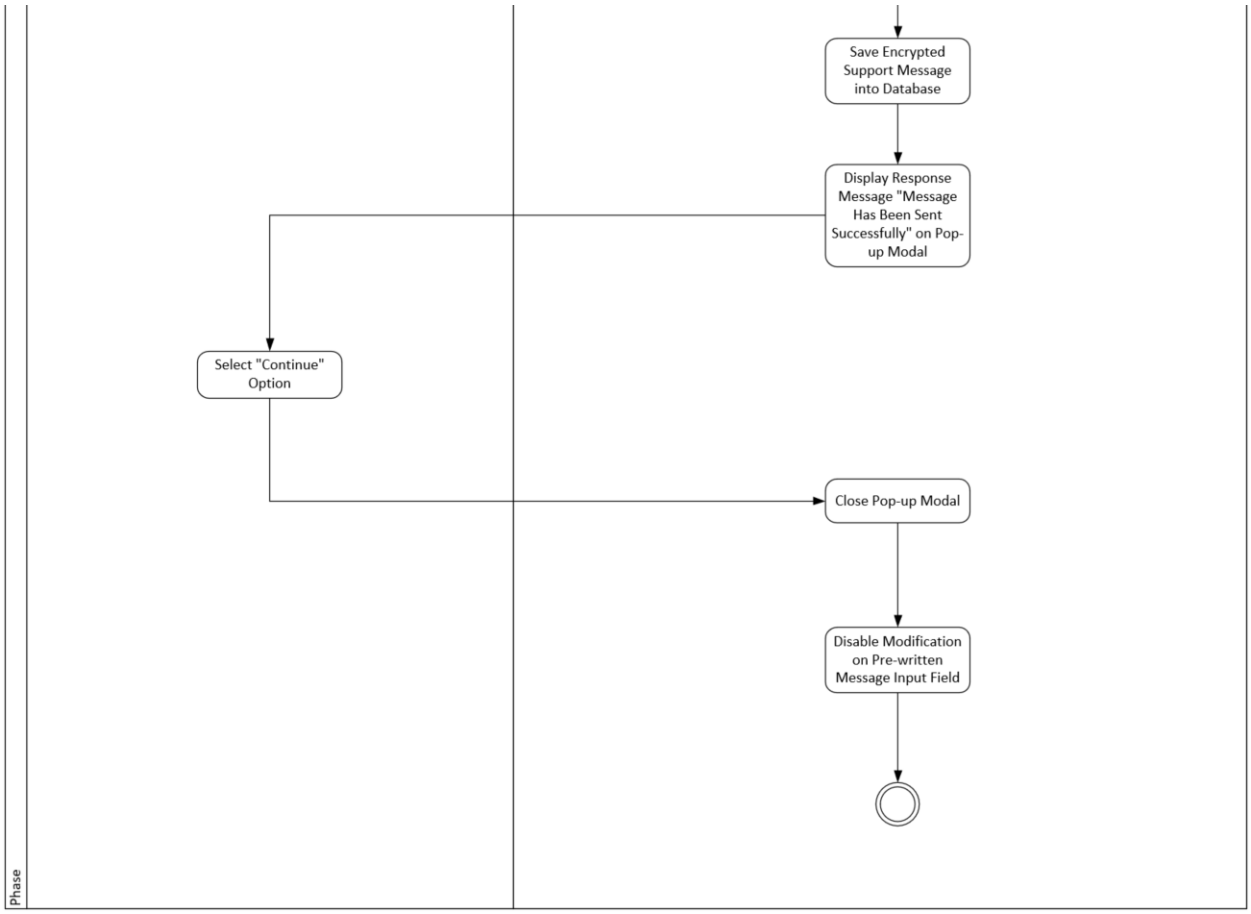


Figure 145: Activity Diagram - Modify Pre-written Message - Part 3

7.2.1.3.18 View Organisation Account

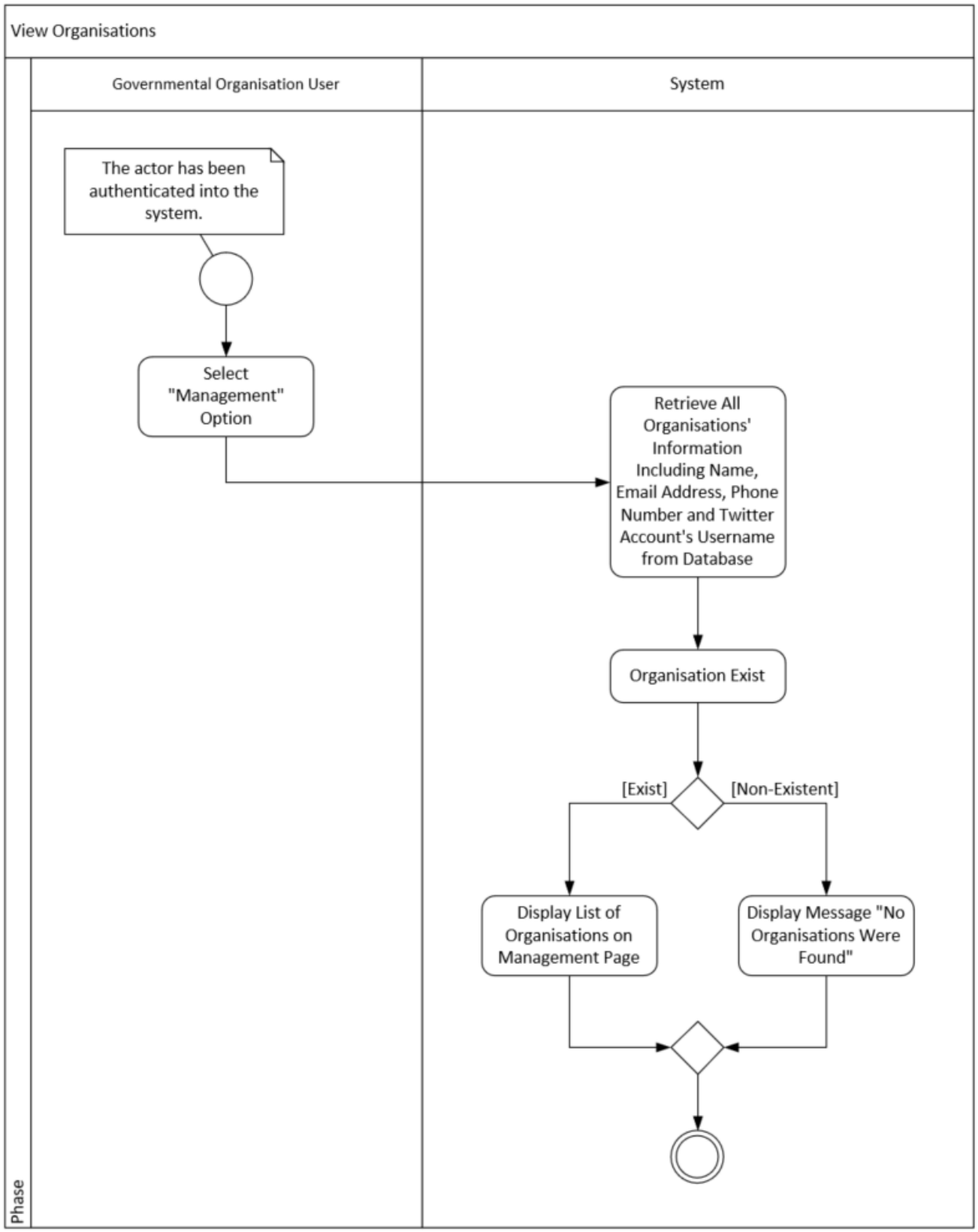


Figure 146: Activity Diagram - View Organisation Account

7.2.1.3.19 Change Password

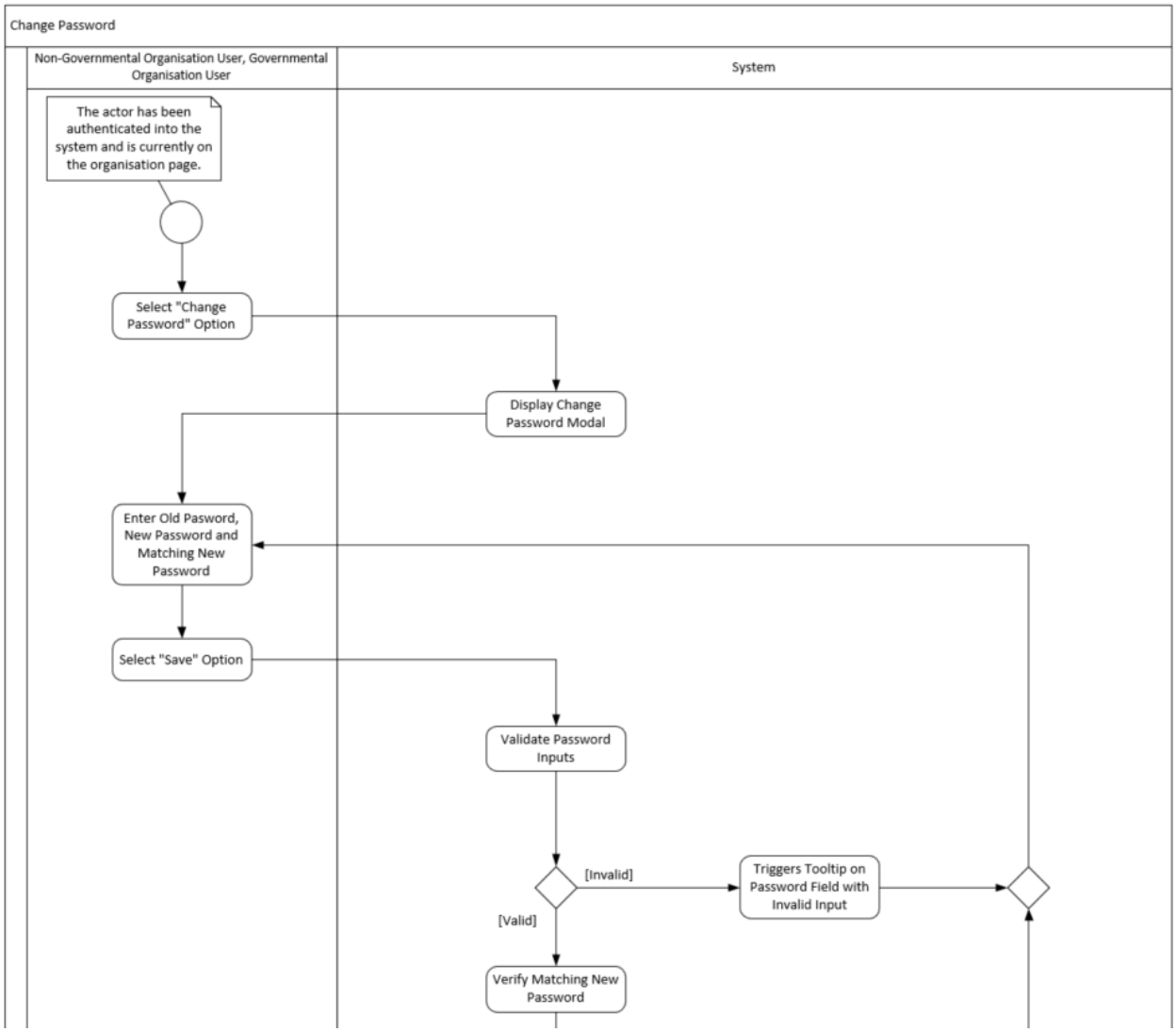


Figure 147: Activity Diagram - Change Password - Part 1

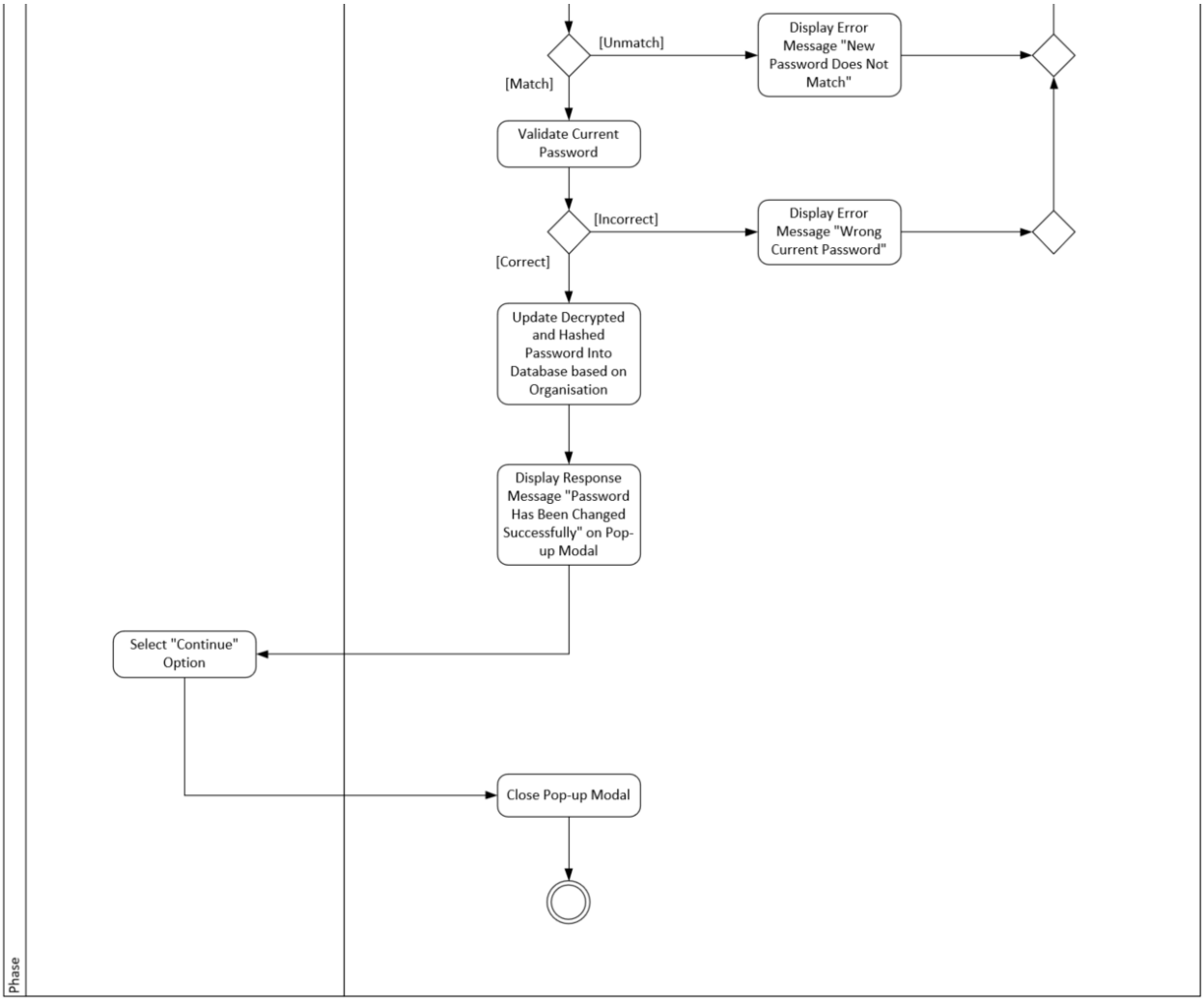


Figure 148: Activity Diagram - Change Password - Part 2

7.2.1.3.20 Edit Organisation Account

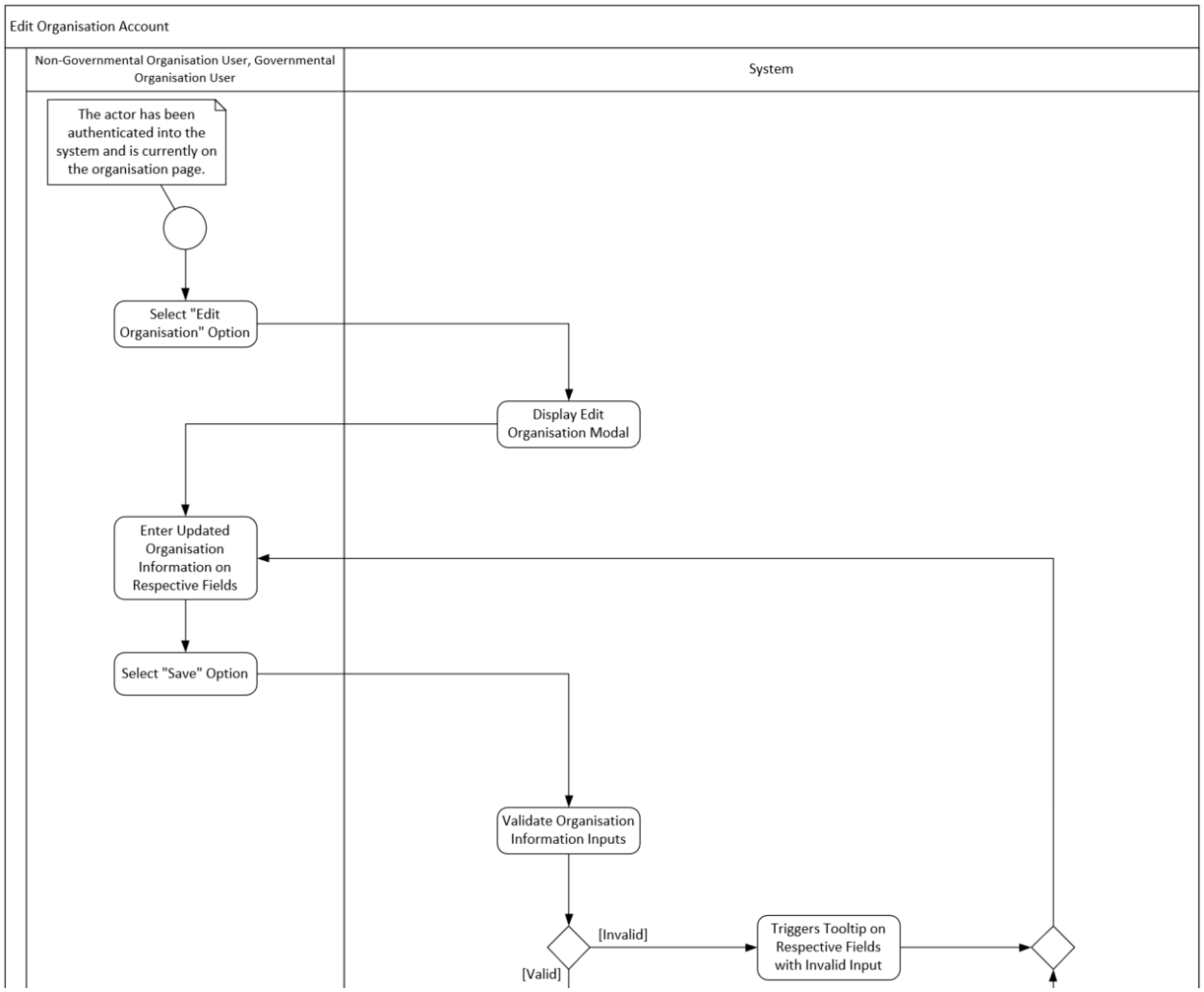


Figure 149: Activity Diagram - Edit Organisation Account - Part 1

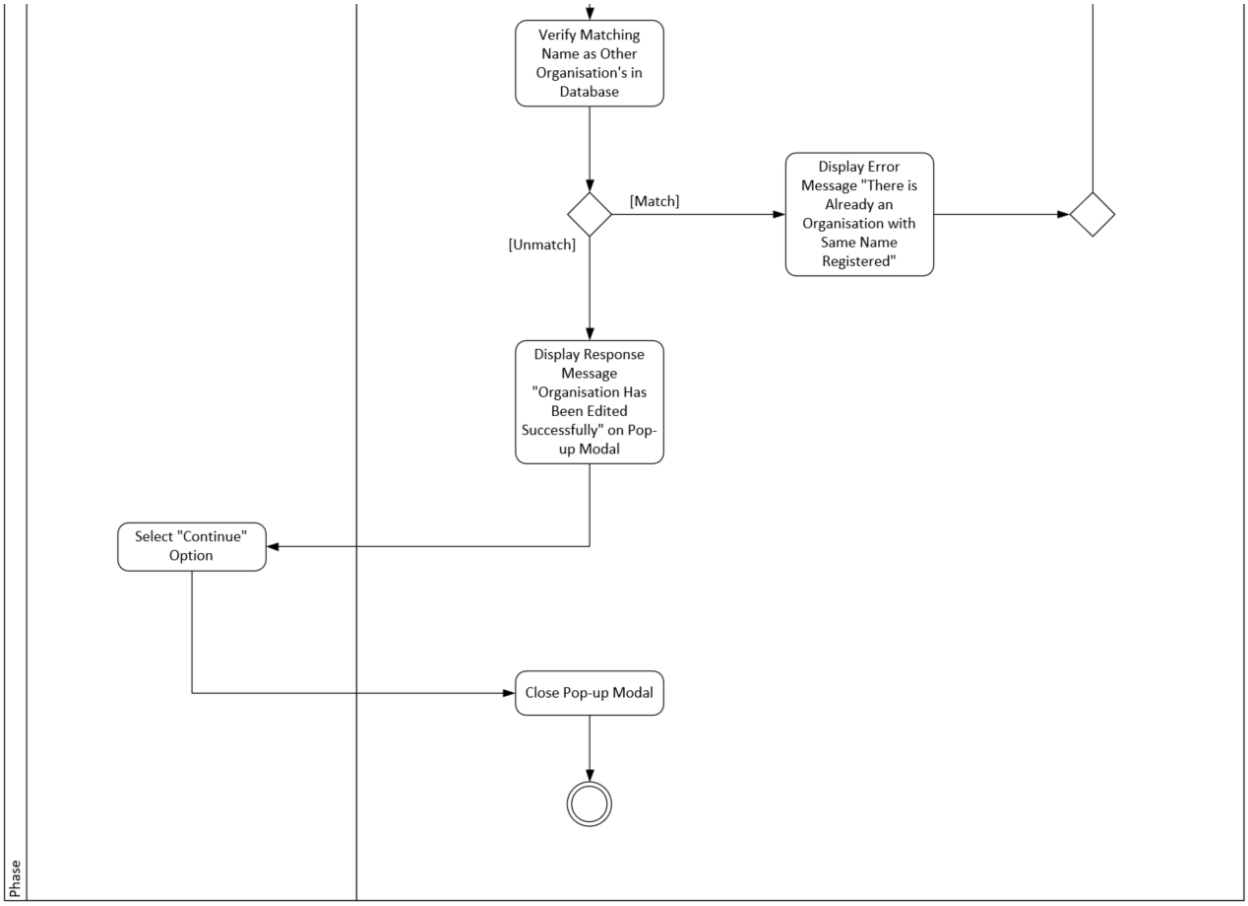


Figure 150: Activity Diagram - Edit Organisation Account - Part 2

7.2.1.3.21 View Organisations

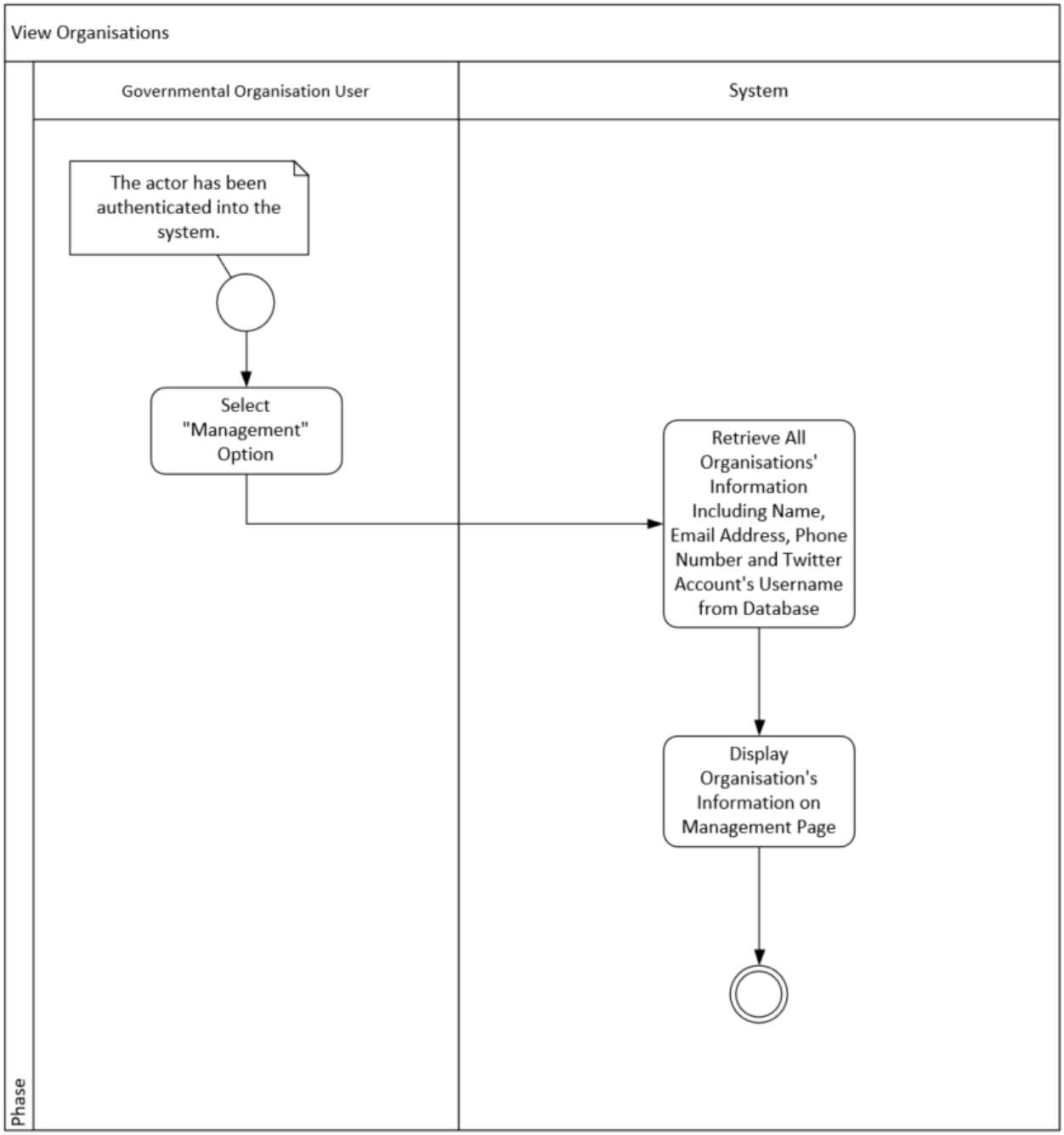


Figure 151: Activity Diagram - View Organisations

7.2.1.3.22 Filter Organisations

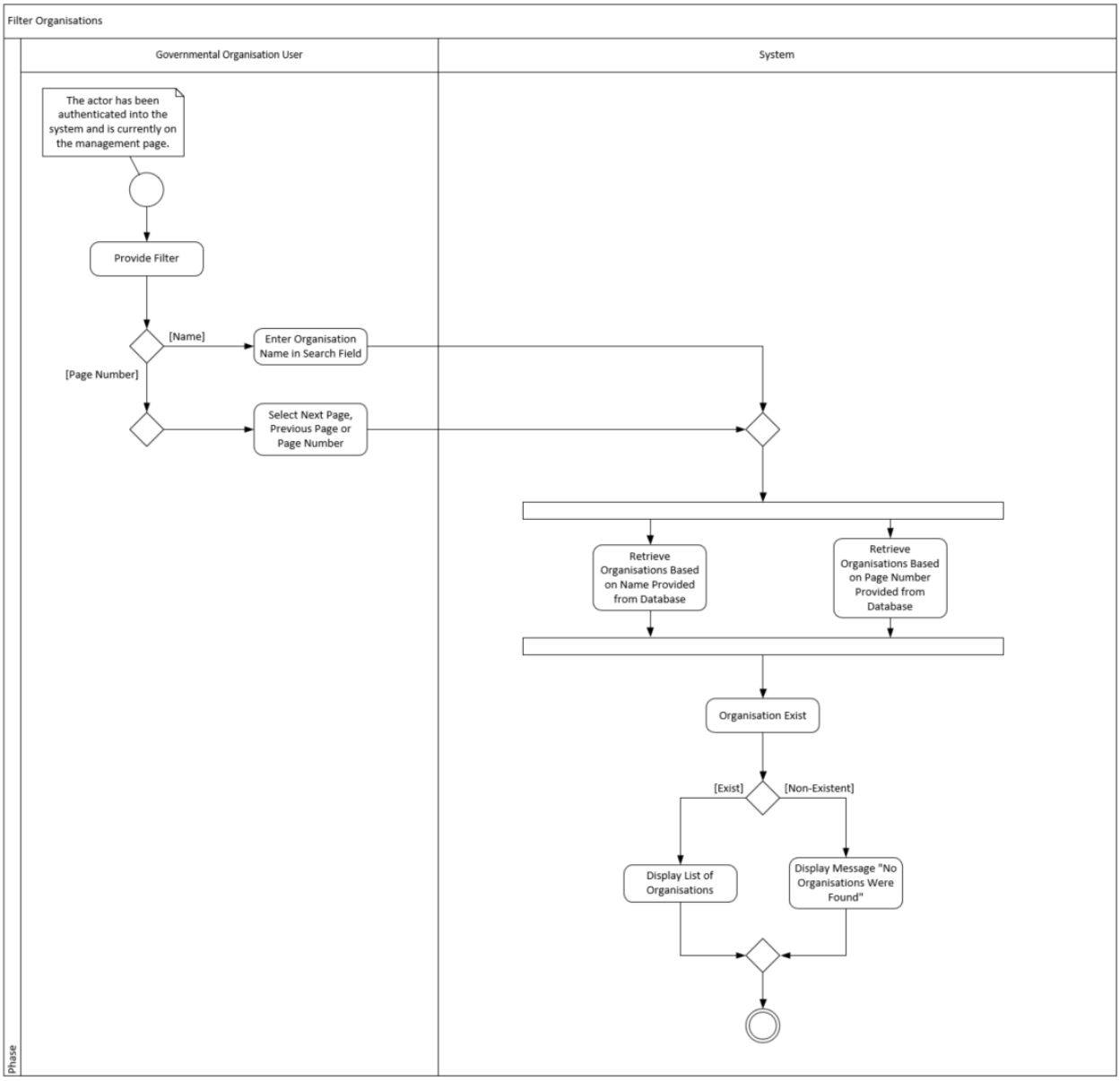


Figure 152: Activity Diagram - Filter Organisations

7.2.1.3.23 Add New Organisation

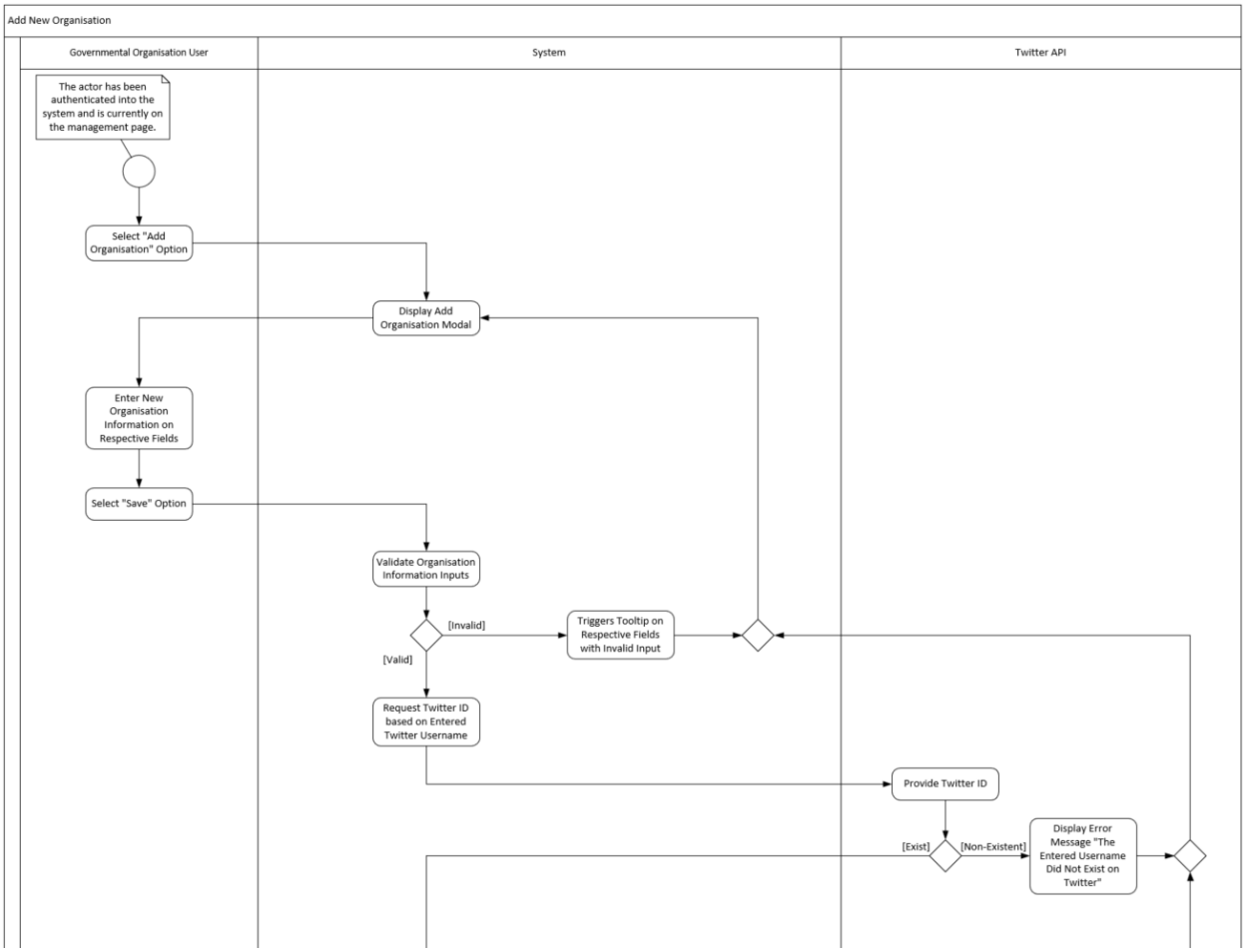


Figure 153: Activity Diagram - Add Organisation Account - Part 1

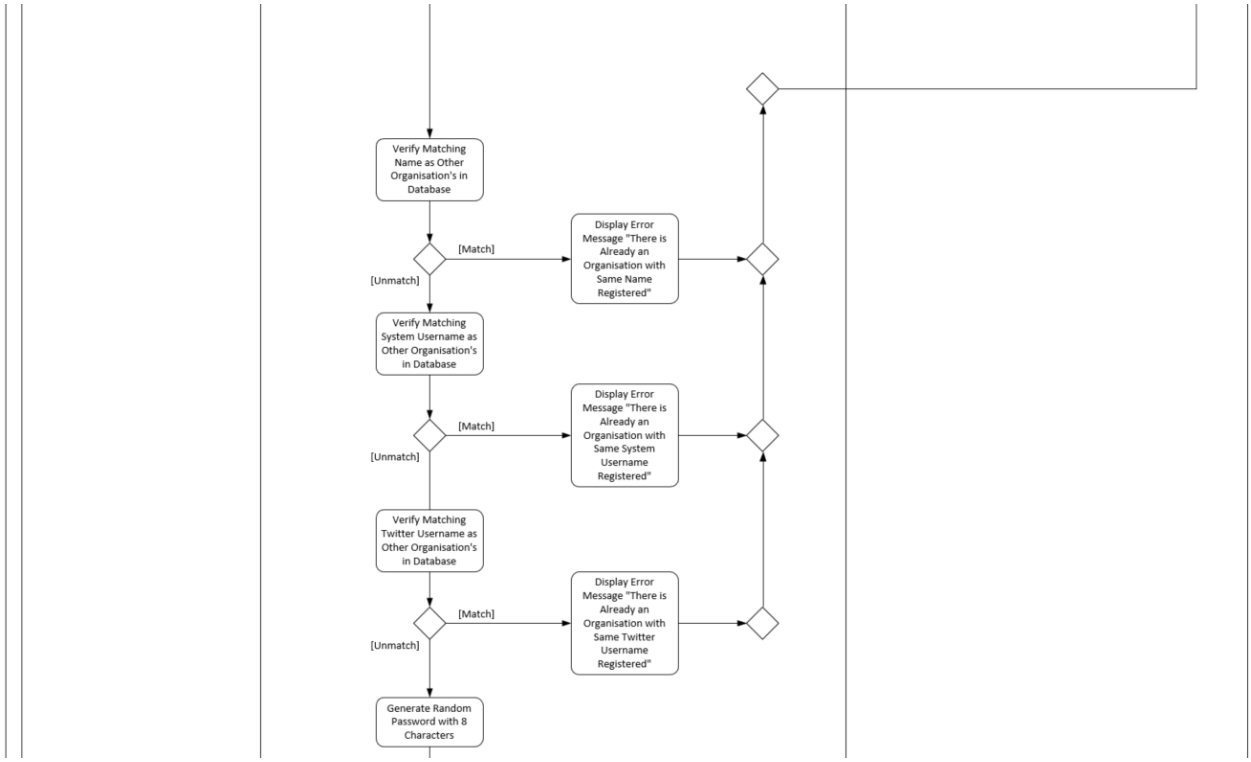


Figure 154: Activity Diagram - Add Organisation Account - Part 2

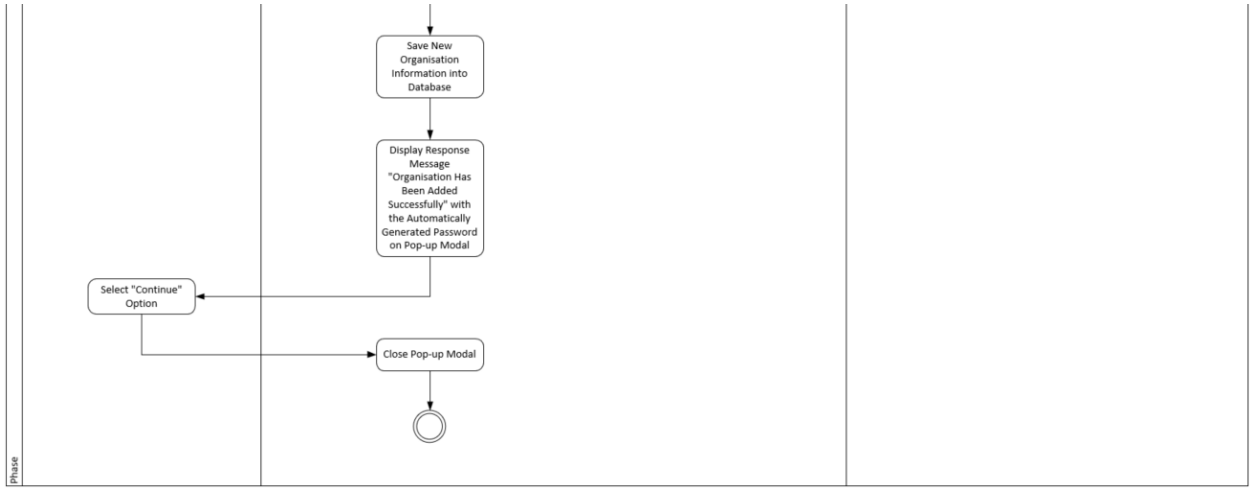


Figure 155: Activity Diagram - Add New Organisation - Part 3

7.2.1.4 Sequence Diagram

7.2.1.4.1 Stream Tweets

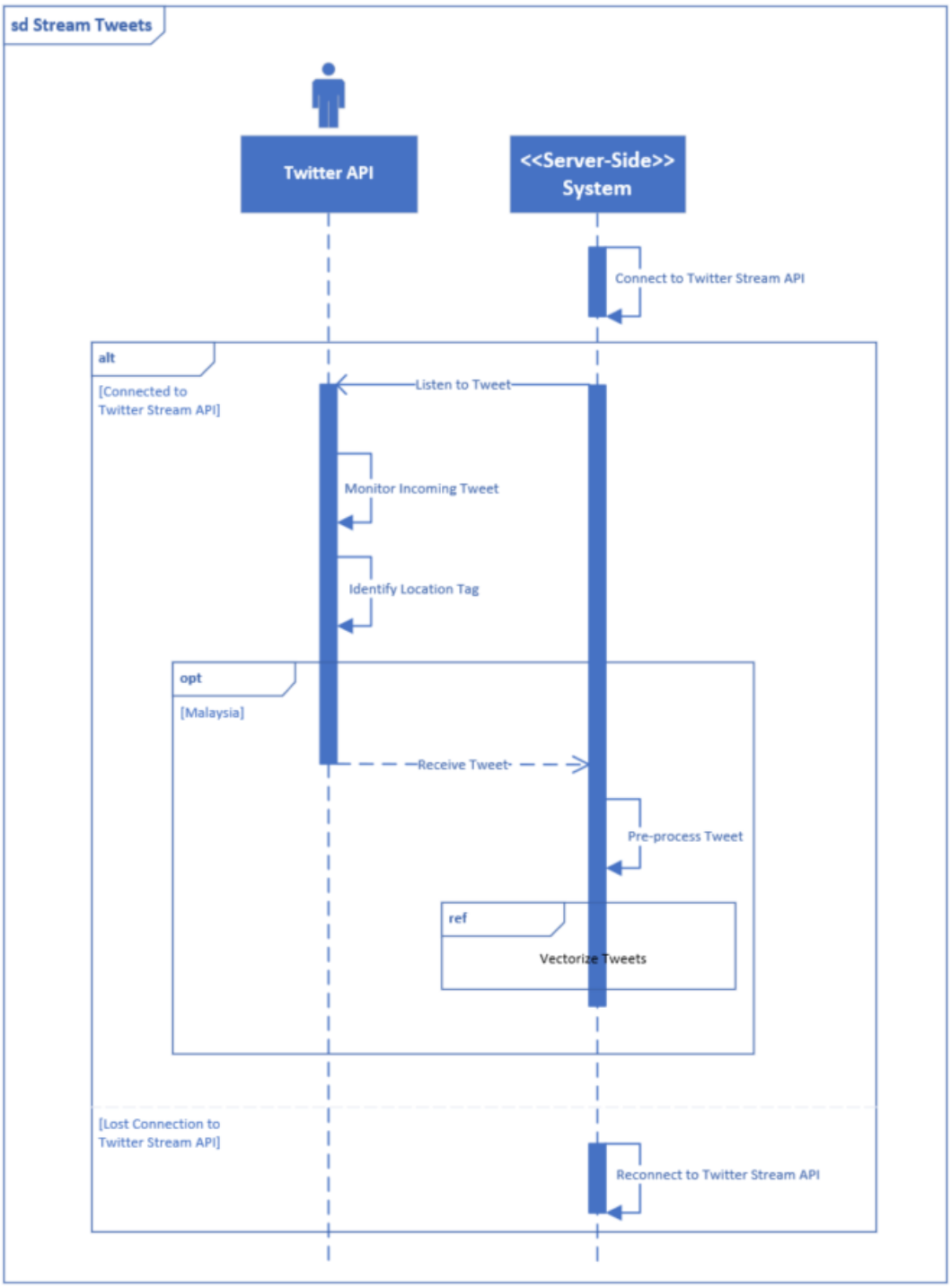


Figure 156: Sequence Diagram - Stream Tweets

7.2.1.4.2 Vectorize Tweets

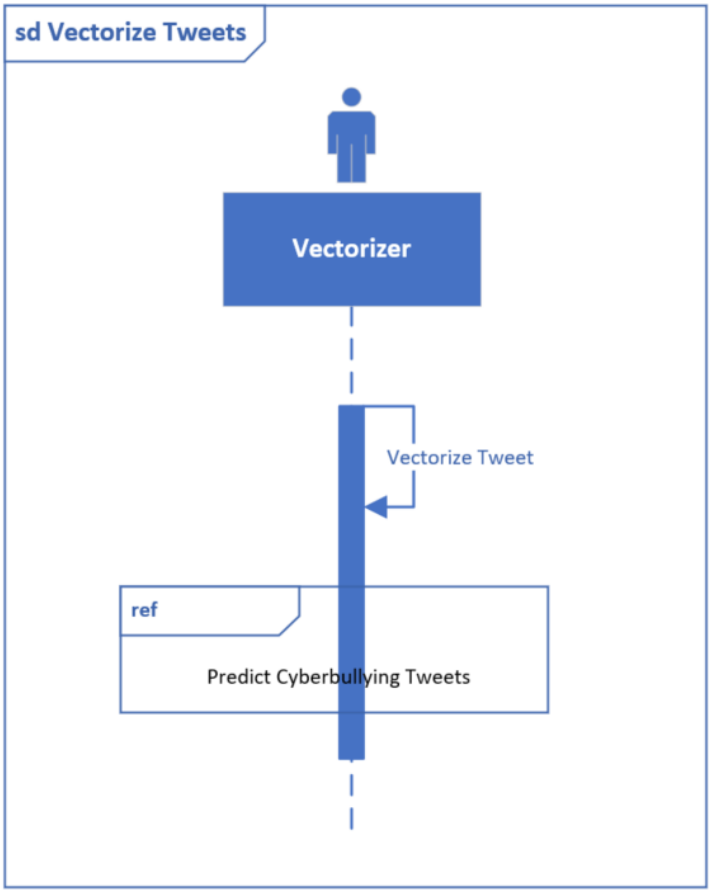


Figure 157: Sequence Diagram - Vectorize Tweets

7.2.1.4.3 Predict Cyberbullying Tweets

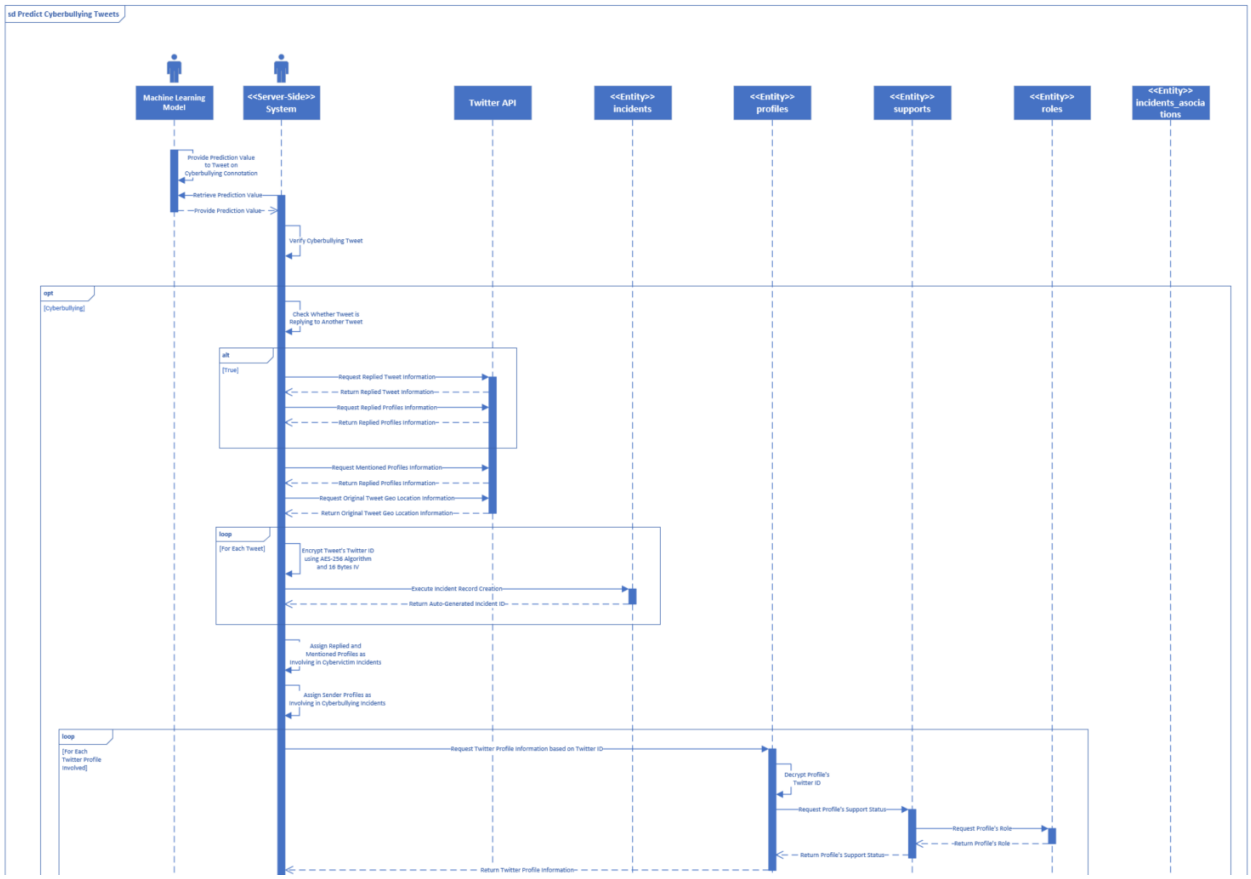


Figure 158: Sequence Diagram - Predict Cyberbullying Tweets – Part 1

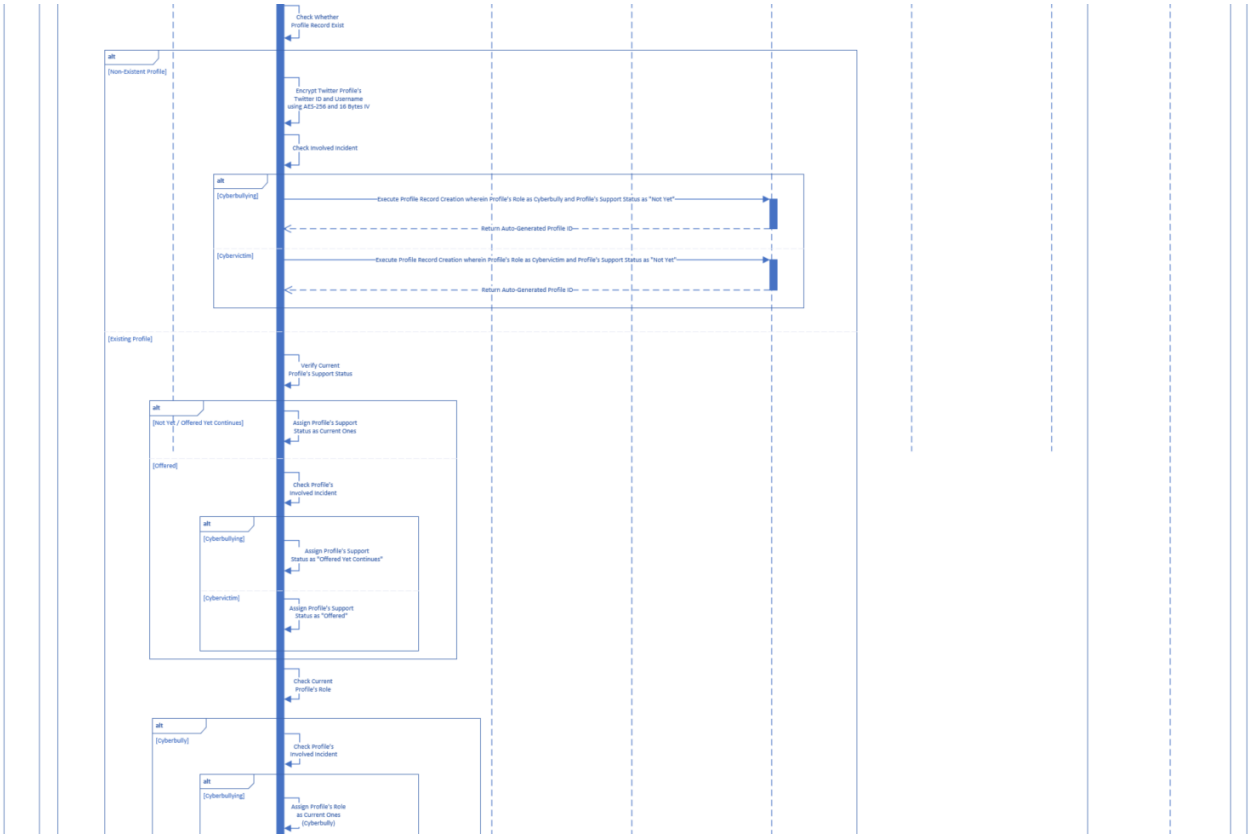


Figure 159: Sequence Diagram - Predict Cyberbullying Tweets - Part 2

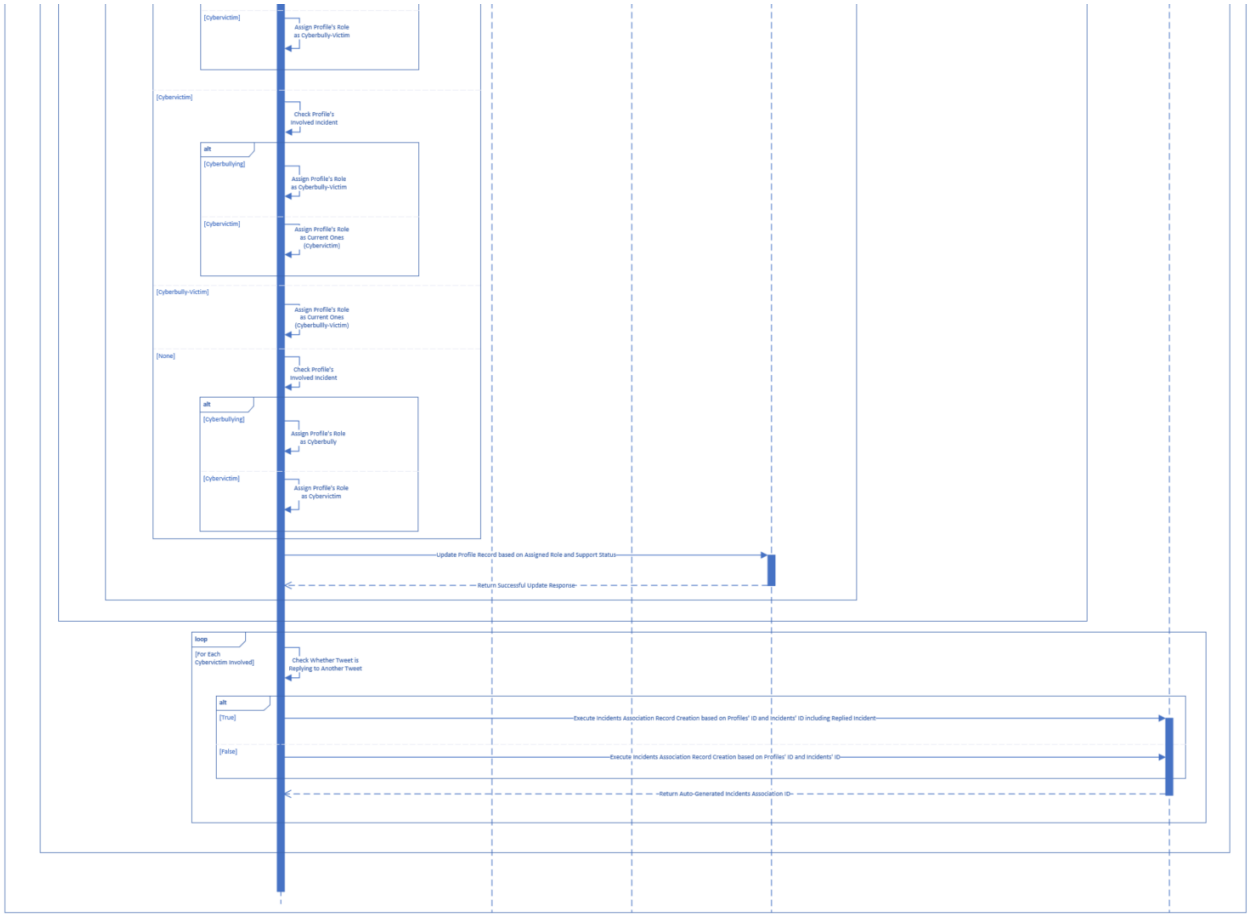


Figure 160: Sequence Diagram - Predict Cyberbullying Tweets - Part 3

7.2.1.4.4 Login

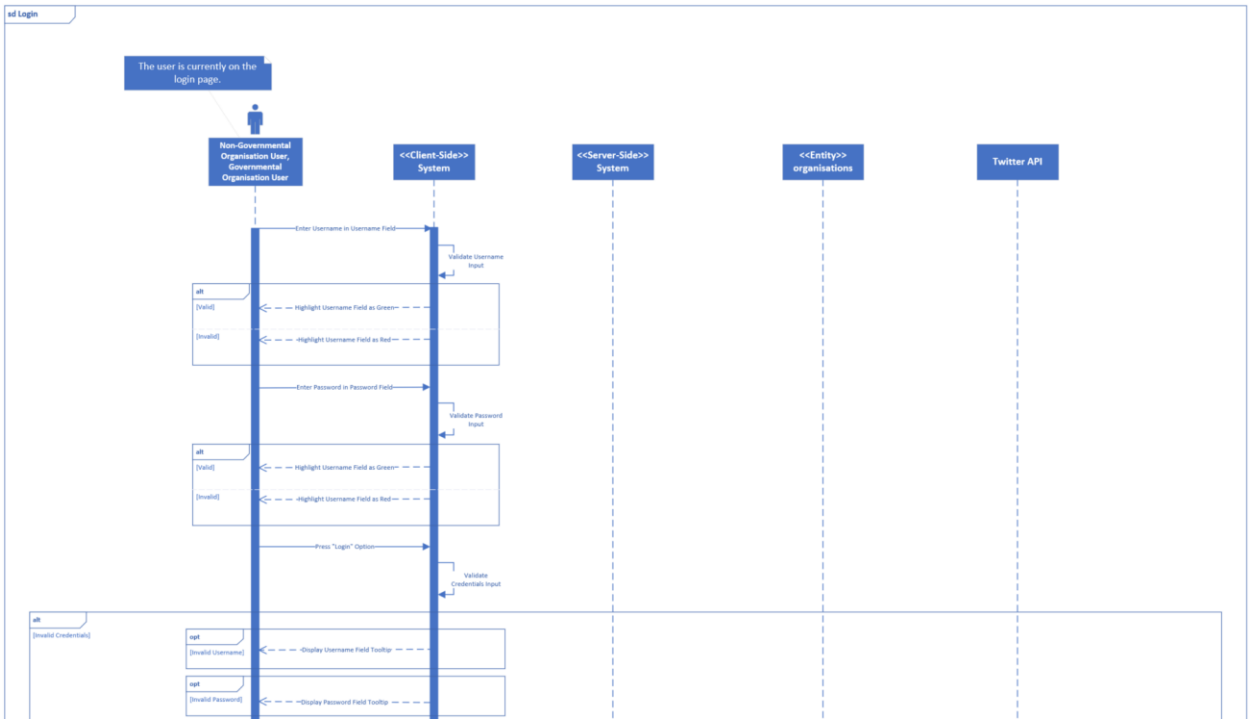


Figure 161: Sequence Diagram - Login - Part 1

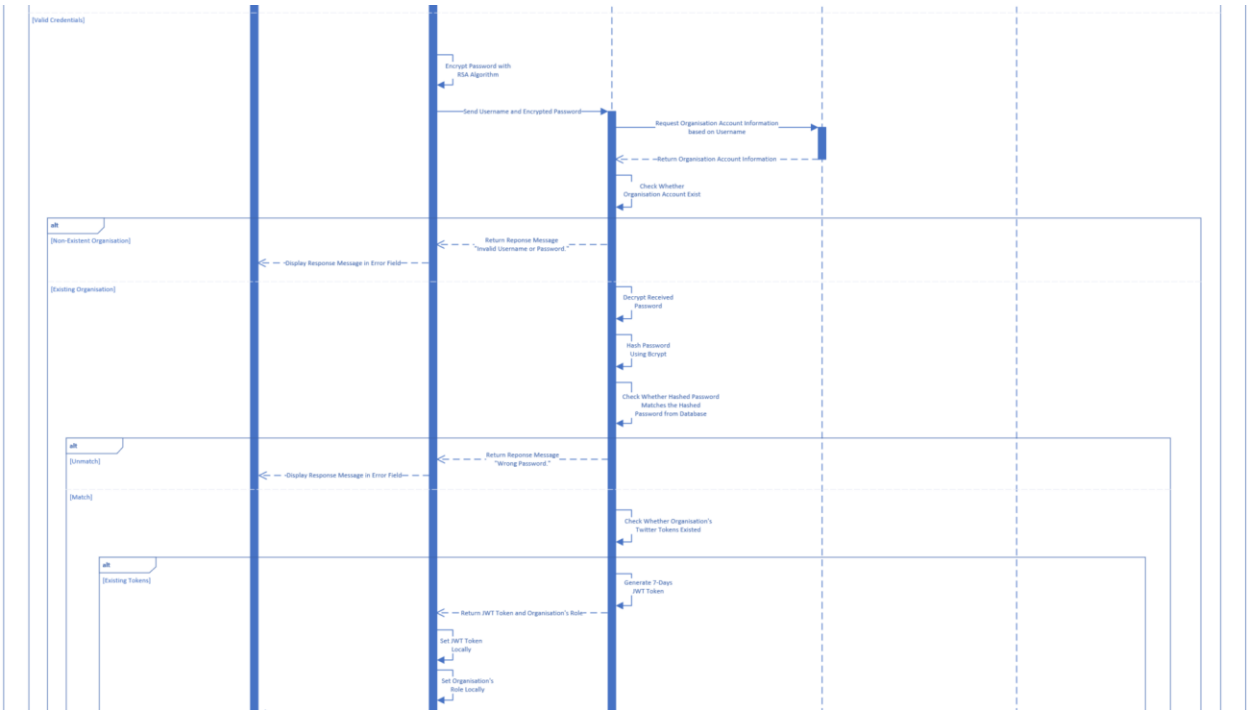


Figure 162: Sequence Diagram - Login - Part 2

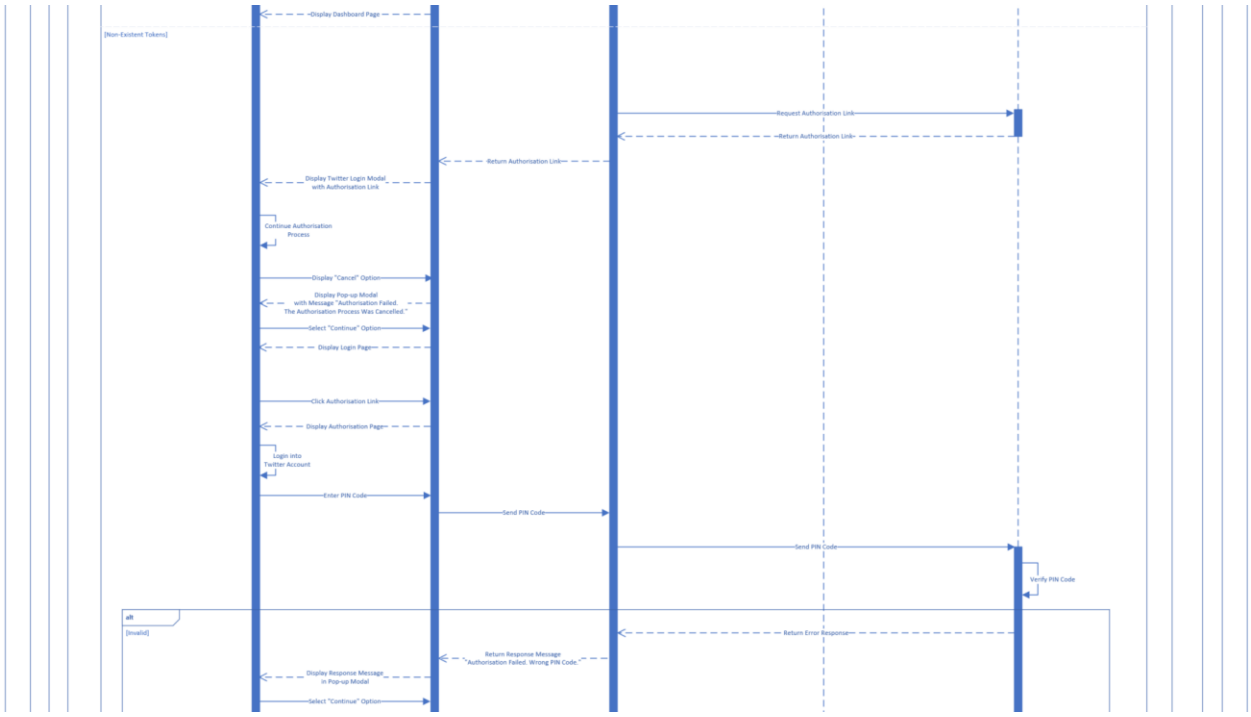


Figure 163: Sequence Diagram - Login - Part 3

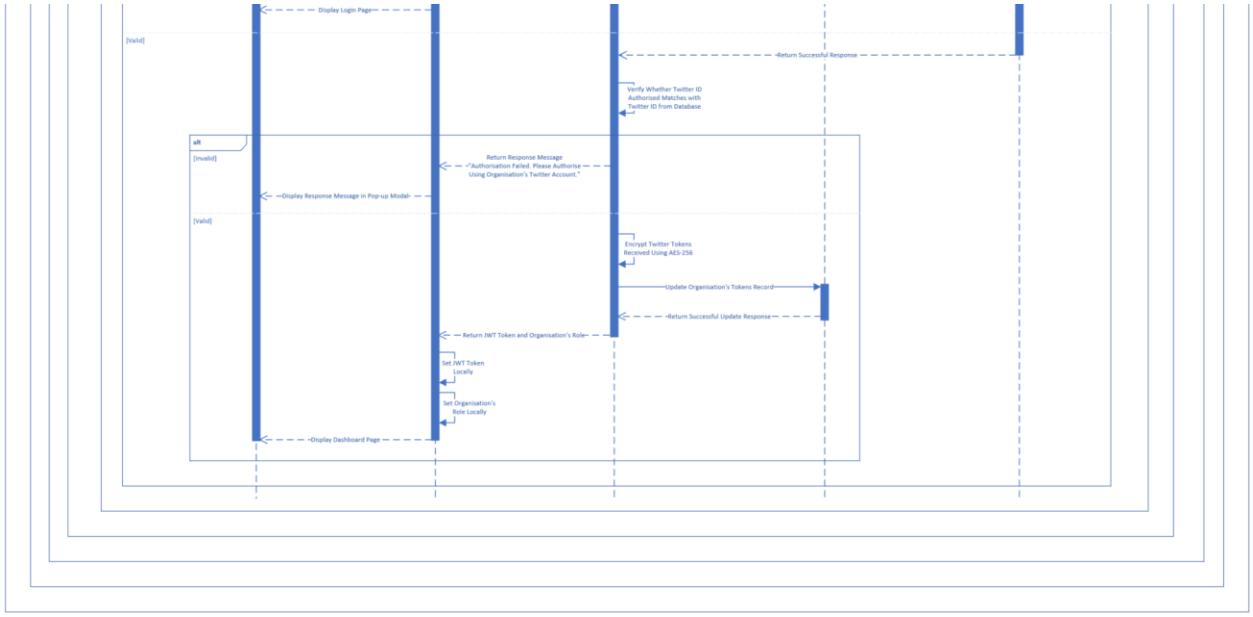


Figure 164: Sequence Diagram - Login - Part 4

7.2.1.4.5 Logout

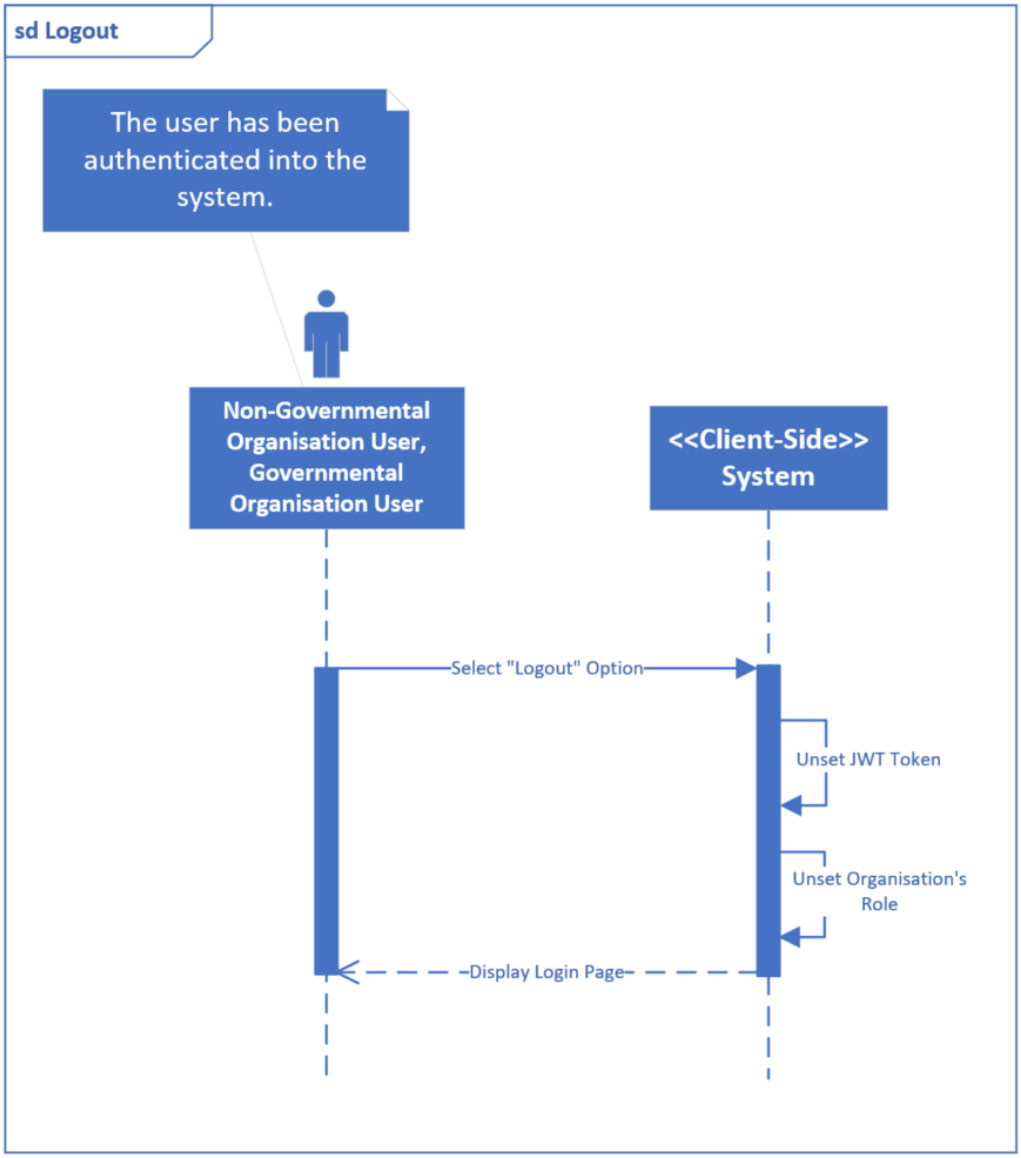


Figure 165: Sequence Diagram - Logout

7.2.1.4.6 View Dashboard Statistics

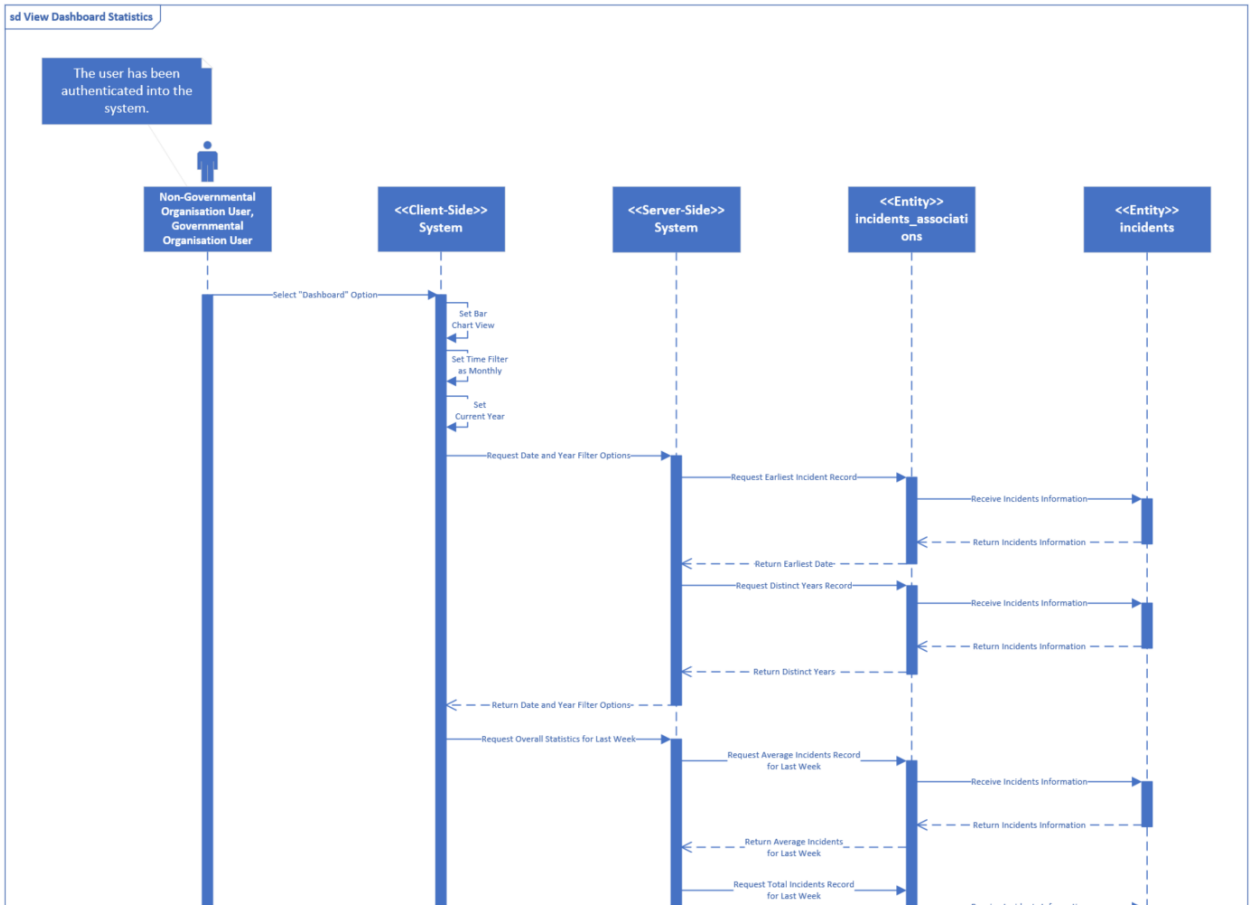


Figure 166: Sequence Diagram - View Dashboard Statistics – Part 1

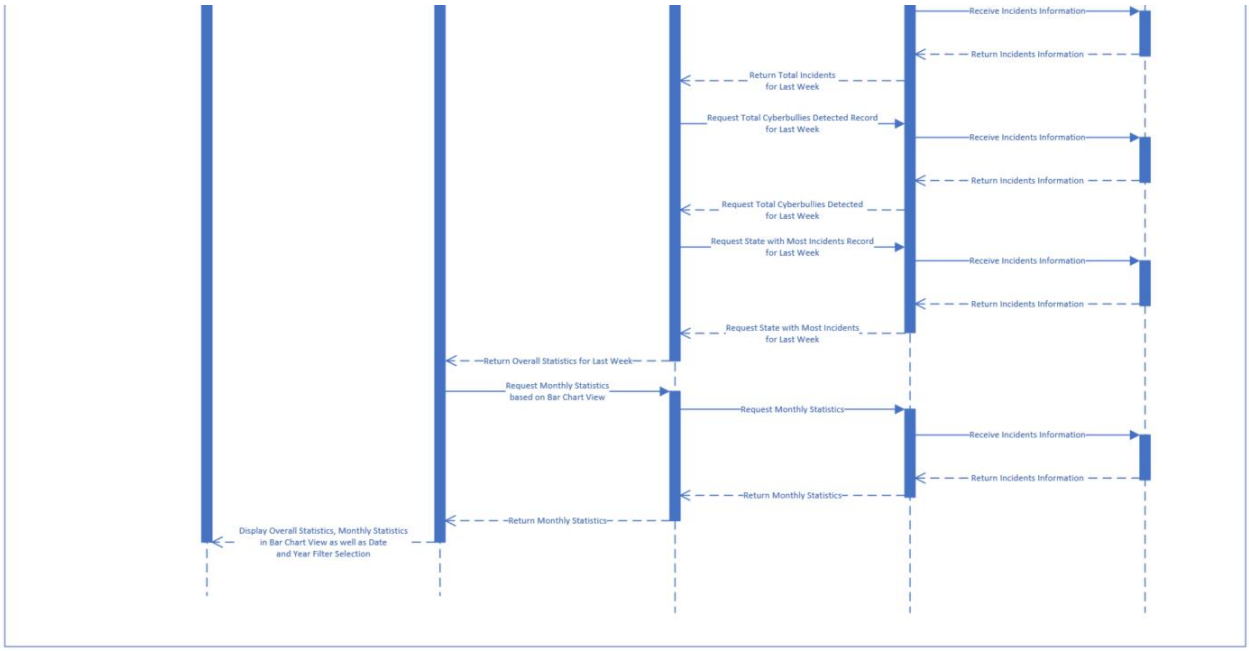


Figure 167: Sequence Diagram - View Dashboard Statistics – Part 2

7.2.1.4.7 Change Dashboard Statistics View

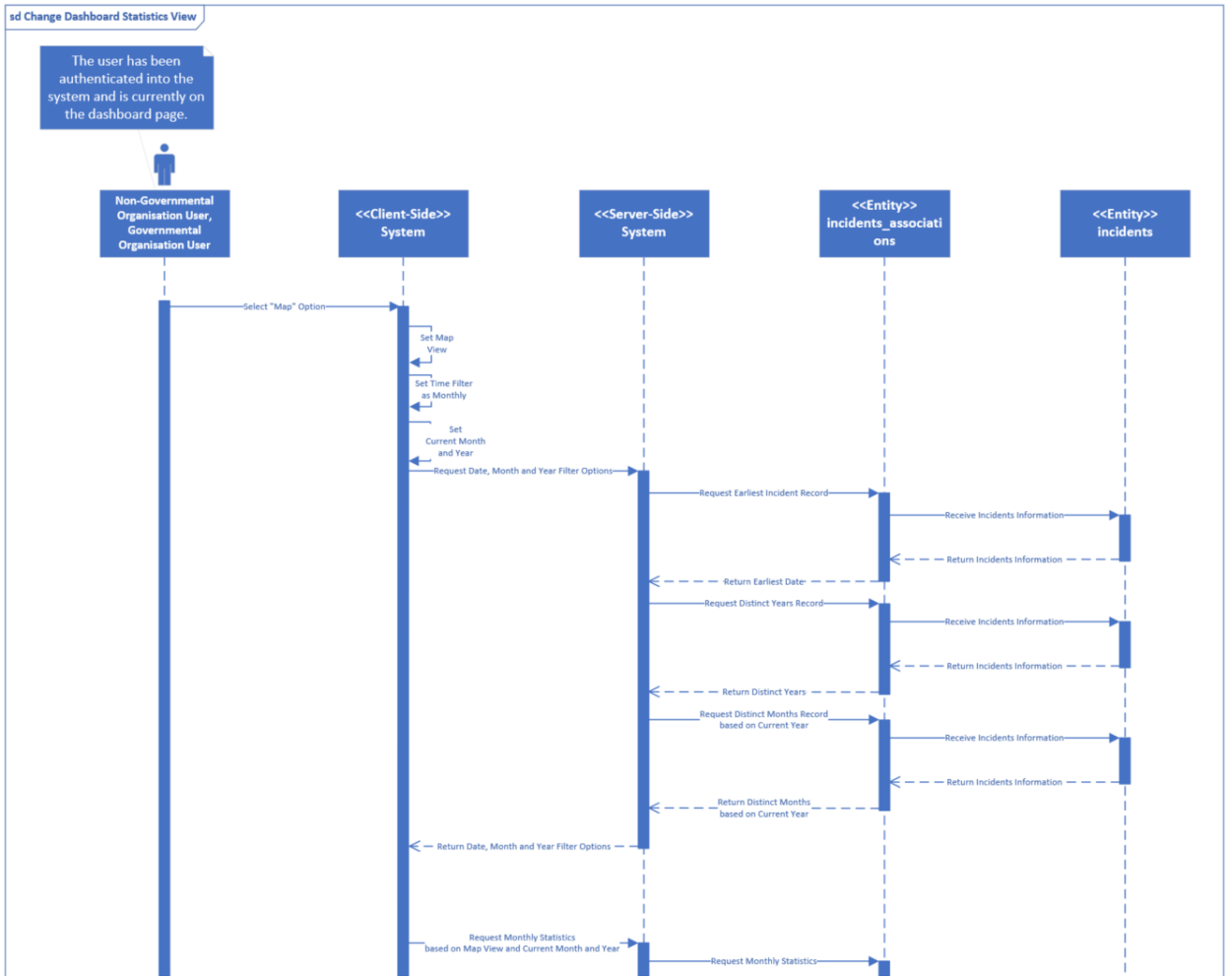


Figure 168: Sequence Diagram - Change Dashboard Statistics View - Part 1

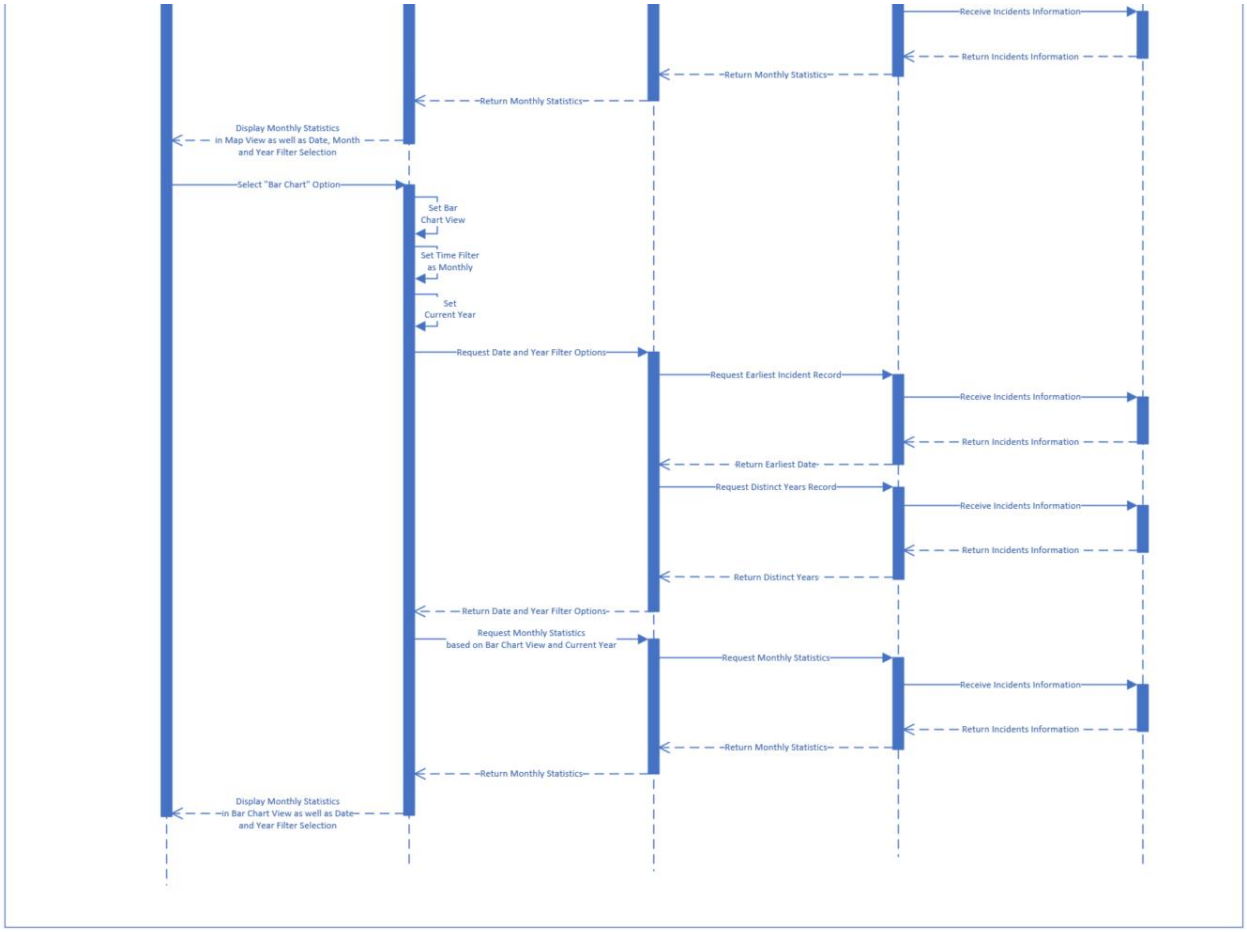


Figure 169: Sequence Diagram - Change Dashboard Statistics View - Part 2

7.2.1.4.8 Filter Dashboard Statistics

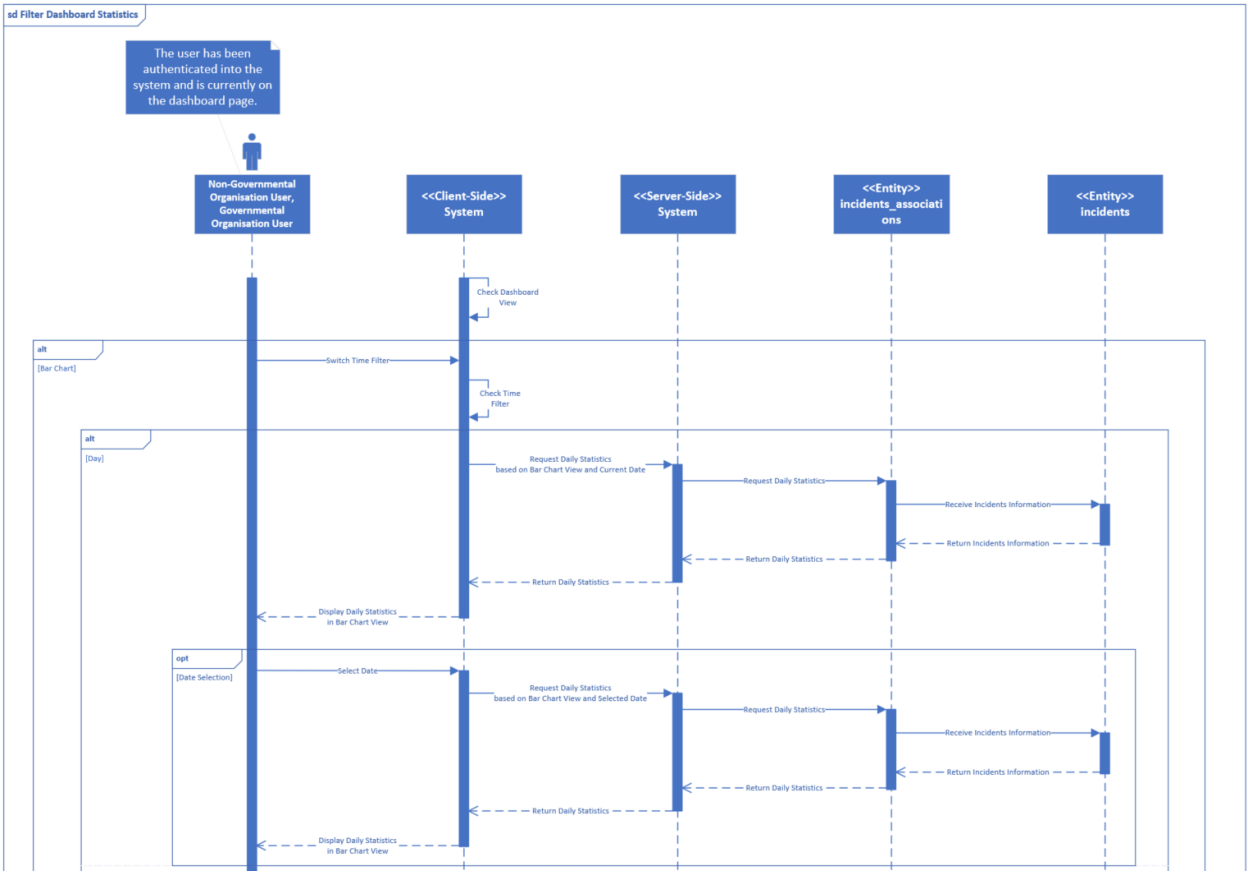


Figure 170: Sequence Diagram - Filter Dashboard Statistics - Part 1

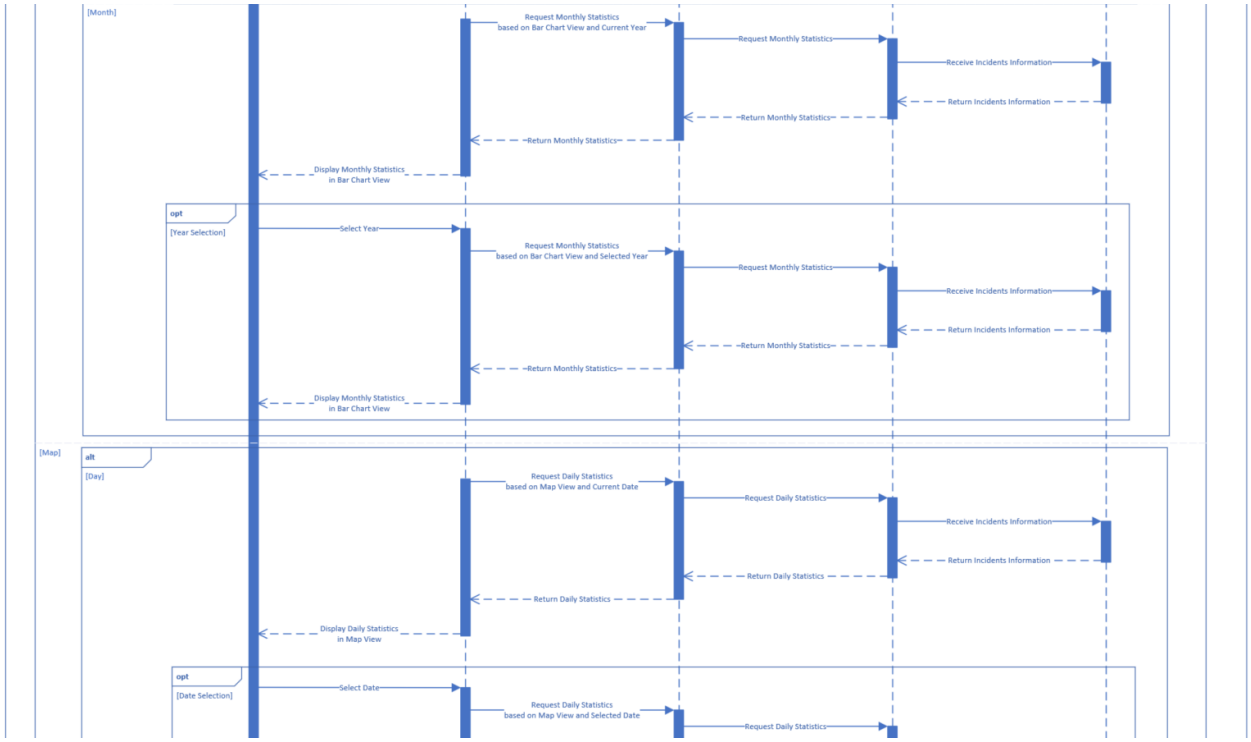


Figure 171: Sequence Diagram - Filter Dashboard Statistics - Part 2

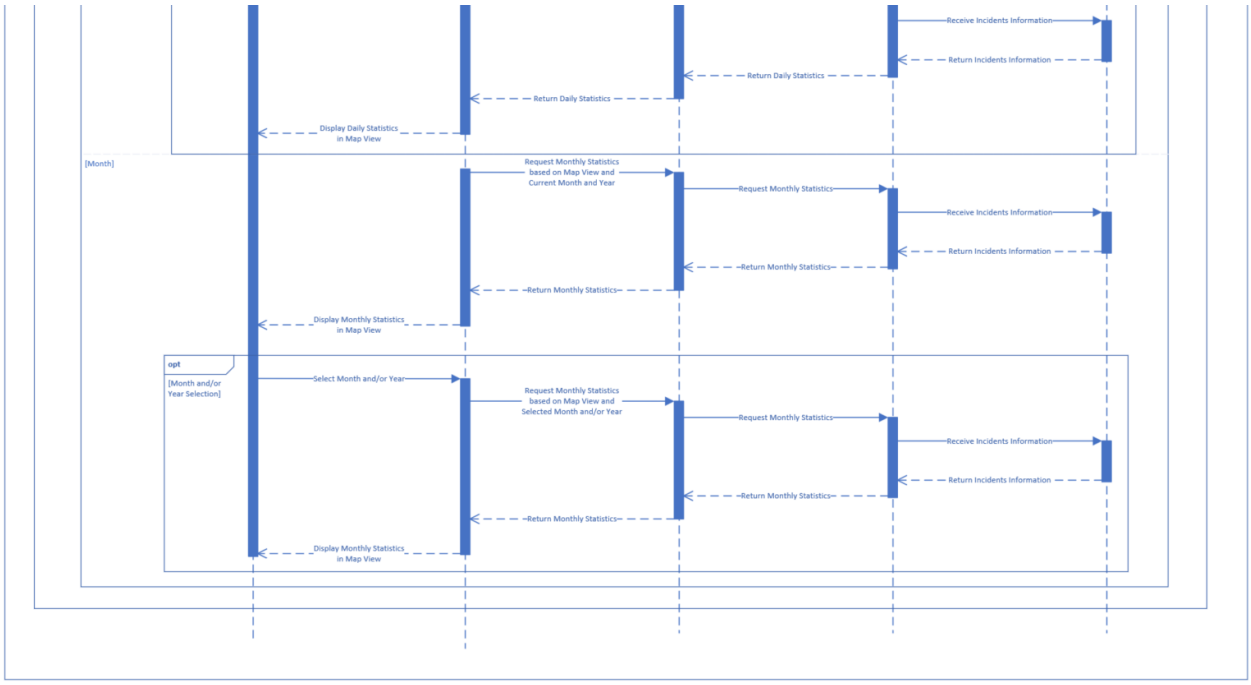


Figure 172: Sequence Diagram - Filter Dashboard Statistics - Part 3

7.2.1.4.9 View Twitter Profiles

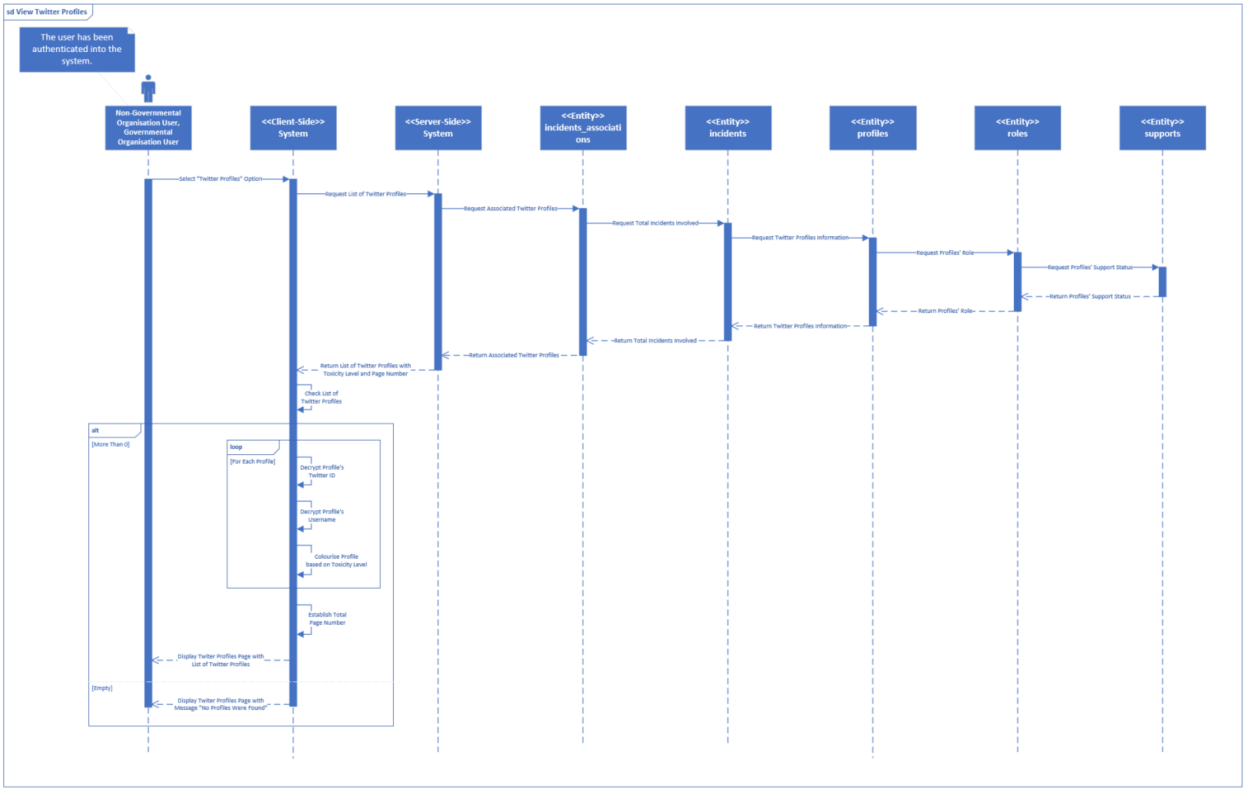


Figure 173: Sequence Diagram - View Twitter Profiles

7.2.1.4.10 Filter Twitter Profiles

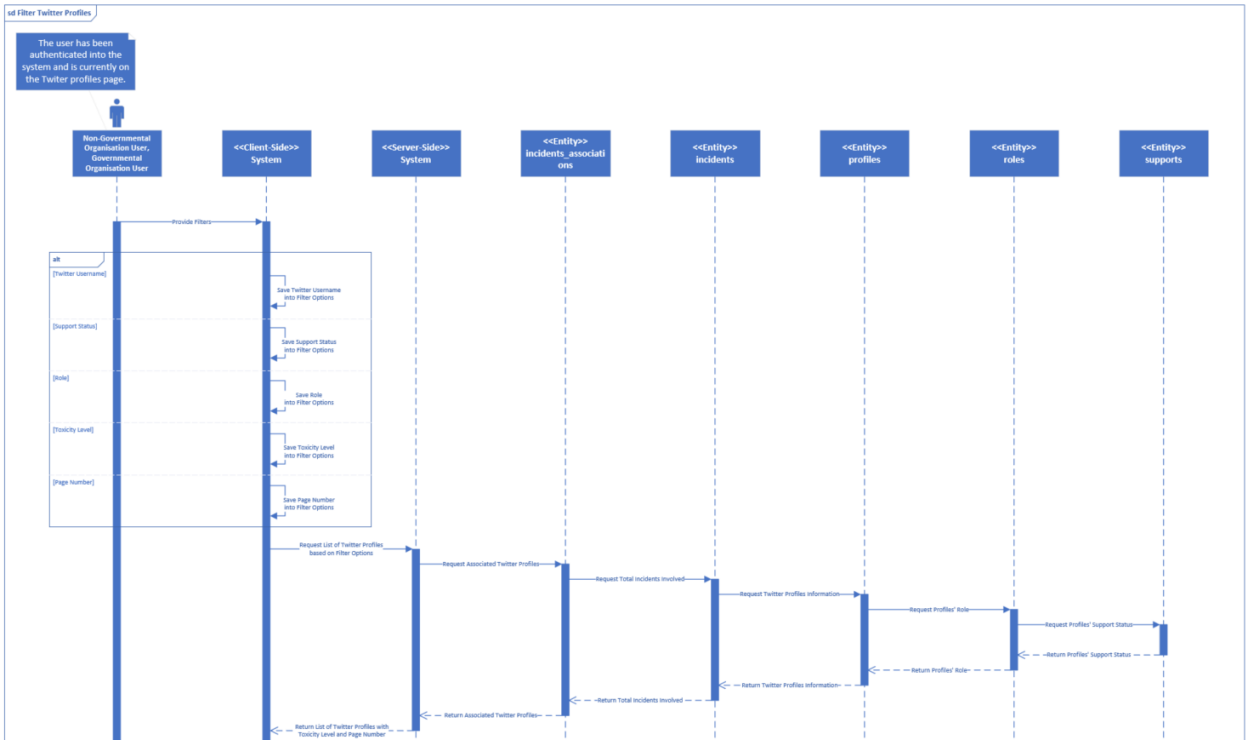


Figure 174: Sequence Diagram - Filter Twitter Profiles - Part 1

Figure 175: Sequence Diagram - Filter Twitter Profiles - Part 2

7.2.1.4.11 View Incidents

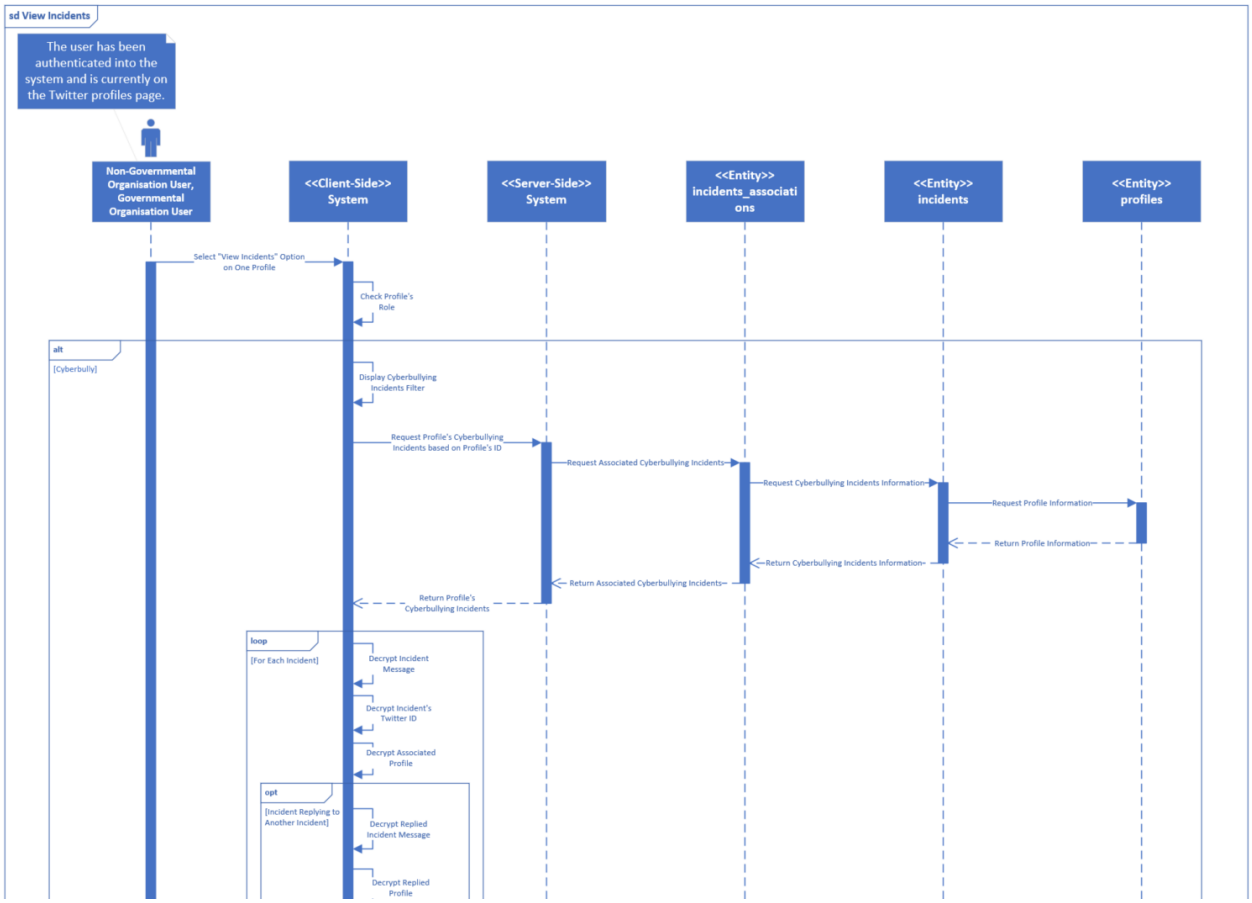


Figure 176: Sequence Diagram - View Incidents - Part 1

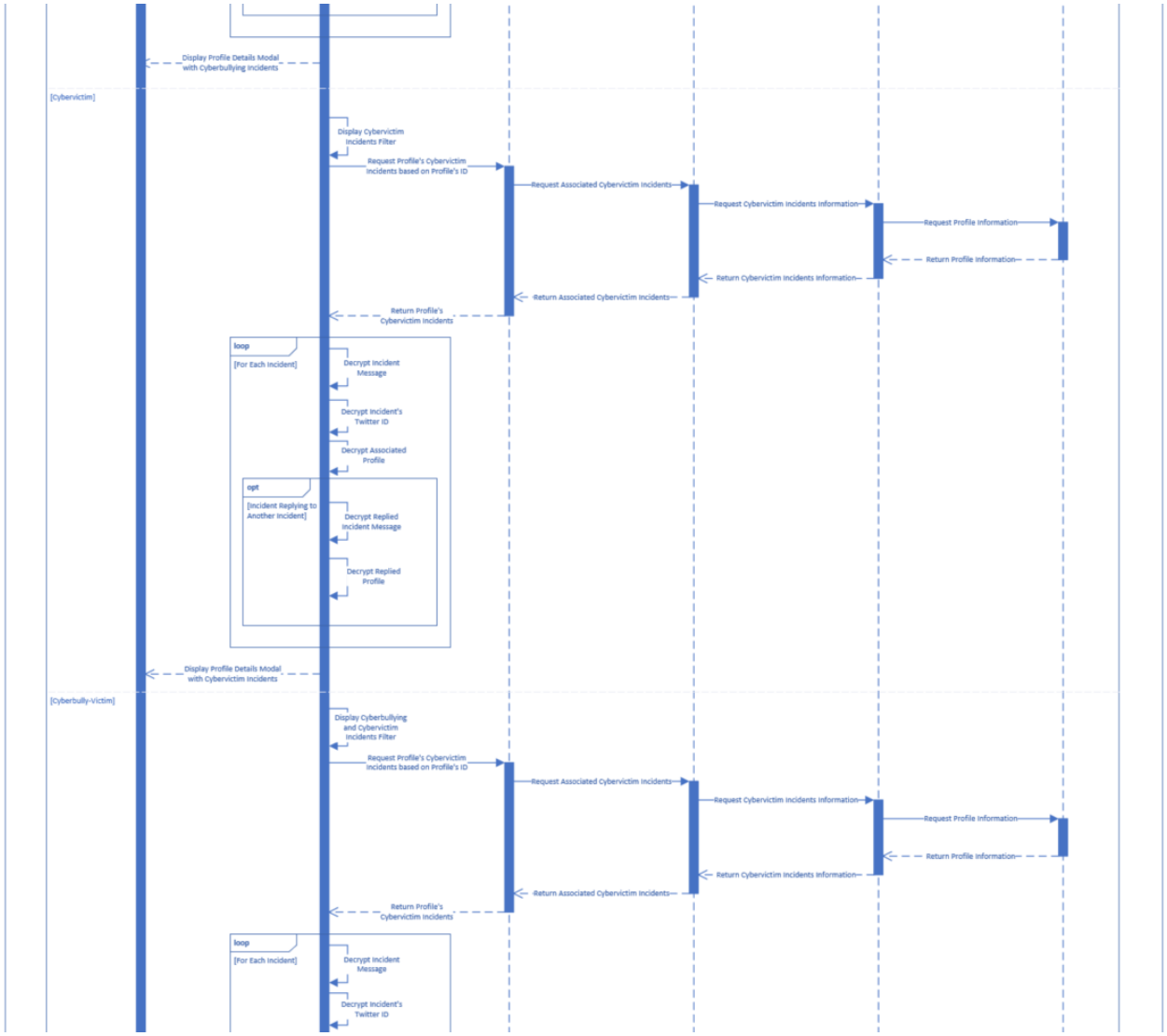


Figure 177: Sequence Diagram - View Incidents - Part 2

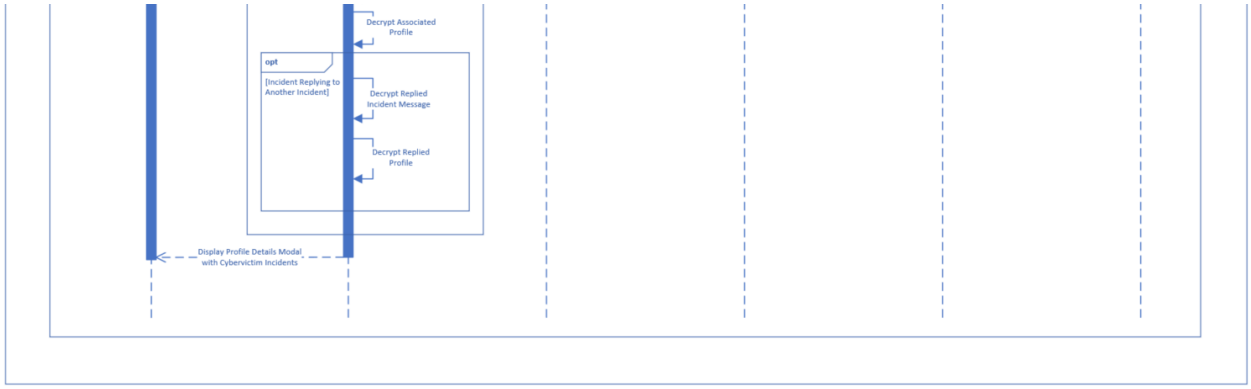


Figure 178: Sequence Diagram - View Incidents – Part 3

7.2.1.4.12 Filter Incidents

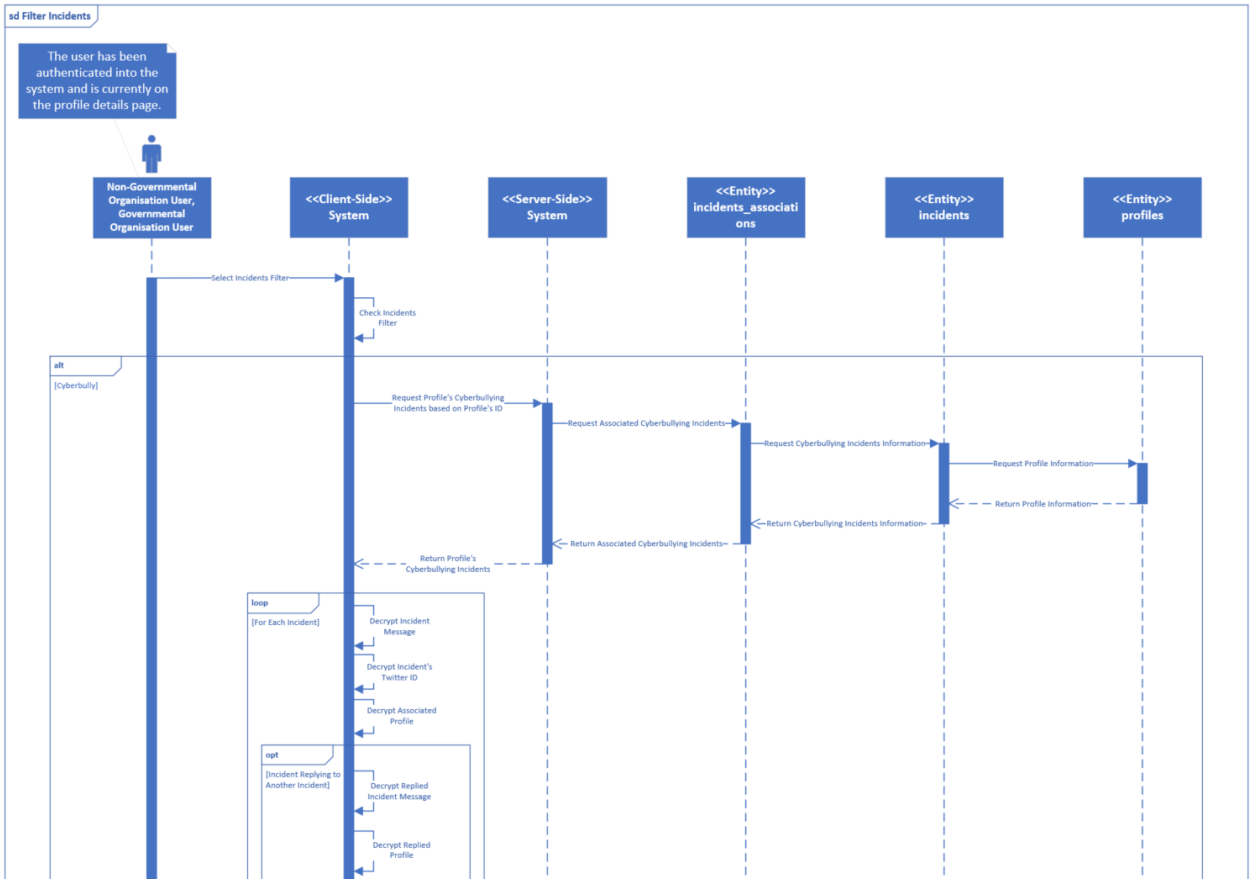


Figure 179: Sequence Diagram - Filter Incidents - Part 1

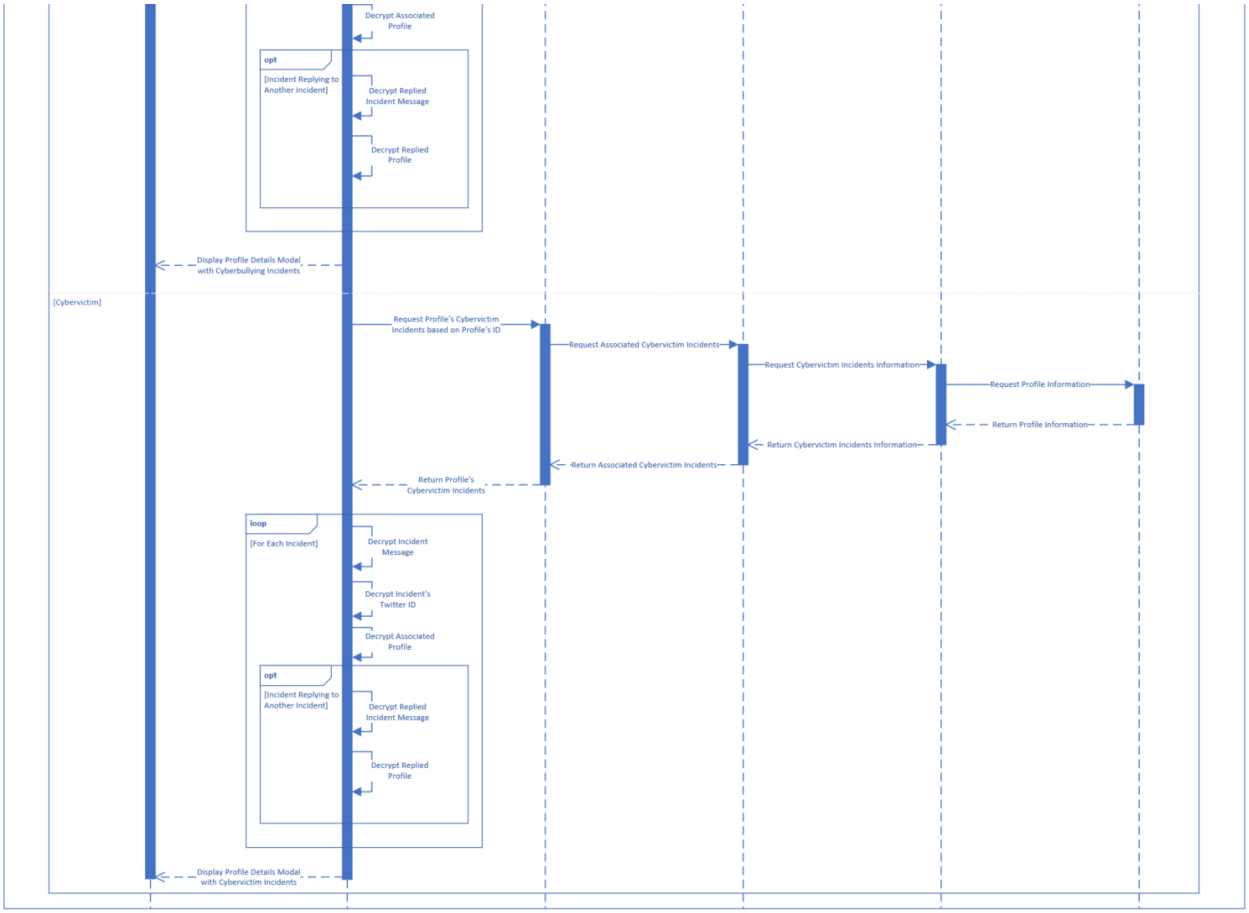


Figure 180: Sequence Diagram - Filter Incidents - Part 2

7.2.1.4.13 Remove Misclassified Incident

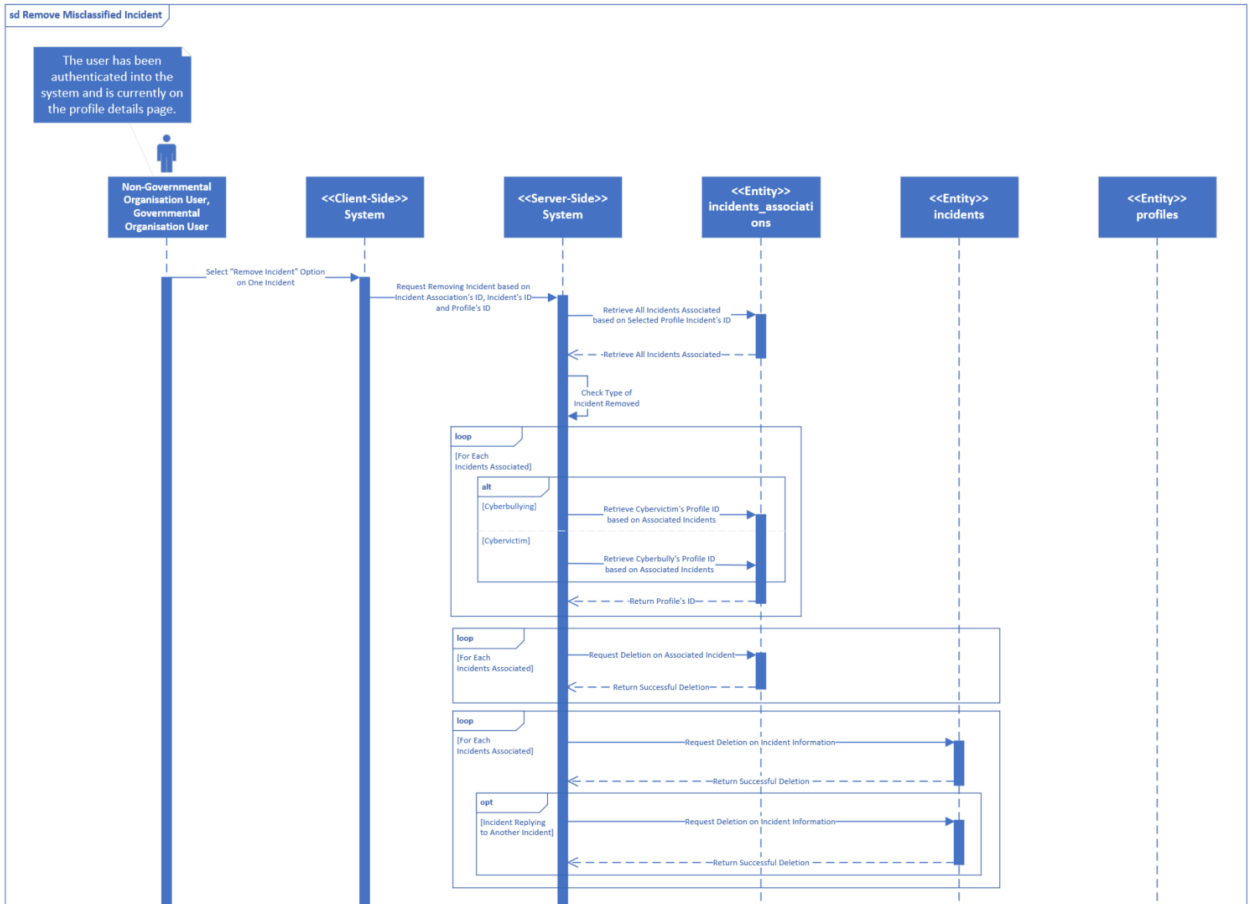


Figure 181: Sequence Diagram - Remove Misclassified Incident - Part 1

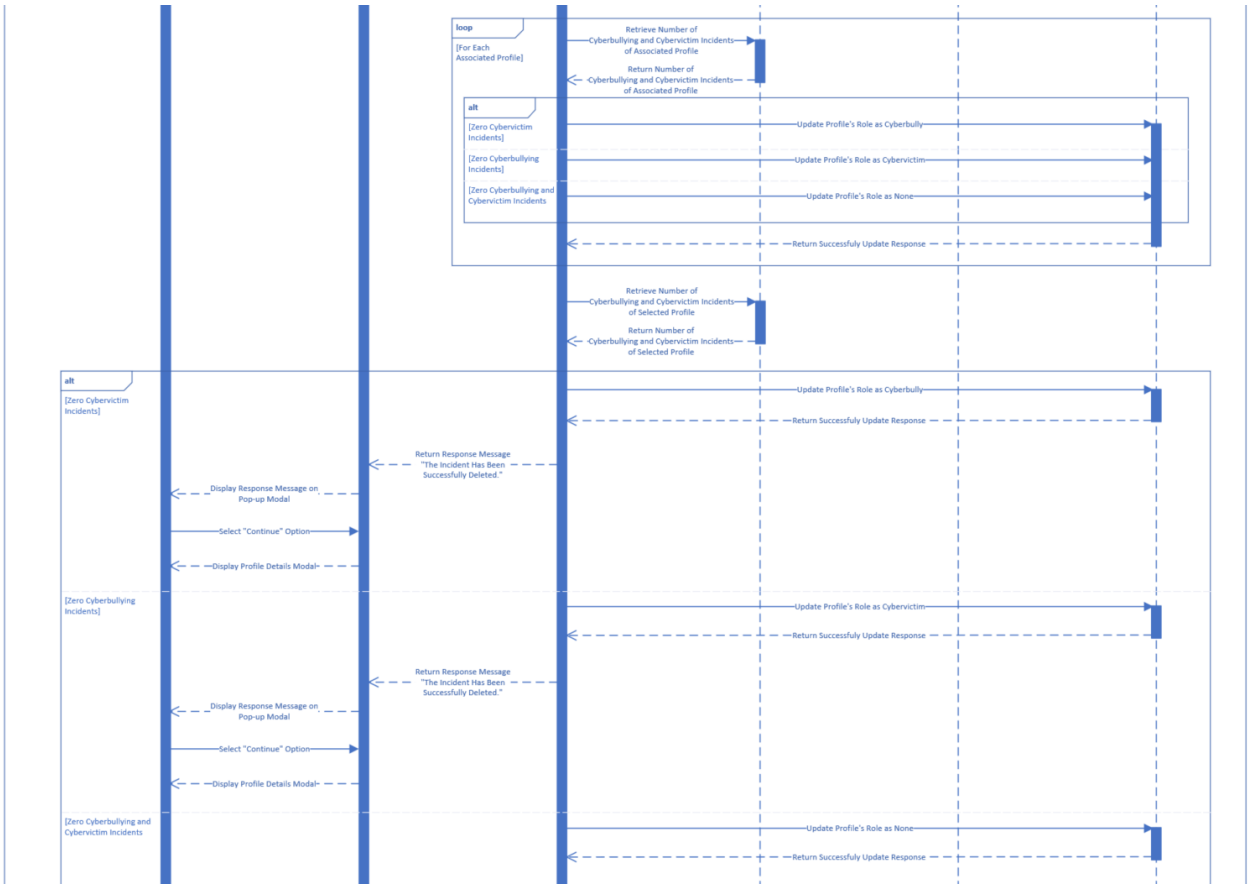


Figure 182: Sequence Diagram - Remove Misclassified Incident - Part 2

Figure 183: Sequence Diagram - Remove Misclassified Incident – Part 3

7.2.1.4.14 Send Support Message By Reply Tweet

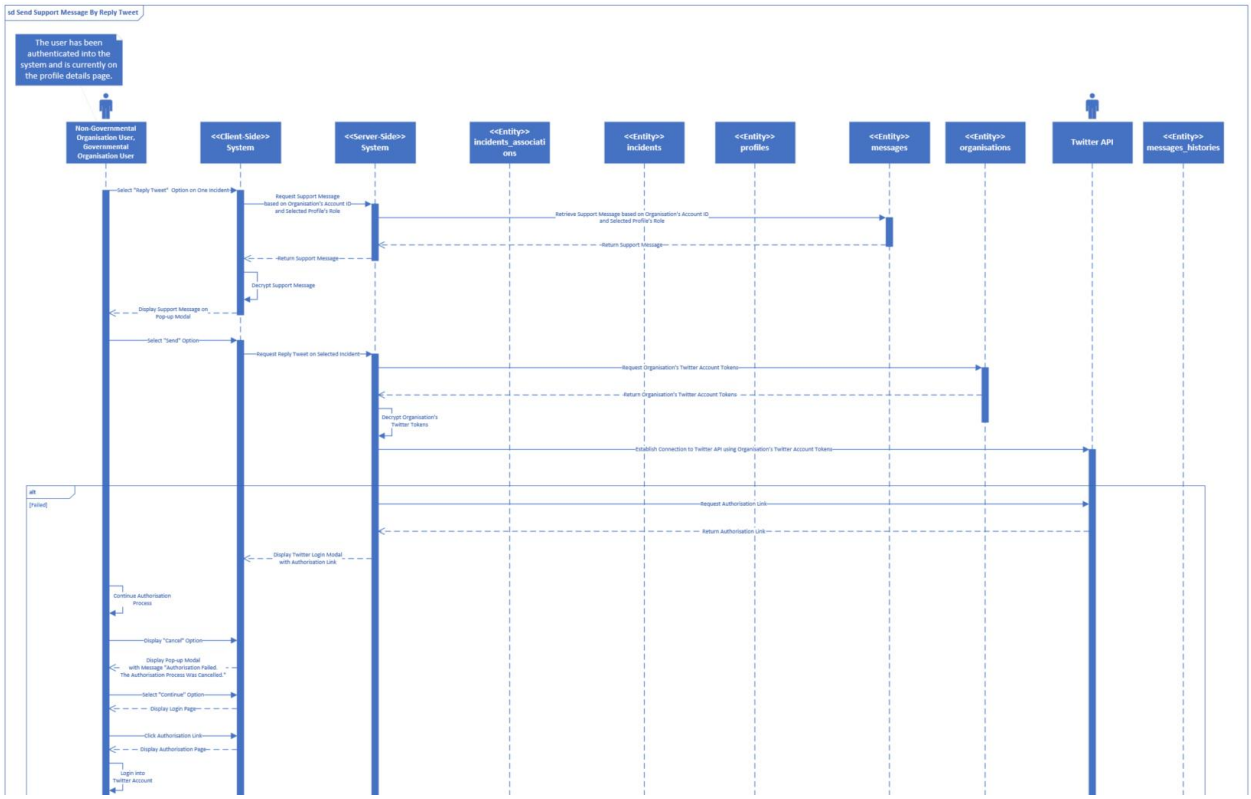


Figure 184: Sequence Diagram - Send Support Message By Reply Tweet - Part 1

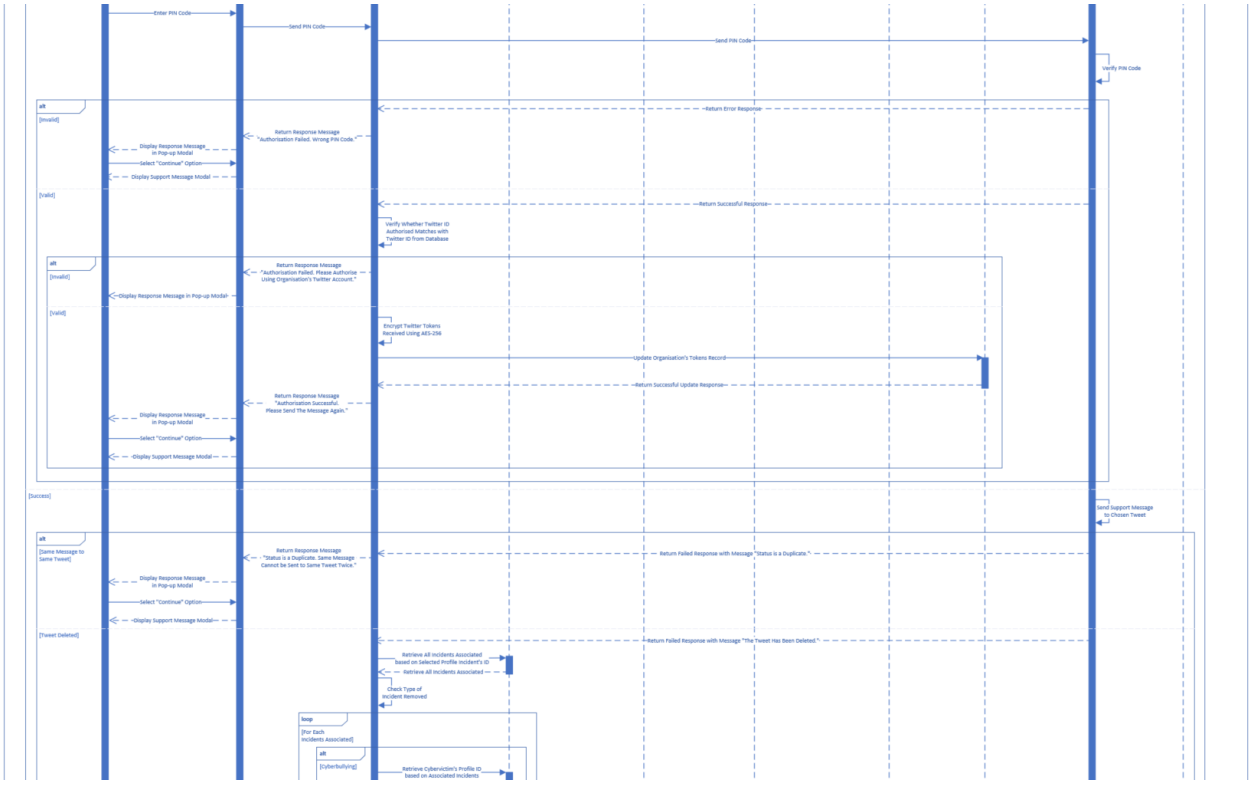


Figure 185: Sequence Diagram - Send Support Message By Reply Tweet - Part 2

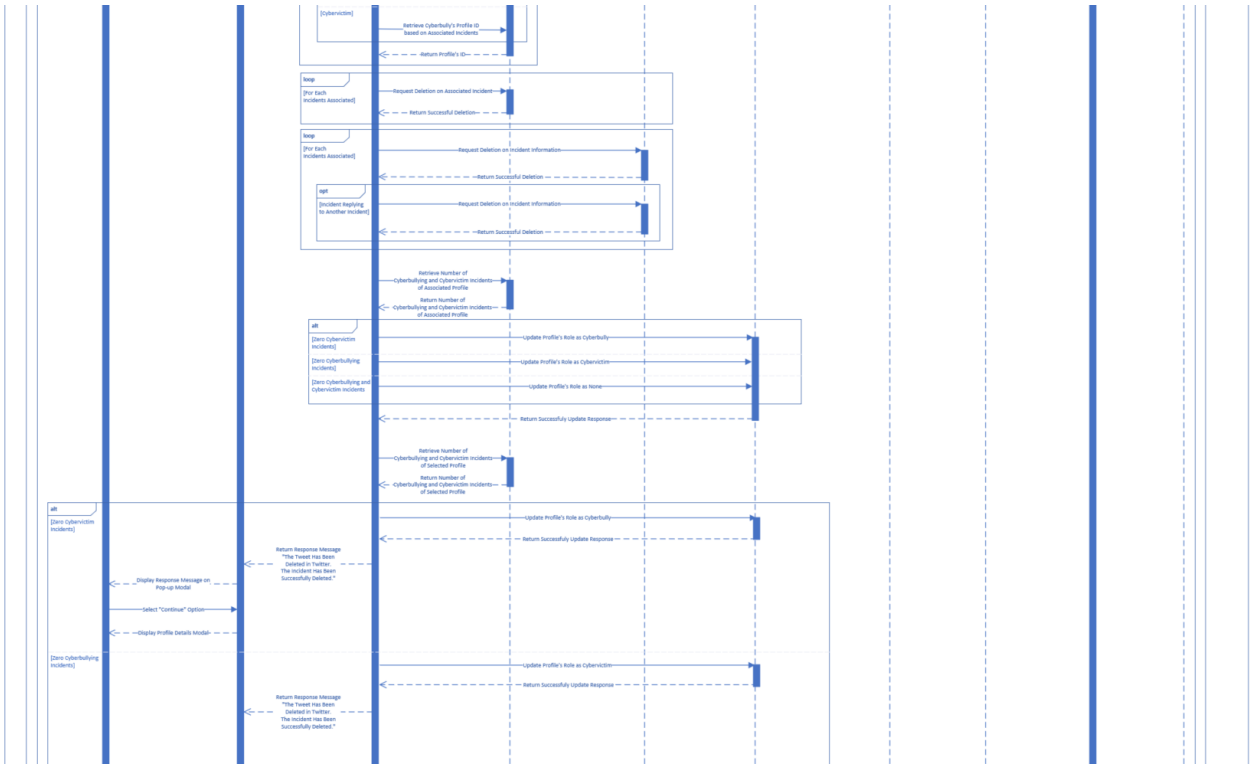


Figure 186: Sequence Diagram - Send Support Message By Reply Tweet - Part 3

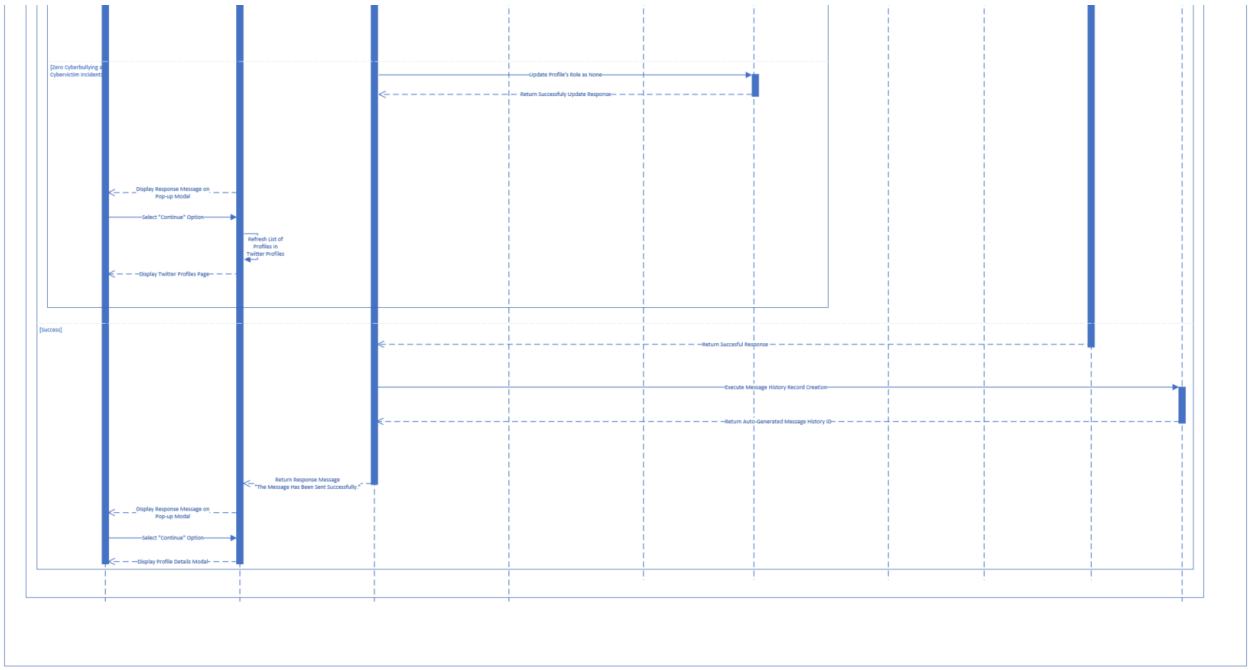


Figure 187: Sequence Diagram - Send Support Message By Reply Tweet – Part 4

7.2.1.4.15 Send Support Message By Support Message

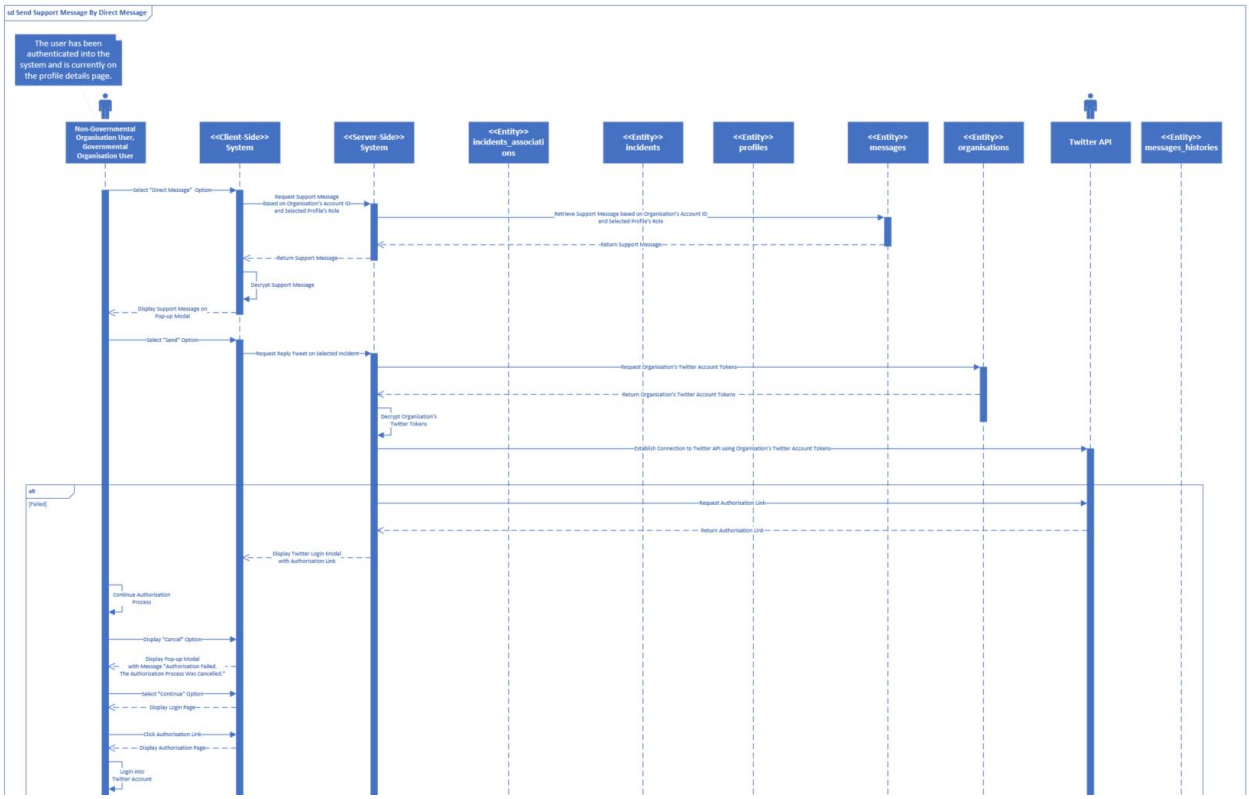


Figure 188: Sequence Diagram - Send Support Message By Support Message - Part 1

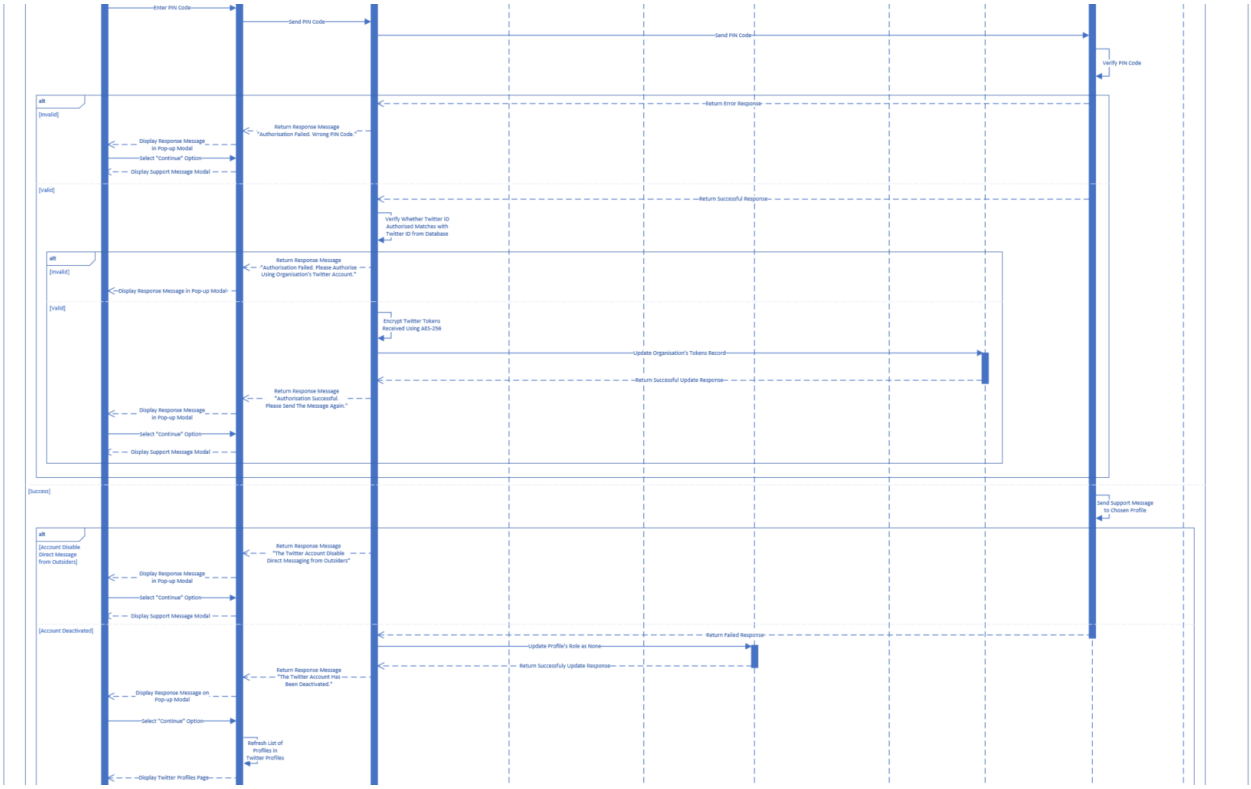


Figure 189: Sequence Diagram - Send Support Message By Support Message - Part 2

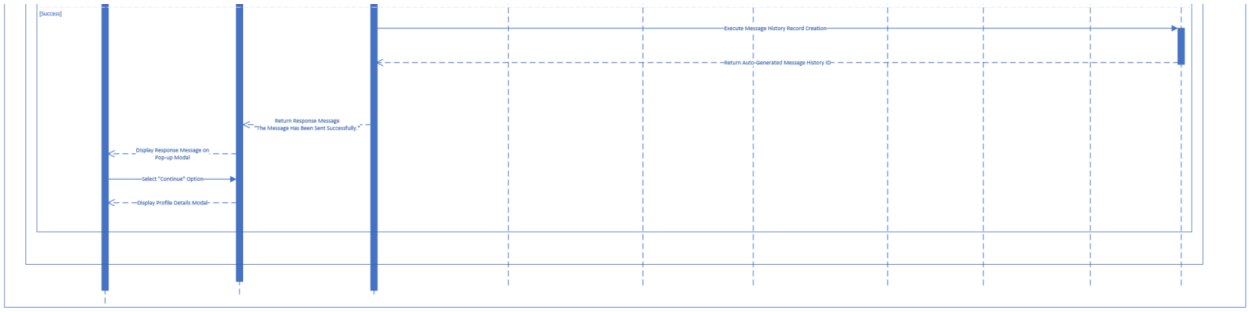


Figure 190: Sequence Diagram - Send Support Message By Support Message - Part 3

7.2.1.4.16 View Support Message History

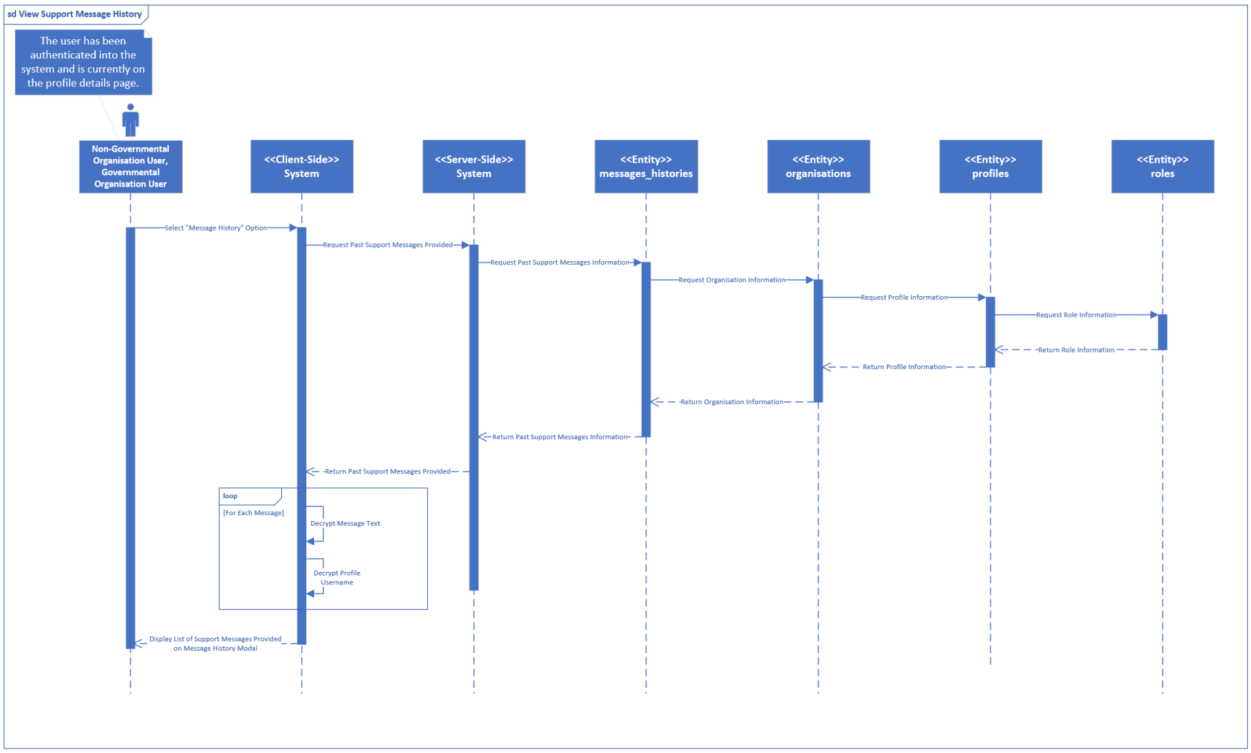


Figure 191: Sequence Diagram - View Support Message History

7.2.1.4.17 Modify Pre-written Message

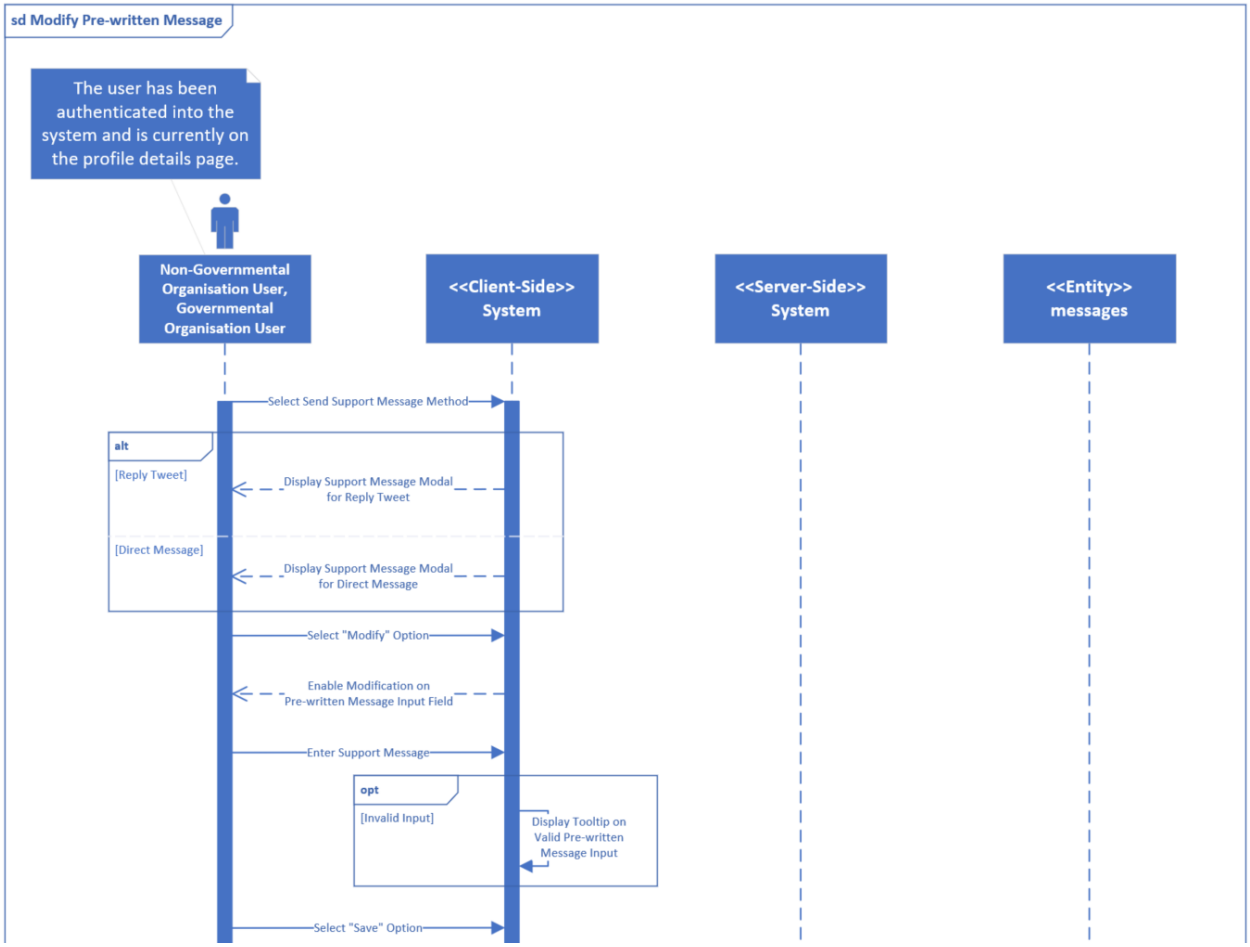


Figure 192: Sequence Diagram - Modify Pre-written Message - Part 1

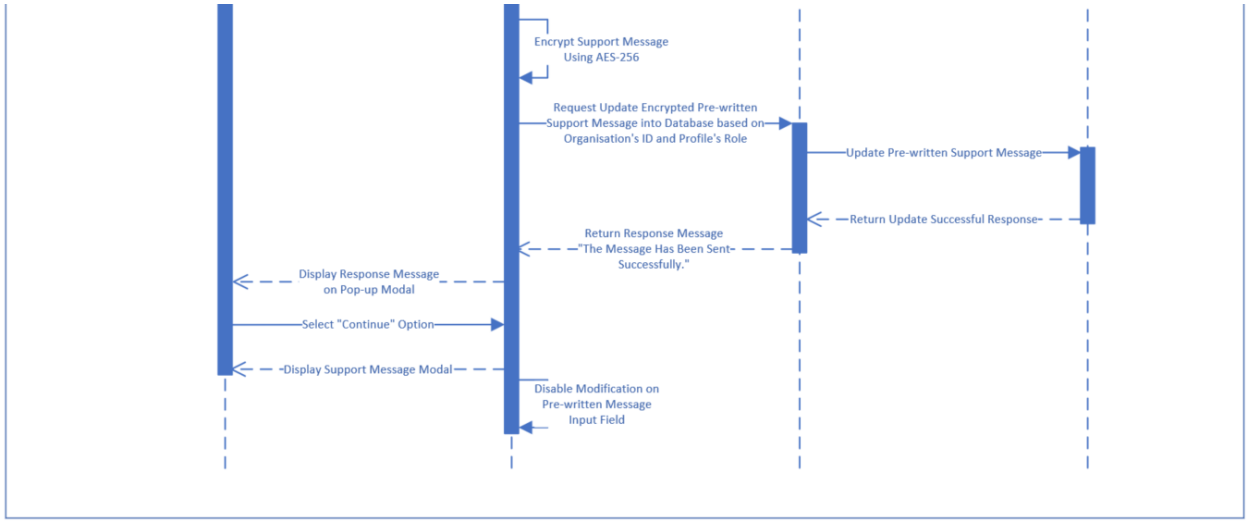


Figure 193: Sequence Diagram - Modify Pre-written Message - Part 2

7.2.1.4.18 View Organisation Account

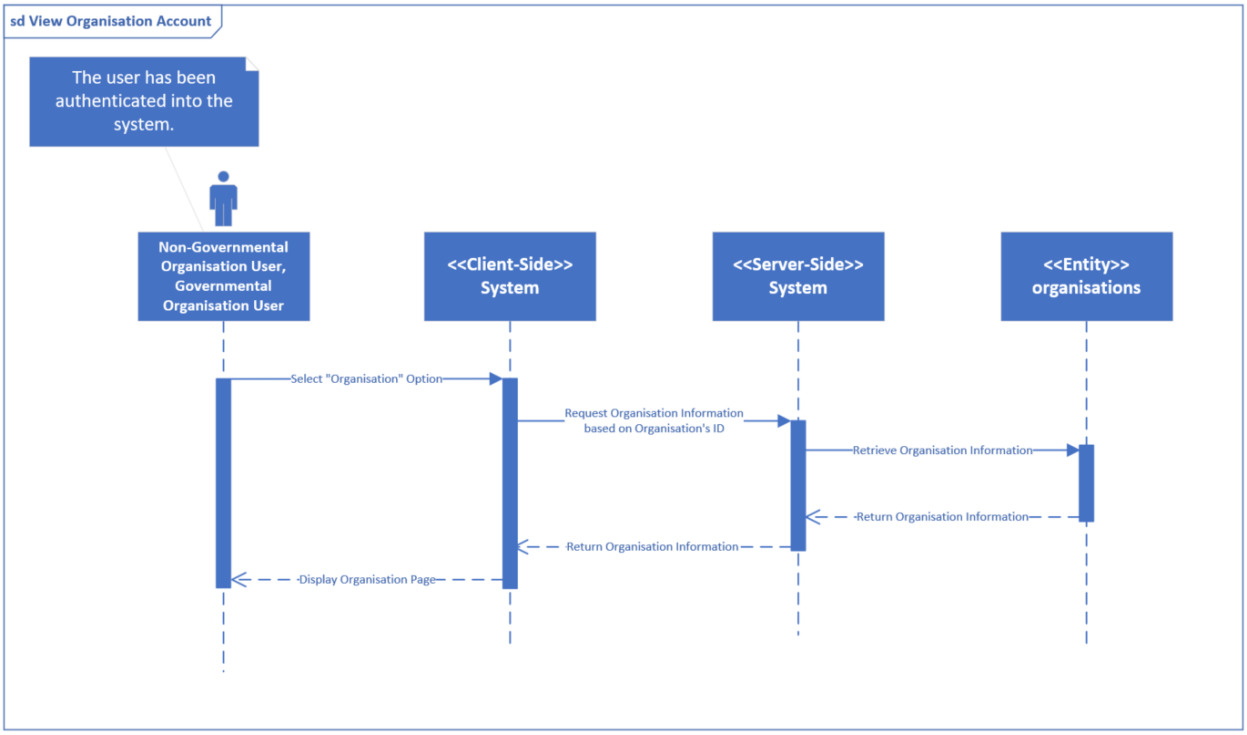


Figure 194: Sequence Diagram - View Organisation Account

7.2.1.4.19 Change Password

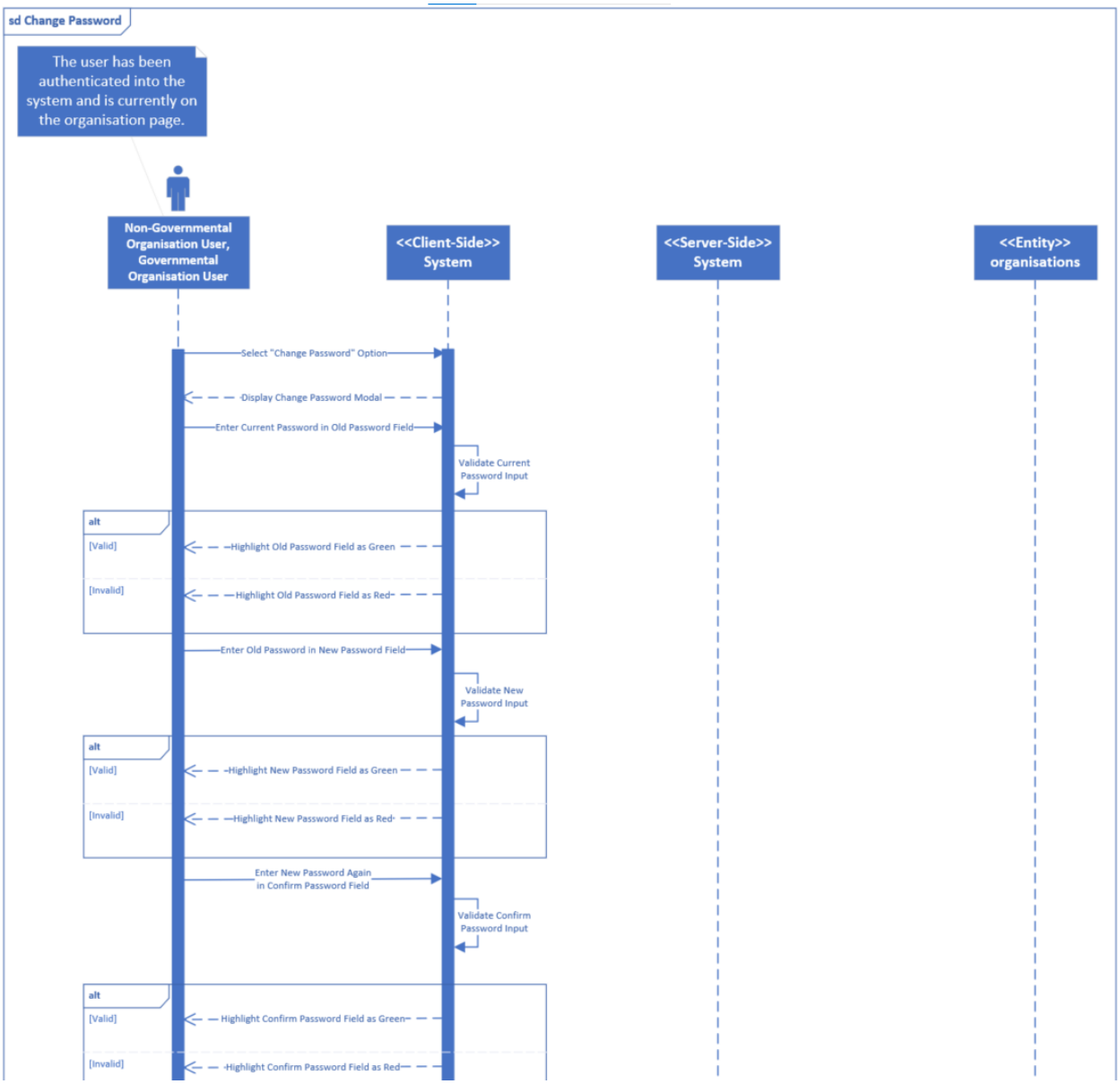


Figure 195: Sequence Diagram - Change Password - Part 1

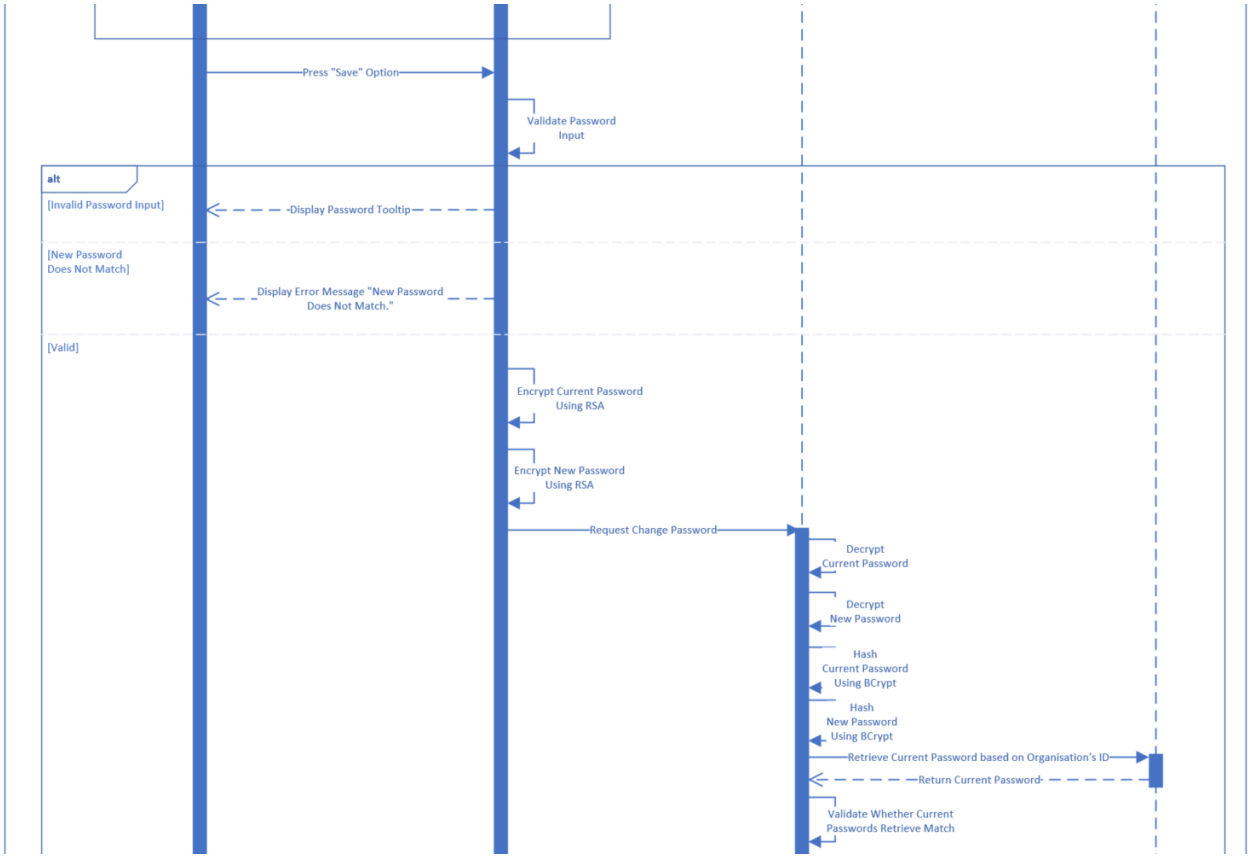


Figure 196: Sequence Diagram - Change Password - Part 2

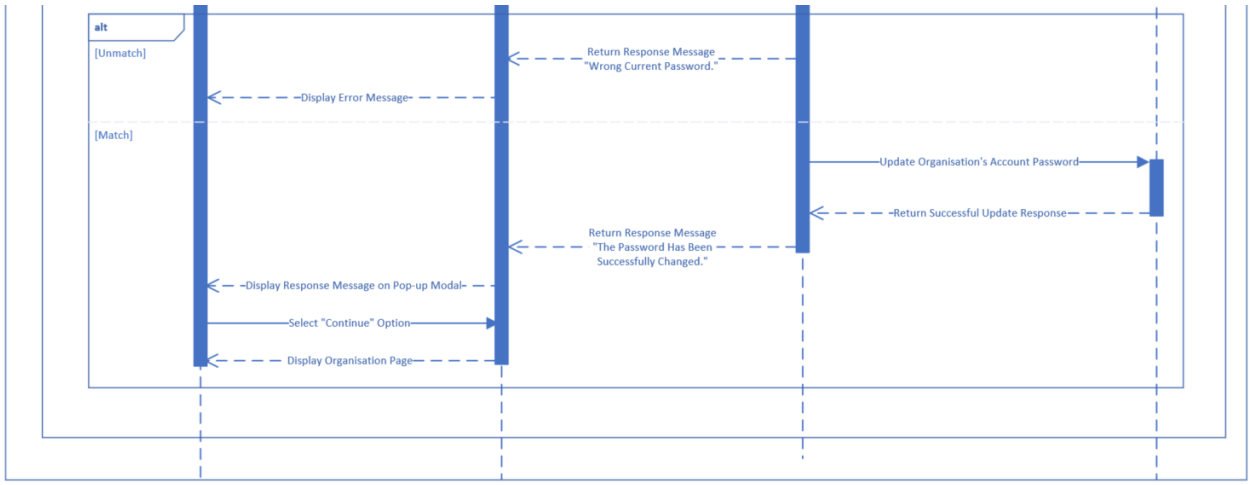


Figure 197: Sequence Diagram - Change Password - Part 3

7.2.1.4.20 Edit Organisation Account

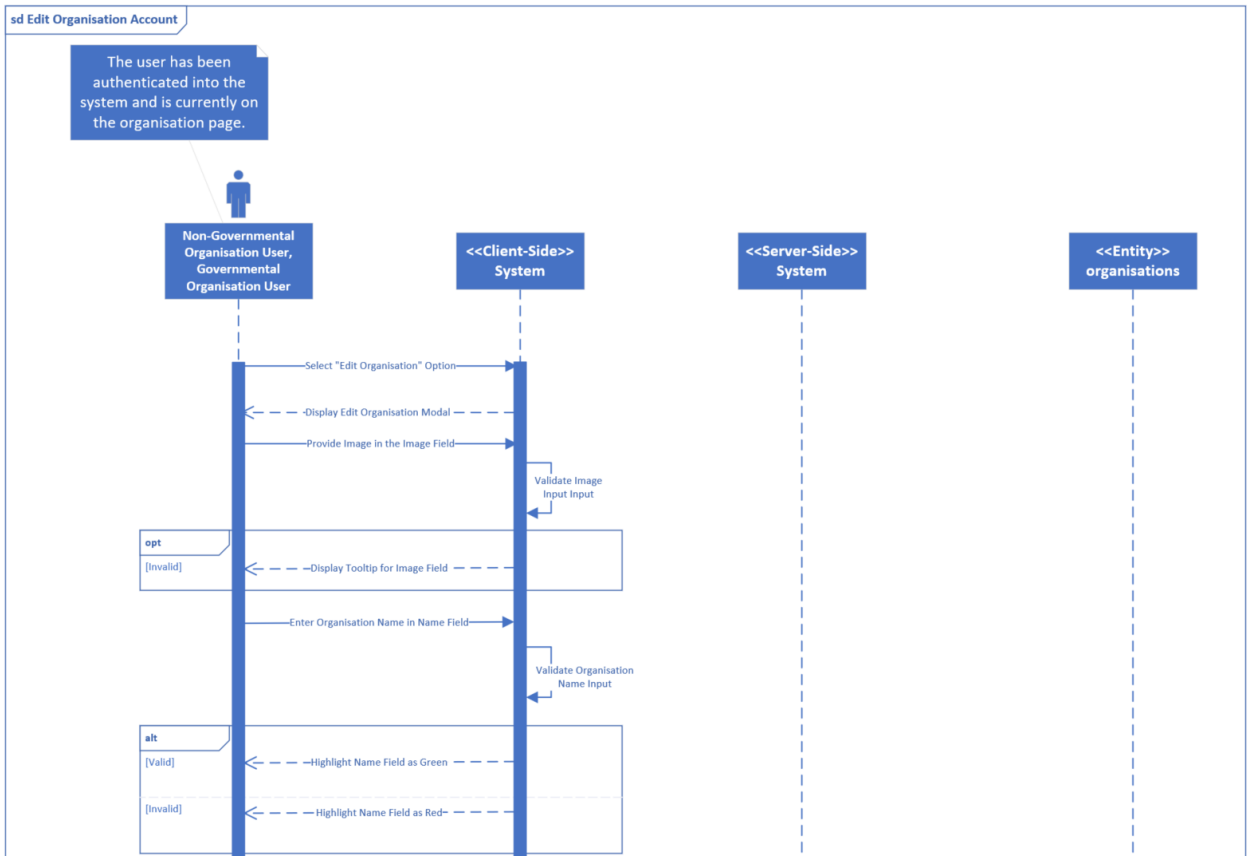


Figure 198: Sequence Diagram - Edit Organisation Account - Part 1

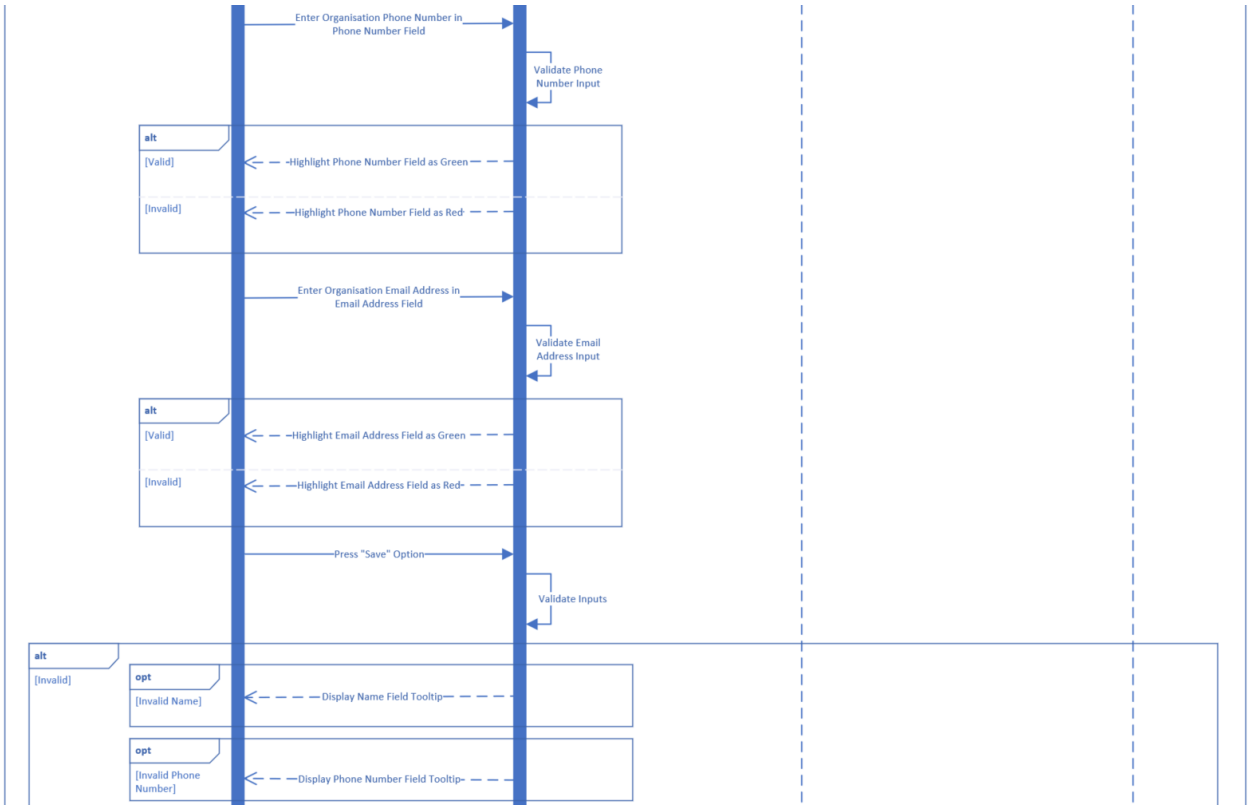


Figure 199: Sequence Diagram - Edit Organisation Account - Part 2

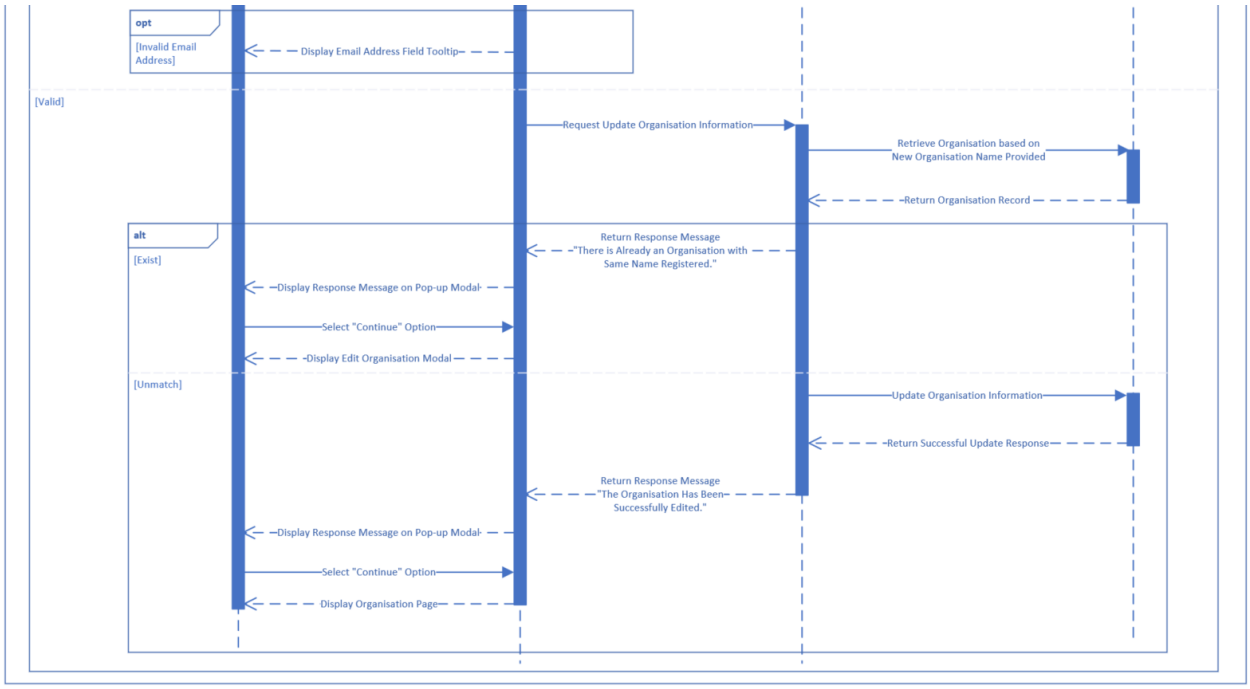


Figure 200: Sequence Diagram - Edit Organisation Account - Part 3

7.2.1.4.21 View Organisations

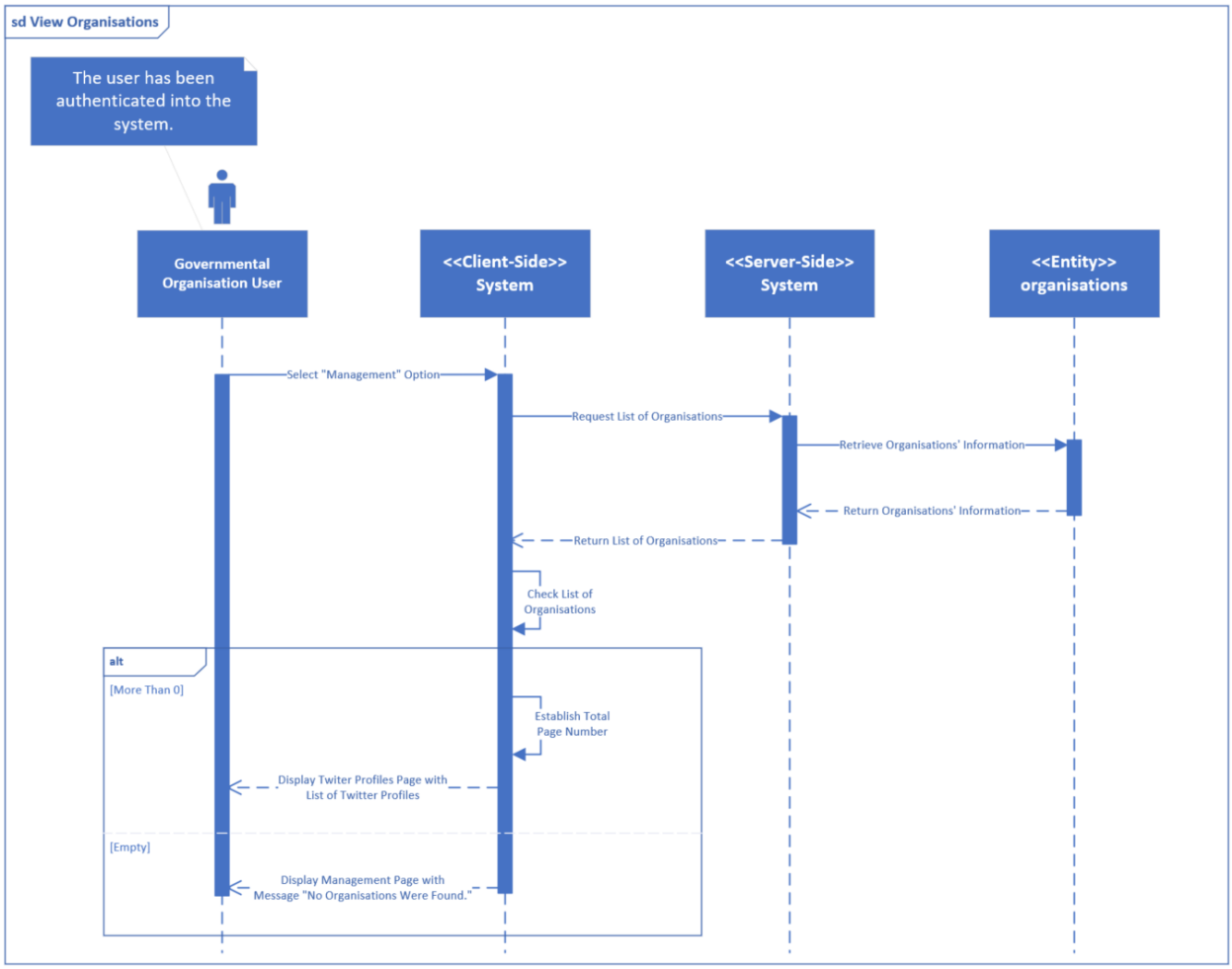


Figure 201: Sequence Diagram - View Organisations

7.2.1.4.22 Filter Organisations

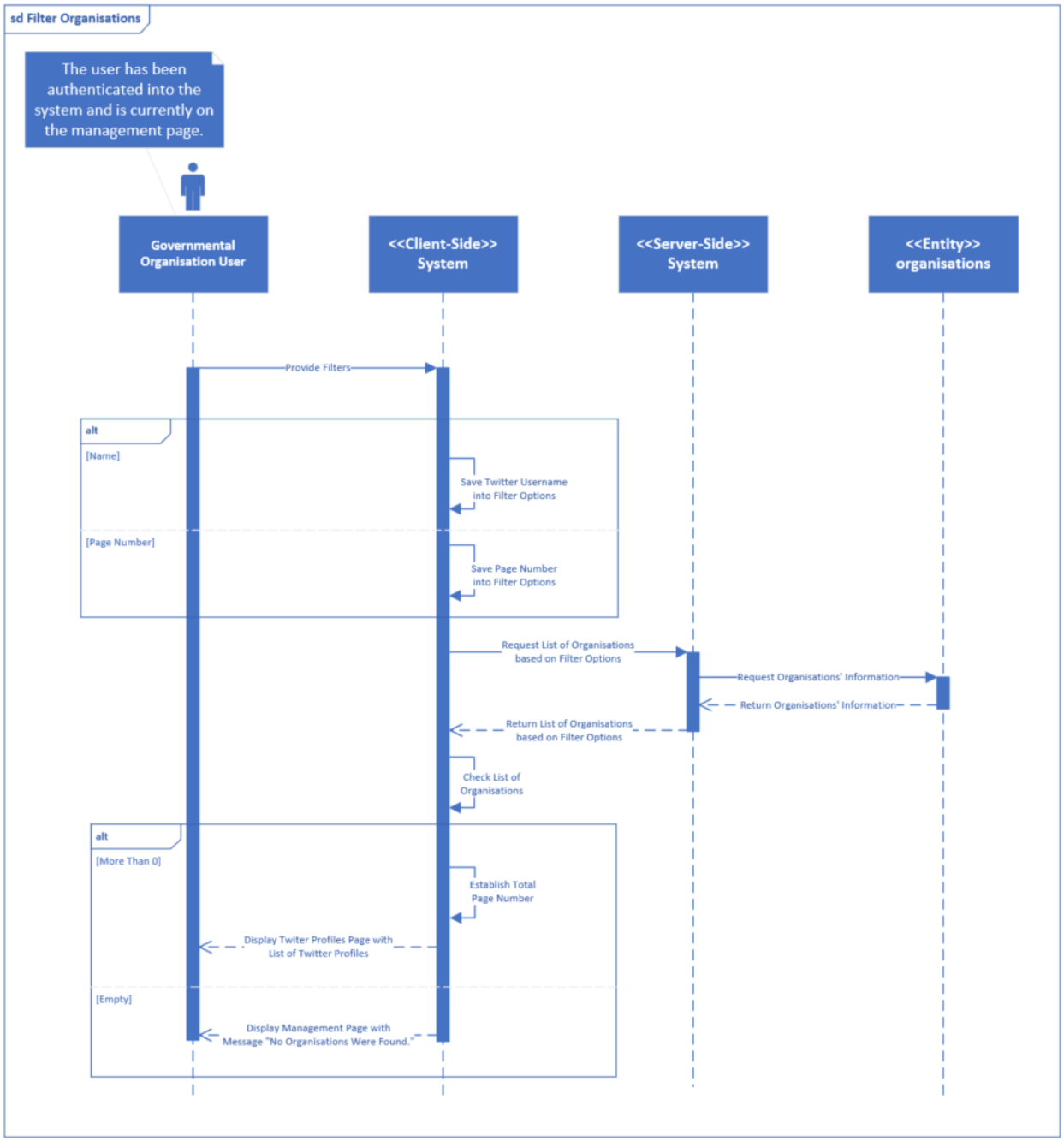


Figure 202: Sequence Diagram - Filter Organisations

7.2.1.4.23 Add New Organisation

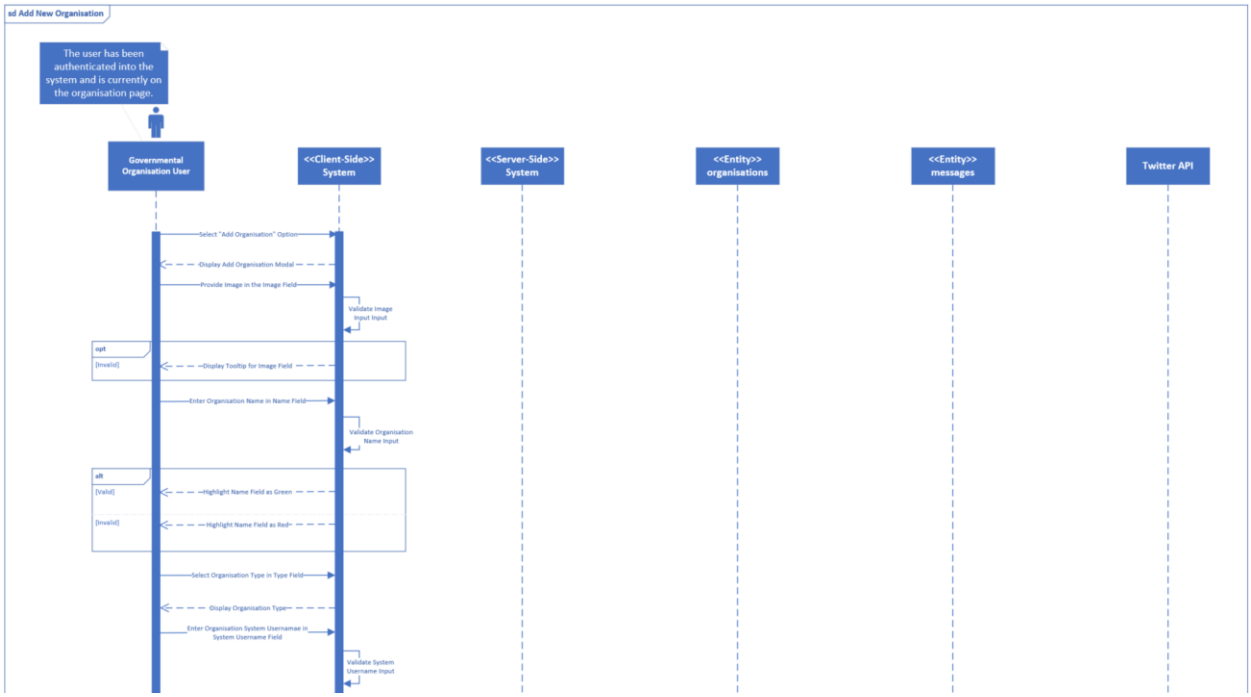


Figure 203: Sequence Diagram - Add Organisation - Part 1

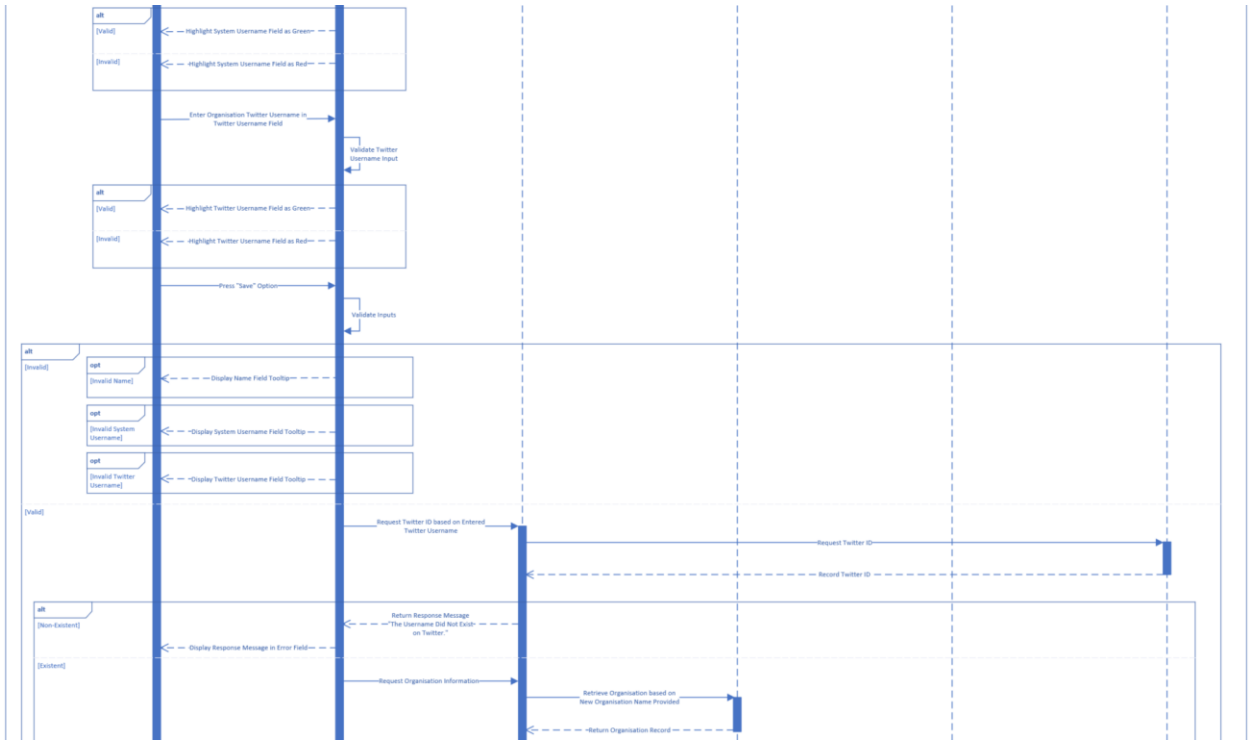


Figure 204: Sequence Diagram - Add Organisation - Part 2

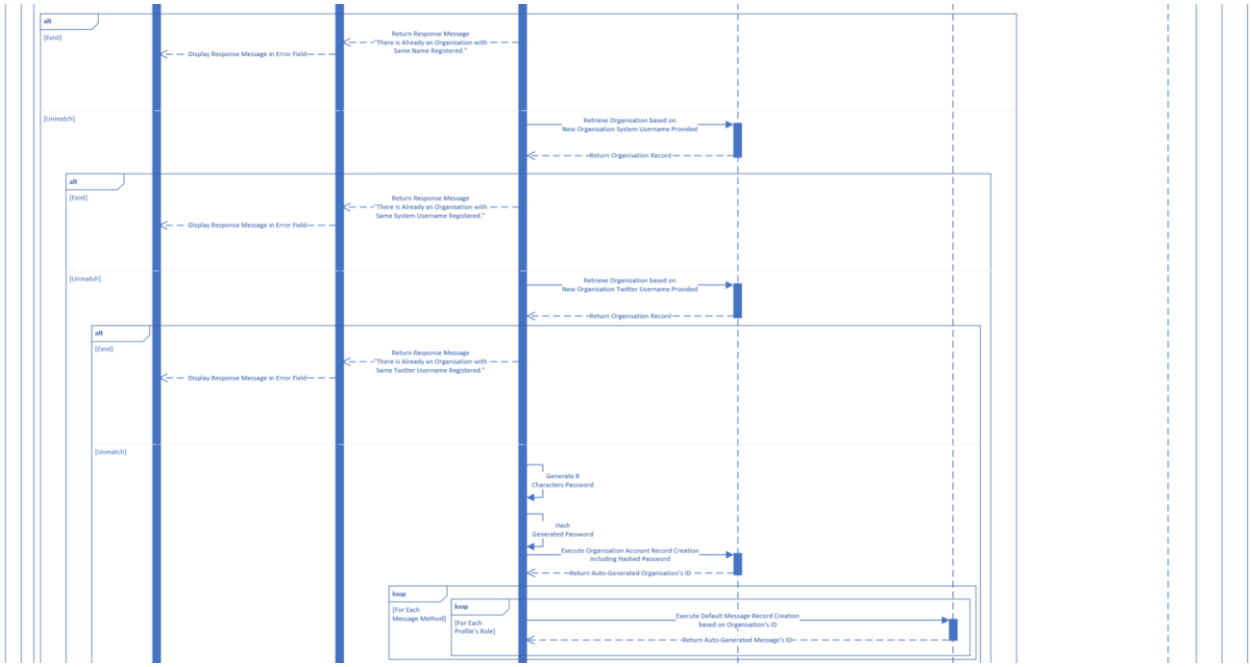


Figure 205: Sequence Diagram - Add Organisation - Part 3

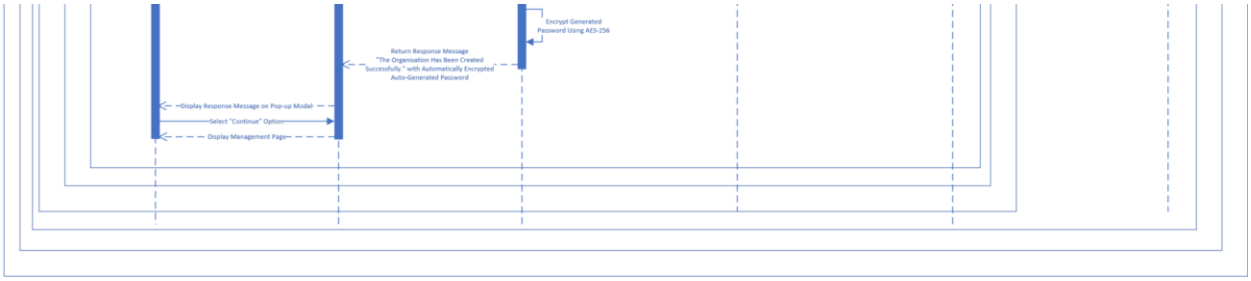


Figure 206: Sequence Diagram - Add Organisation - Part 4

7.2.2 Database Design

7.2.2.1 Entity Relationship Diagram

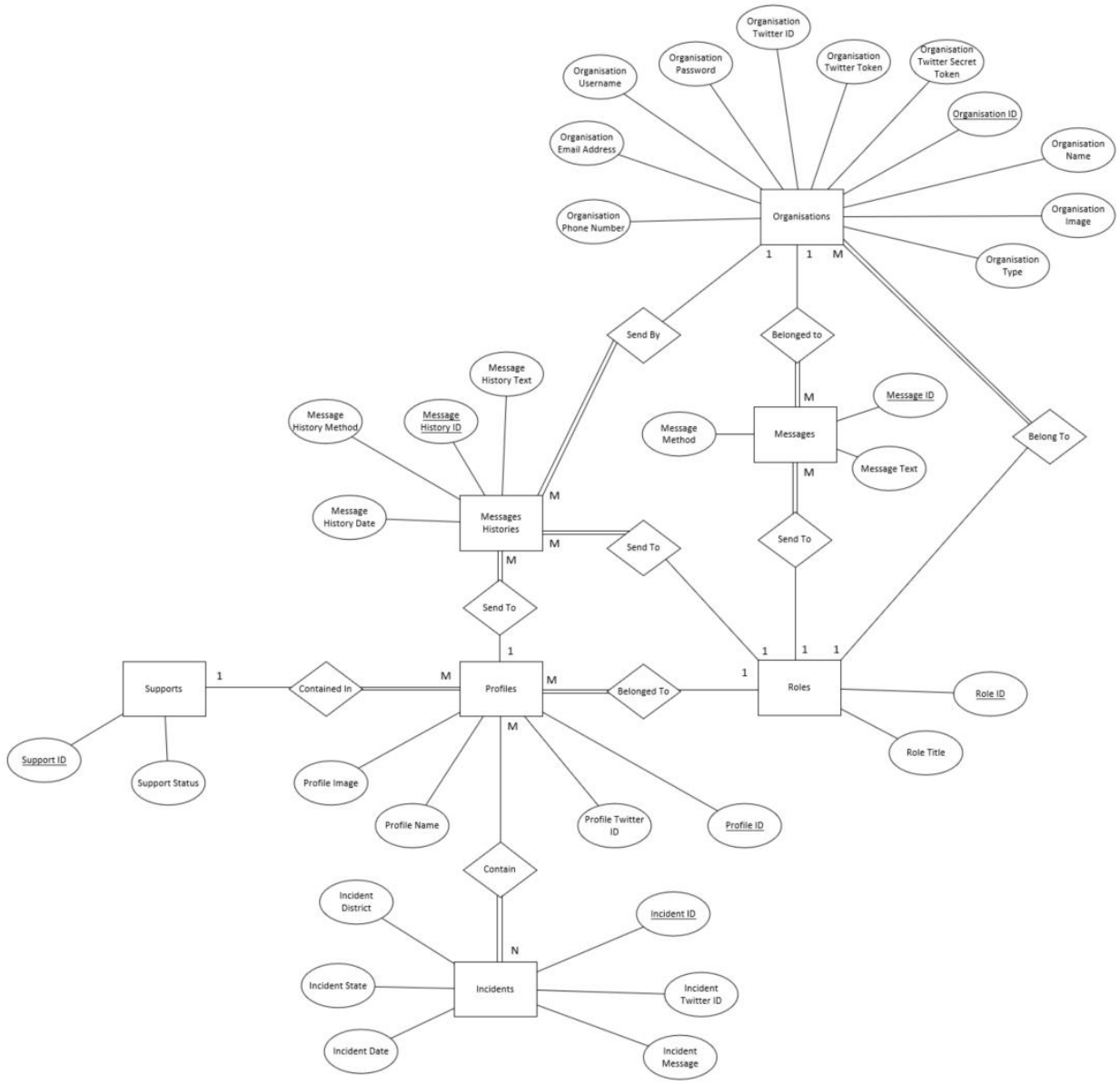


Figure 207: Entity Relationship Diagram

7.2.2.2 Database Table Structure

7.2.2.2.2 organisations

Table 82: Table Structure - organisations

Table Name	organisations				
Description	A table that stores information regarding the organisations (government and non-government) that utilises the system.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
organisation_id	SMALLINT	5	1	Primary Key, Auto Increment	Unique organisation's ID.
organisation_name	CHAR	60	Malaysian Communications and Multimedia Commission (MCMC)	Not Null	Organisation's name.
organisation_image	CHAR	50	image11.png	Nullable	Organisation's image file name.
organisation_type	CHAR	14	government	Not Null	Organisation's type.
organisation_phone_number	CHAR	12	03-21312212	Nullable	Organisation's phone number.
organisation_email_address	VARCHAR	320	mcmc@mcmc.org	Nullable	Organisation's email address.

organisation_username	CHAR	50	mcmcadmin	Not Null	Organisation's system username.
organisation_password	CHAR	60	$2b$12$6K615qos9…	Not Null	RSA encrypted organisation's system password.
organisation_twitter_id	CHAR	64	1342489774863466496	Not Null	Organisation's Twitter ID.
organisation_twitter_token	VARCHAR	255	MYCn/YGCmef6x…	Nullable	AES-256 encrypted organisation's Twitter token.
organisation_secret_token	VARCHAR	255	LsUOVNuhcSOrCnM…	Nullable	AES-256 encrypted organisation's Twitter secret token.
role_id	TINYINT	1	4	Not Null	Organisation's role ID.

7.2.2.2.3 roles

Table 83: Table Structure - roles

Table Name	roles

Description	A table that stores information regarding the roles associated with the system.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
role_id	TINYINT	1	1	Primary Key	Unique role's ID.
role_title	CHAR	17	cyberbully	Not Null	Role's title or name.

7.2.2.2.4 incidents

Table 84: Table Structure - incidents

Table Name	incidents				
Description	A table that stores information regarding the incidents (mainly cyberbullying incidents), specifically the tweets coming from Twitter.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
incident_id	INT	10	1	Primary Key, Auto Increment	Unique incident's ID.
incident_twitter_id	CHAR	64	ljpfD1z92…	Not Null	AES-256 encrypted tweet's ID.
incident_message	VARCHAR	408	FfAOu8I…	Not Null	AES-256 encrypted incident's message.

incident_date	TIMESTAMP	-	2021-06-16 19:30:11	Not Null	Date when the incident occurred.
incident_district	CHAR	74	Petaling	Nullable	District where the incident occurred.
incident_state	CHAR	32	Selangor	Nullable	State where the incident occurred.

7.2.2.2.5 profiles

Table 85: Table Structure - profiles

Table Name	profiles				
Description	A table that stores information regarding the profiles (cyberbully, cybervictim and associated profile) involved in certain incidents, specifically the profiles coming from Twitter.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
profile_id	INT	10	1	Primary Key, Auto Increment	Unique profile's ID.
profile_twitter_id	CHAR	64	s/RdNaV…	Not Null	AES-256 encrypted profile's twitter ID.

profile_username	CHAR	44	SlSizeY8…	Not Null	AES-256 profile's twitter username.
profile_image	VARCHAR	2048	http://abs...	Not Null	Profile's twitter image URL.
role_id	TINYINT	1	1	Foreign Key, Not Null	Profile's role ID.
support_id	TINYINT	1	1	Foreign Key, Not Null	Profile's support ID.

7.2.2.2.6 supports

Table 86: Table Structure - supports

Table Name	supports				
Description	A table that stores information regarding the support status of the profiles wherein system users can identify whether certain individuals have been approached or not.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
support_id	TINYINT	1	1	Primary Key	Unique support's ID.
support_status	CHAR	21	not yet	Not Null	Support's status.

7.2.2.2.7 incidents_associations

Table 87: Table Structure - incidents_associations

Table Name	incidents_associations				
Description	A junction table that stores information regarding the associated incidents and profiles involved in an instance. The table also stores notification statuses from both cyberbully's and cybervictim's perspective to remind system users of newly detected cyberbullying incident and view them separately which helps decide their course of action.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
incidents_association_id	INT	10	1	Primary Key, Auto Increment	Unique incidents association's ID.
cyberbullying_id	INT	10	1	Foreign Key, Not Null	Cyberbullying incident's ID.
replied_id	INT	10	2	Foreign Key, Nullable	Incident's ID which the cyberbully replied to.
cyberbully_id	INT	10	1	Foreign Key, Not Null	Cyberbully's profile ID.
cybervictim_id	INT	10	2	Foreign Key, Not Null	Cybervictim's profile ID.

replied_profile_id	INT	10	2	Foreign Key, Nullable	Profile's ID which the cyberbully replied to.
cyberbully_notification	CHAR	6	read	Not Null	Notification status on cyberbully's behalf.
cybervictim_notification	CHAR	6	read	Not Null	Notification status on cybervictim's behalf.

7.2.2.2.8 messages

Table 88: Table Structure - messages

Table Name	messages				
Description	A table that stores information regarding the pre-written messages each organisation possess related to different roles (cyberbully, cybervictim, cyberbully-victim).				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
message_id	INT	10	1	Primary Key	Unique message's ID.
message_text	VARCHAR	1088	1UeVBLc…	Not Null	AES-256 encrypted

					message's text.
message_method	CHAR	14	reply tweet	Not Null	Method to which the message is generated for.
role_id	TINYINT	1	1	Foreign Key, Not Null	Role's ID to which the message is targeted to.
organisation_id	SMALLINT	5	1	Foreign Key, Not Null	Organisation's ID to which the message belongs to.

7.2.2.2.9 messages_histories

Table 89: Table Structure - messages_histories

Table Name	messages_histories				
Description	A junction table that stores information regarding the previous messages sent by the organisations to the respective profiles.				
Column Name	**Data Type**	**Length**	**Example**	**Constraints**	**Description**
messages_history_id	INT	10	1	Primary Key, Auto Increment	Unique ID for each message sent previously.

messages_history_text	VARCHAR	1088	FfOzlWC…	Not Null	AES-256 encrypted message's text.
messages_history_date	TIMESTAMP	-	2021-06-17 17:12:49	Not Null	Date when the message is sent.
message_history_method	CHAR	14	direct message	Not Null	Method to how the message is sent.
organisation_id	SMALLINT	5	1	Foreign Key, Not Null	Organisation's ID that sends the message.
profile_id	INT	10	1	Foreign Key, Not Null	Profile's ID that received the message.
profile_role_id	TINYINT	1	2	Foreign Key, Not Null	Role's ID of the particular profile.

7.2.3 Interface Design

7.2.3.1 Login Page

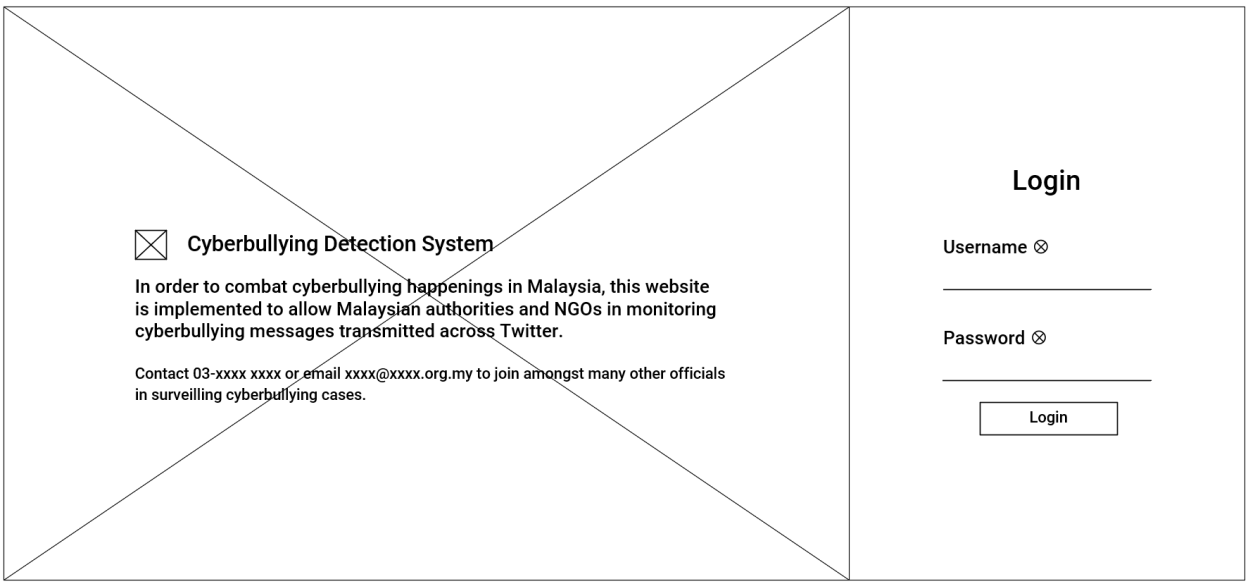


Figure 208: Wireframe - Login Page

The figure above shows the login page. By entering the correct credentials and clicking the "Login" button, the user shall be redirected to the dashboard page.

7.2.3.1.1 Twitter Login Modal

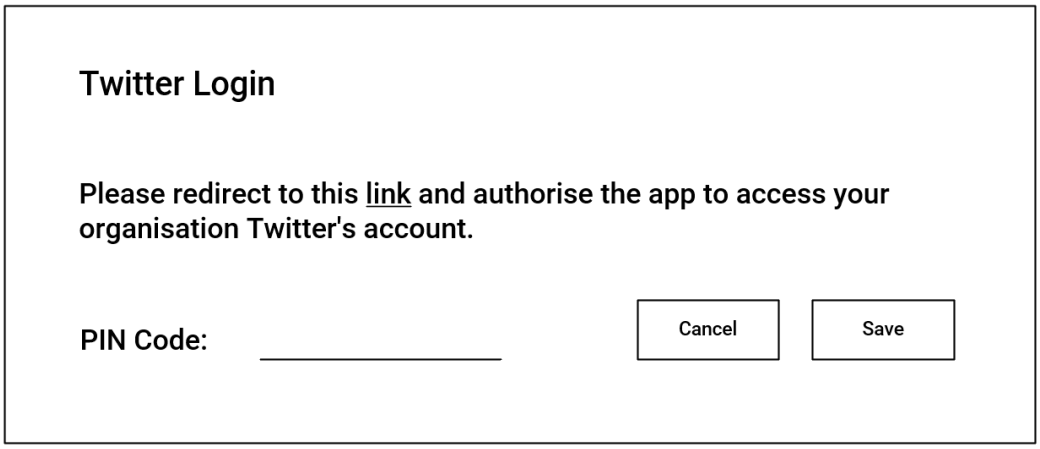


Figure 209: Wireframe - Twitter Login Modal

For the organisations who have yet authorise the app to access their Twitter account, they will be prompted the Twitter login modal as shown above in order to authorise app's access to their organisation's Twitter account.

7.2.3.2 Side Navigation

Figure 210: Wireframe - Side Navigation

The side navigation component shown above contains several clickable links that allow users to perform different actions such as viewing the dashboard or logging out of the system. The slightly greyed out link with the name "Management" is only accessible by the admin users. The notifications displayed beside the "Twitter Profile" link indicates the number of cyberbullying and cybervictim incidents that are left unread.

7.2.3.3 Dashboard Page

7.2.3.3.1 Bar Chart

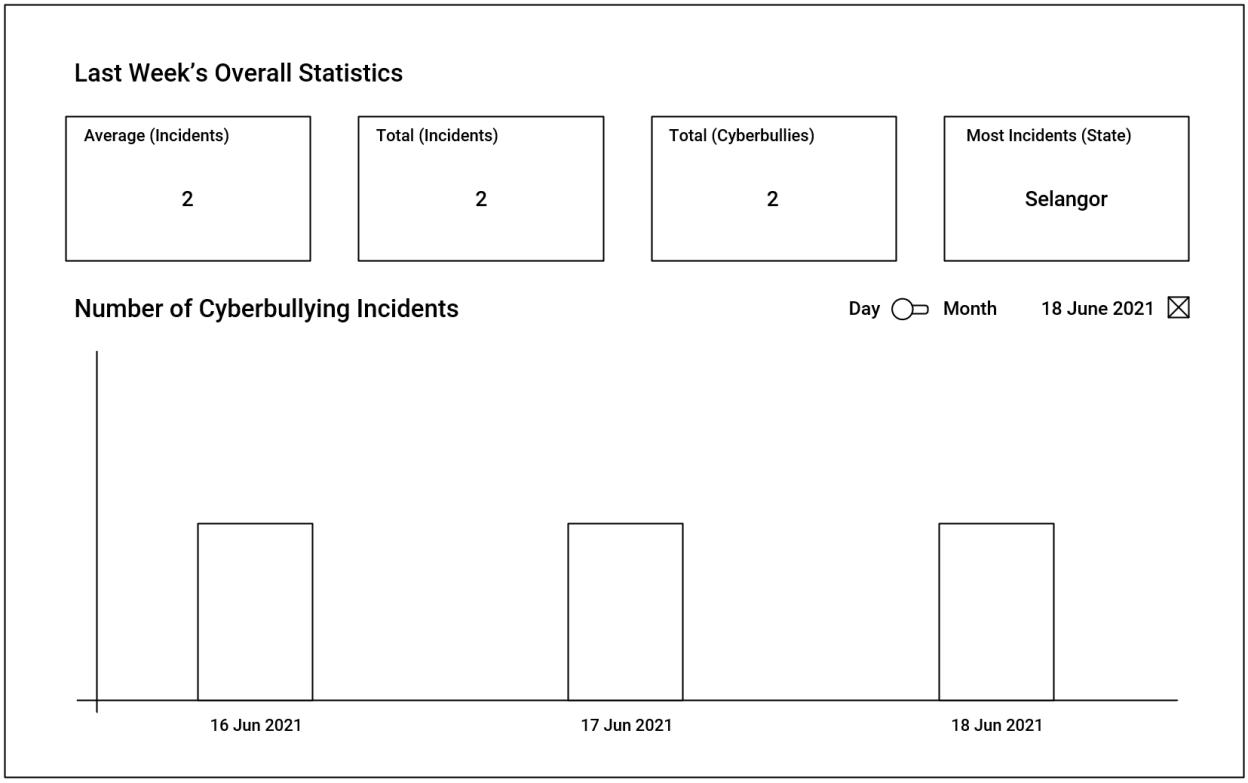


Figure 211: Wireframe - Dashboard Page (Bar Chart)

The figure above displays the dashboard page with two main statistics shown including last week's overall statistics as well as the number of cyberbullying incidents in terms of daily or monthly based on the filter chosen in bar-chart view.

7.2.3.3.2 Map

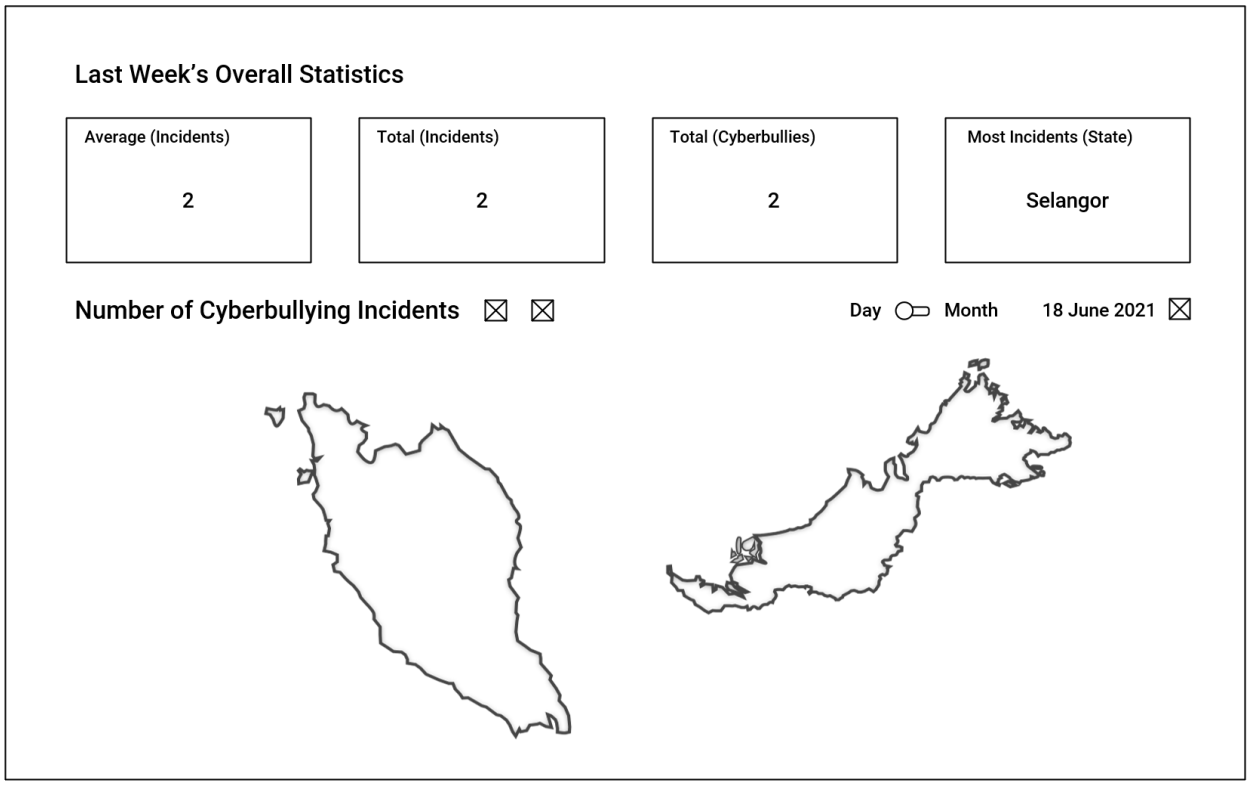


Figure 212: Wireframe - Dashboard Page (Map)

The figure above shows the number of cyberbullying incidents in map view instead, wherein each districts on hover will display individual cases number.

7.2.3.4 Profiles Page

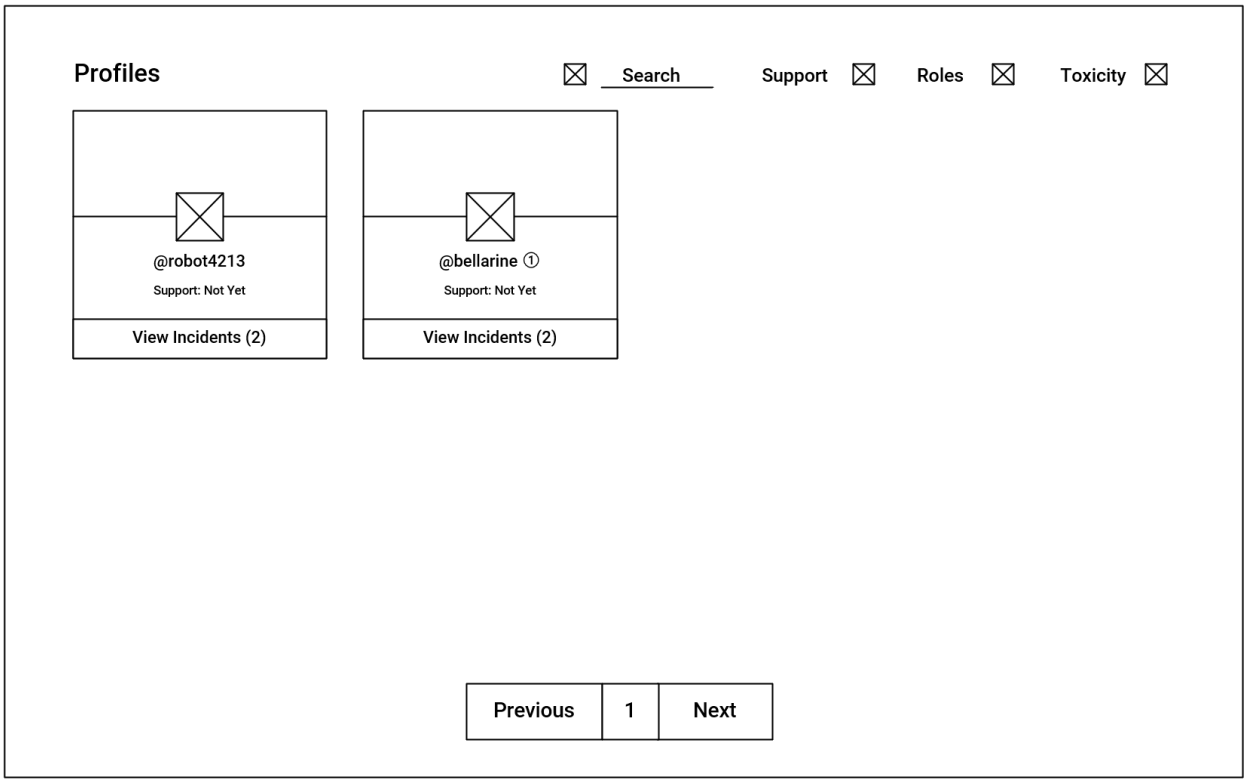


Figure 213: Wireframe - Profile Page

The figure above shows the profile page which contains twitter profiles that are detected as cyberbullies, cybervictims and even cyberbully-victims. There are several options available such as search, support status, roles and toxicity as well as the pagination below that allow the system users to filter the profiles to be displayed. On individual profile, the notifications displayed beside their username indicates the number of cyberbullying and cybervictim incidents involved that are left unread. Meanwhile, the button “View Incidents” will prompt up a modal showing the full details with regards to the incidents they were involved.

7.2.3.5 Profile Details Modal

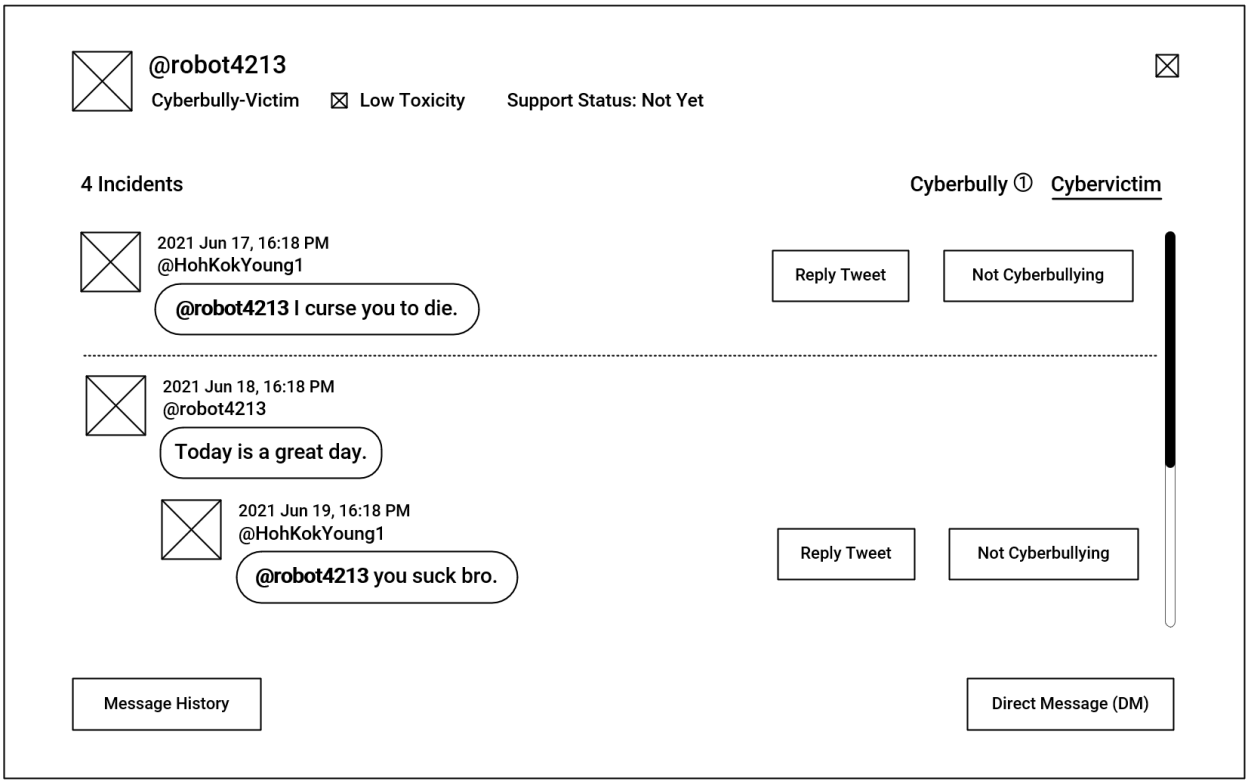


Figure 214: Wireframe - Profile Detail Modal

The figure above displays the details, specifically the incidents the particular profile was involved in. Based on the options given and selected, the users shall be able to filter the incidents to be shown. Each option is paired with notifications which indicates the number of cyberbullying and cybervictim incidents that are left unread. Moreover, on this page alone, the system users are allowed to remove the incident as non-cyberbullying, open up support message modal before offering counselling support either publicly or privately as well as view the support messages provided previously.

7.2.3.6 Support Message Modal – Reply Tweet

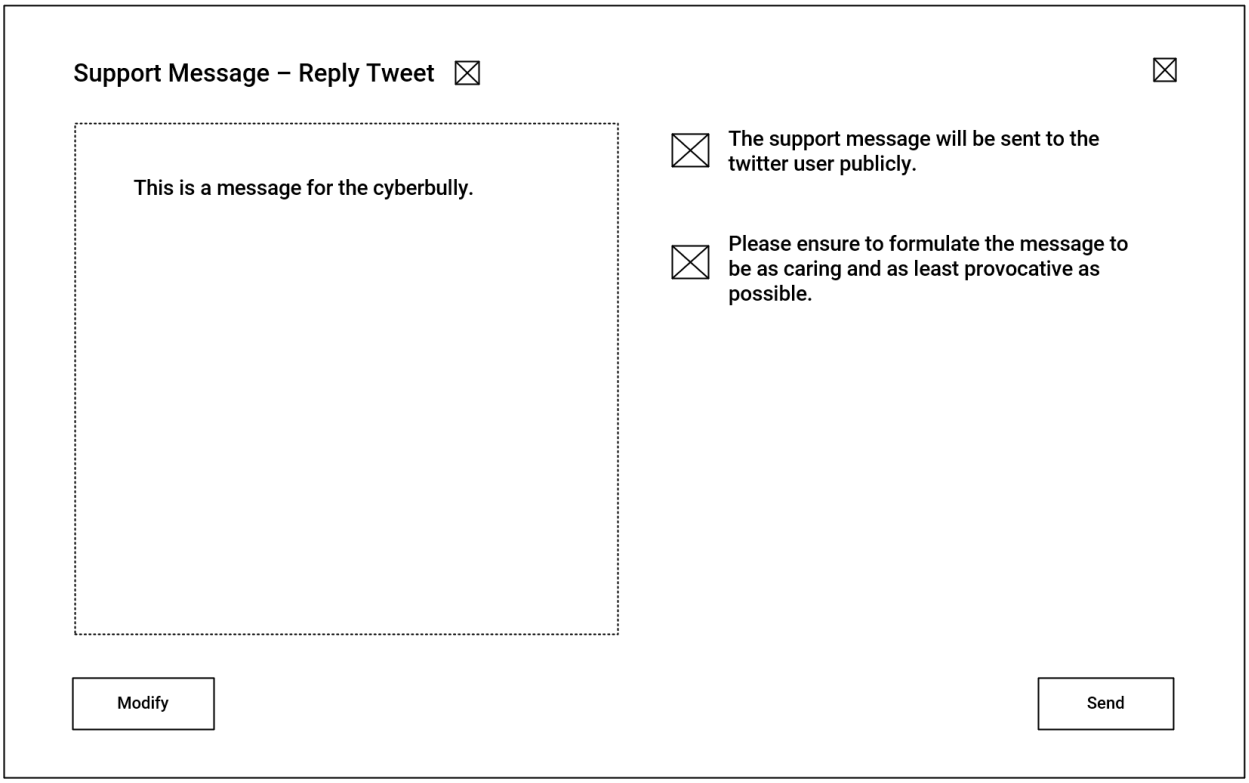


Figure 215: Wireframe - Support Message Modal (Reply Tweet)

The figure above shows the support message modal wherein it grants the system users to offer counselling support through replying to the selected tweet. The users have the option to modify their message on this particular interface as well. The messages vary based on the profile's role (cyberbully, cybervictim and cyberbully-victim).

7.2.3.7 Support Message Modal - Direct Message

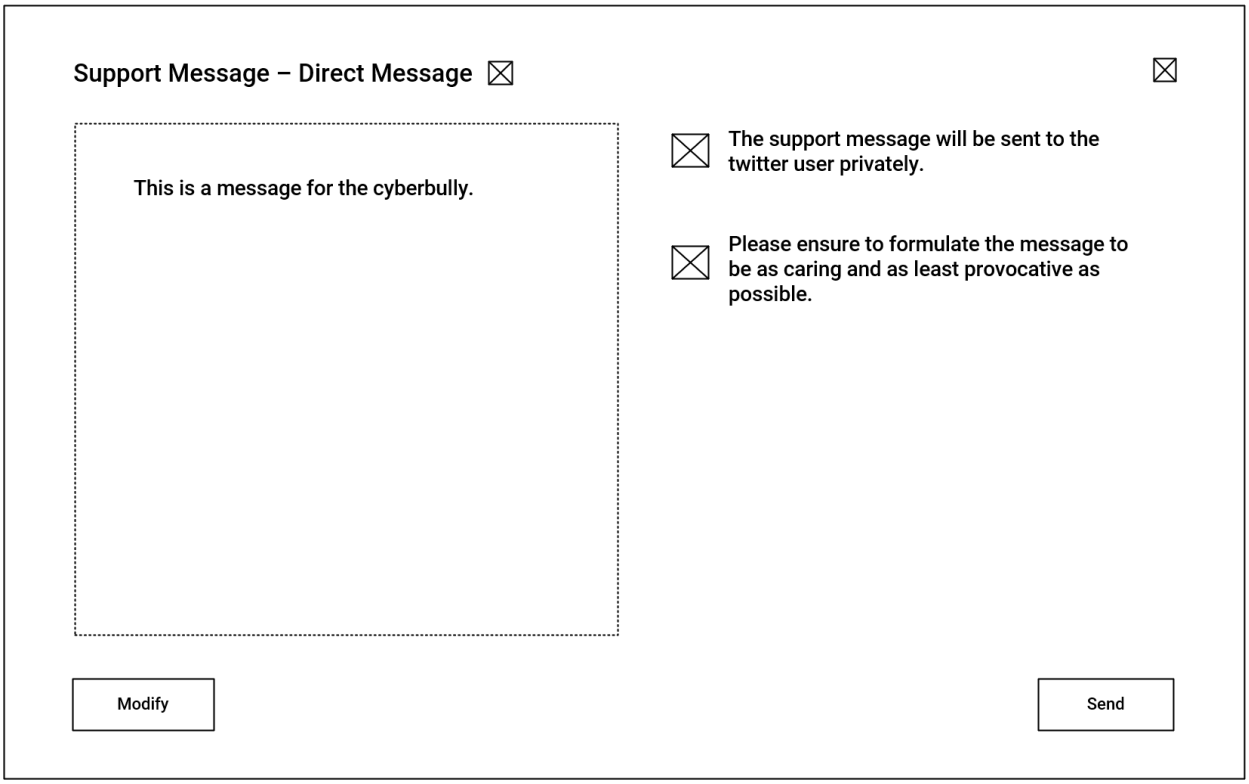


Figure 216: Wireframe - Support Message Modal (Direct Message)

The modal displayed above possesses the similar functionalities and interface as the previous support message modal for replying tweet except the current ones will send the counselling support message directly to the profile instead.

7.2.3.8 Support Message History Modal

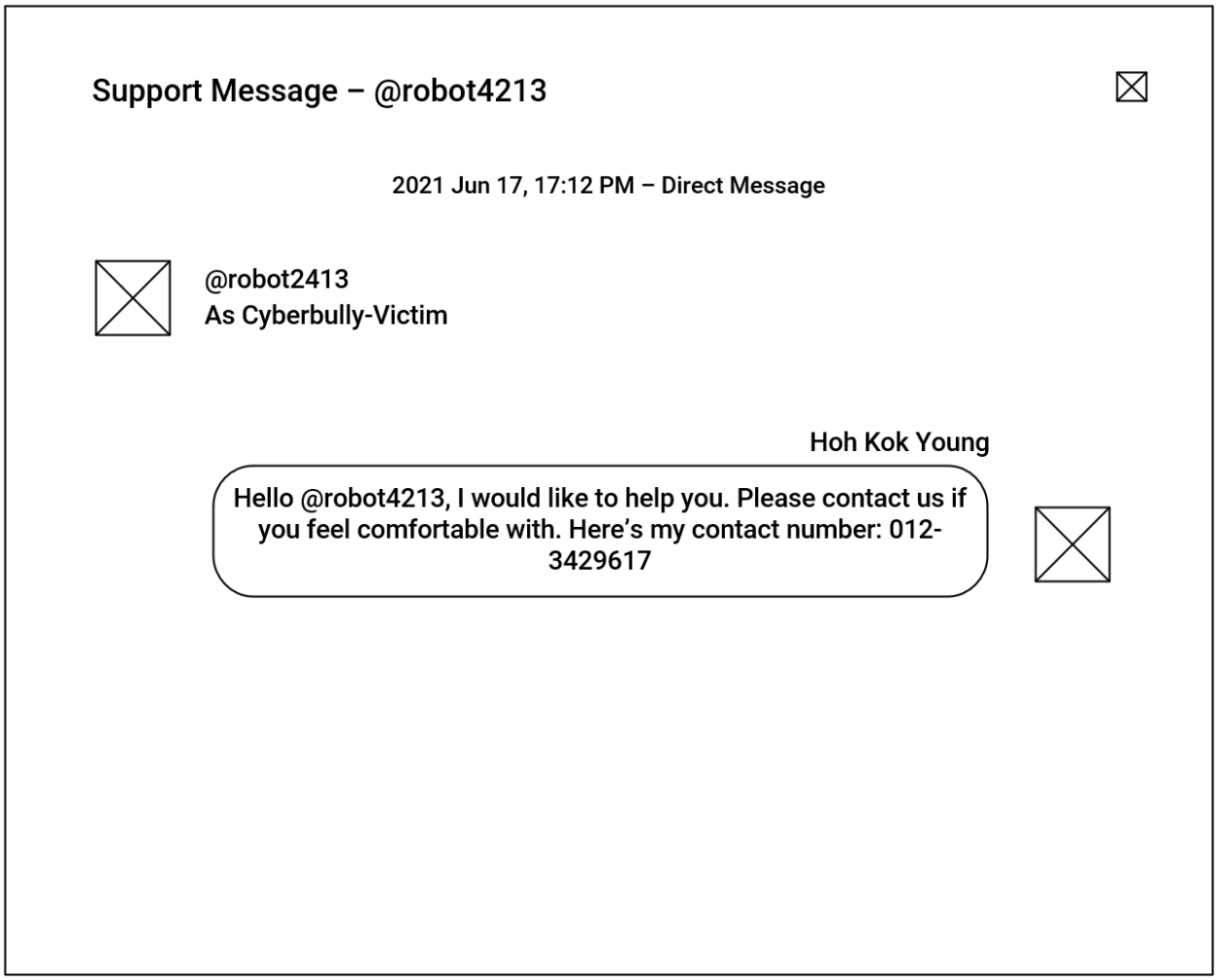


Figure 217: Wireframe - Support Message History Modal

The figure above shows the support message history modal which contains all the support messages sent previously by the system users.

7.2.3.9 Organisation Page

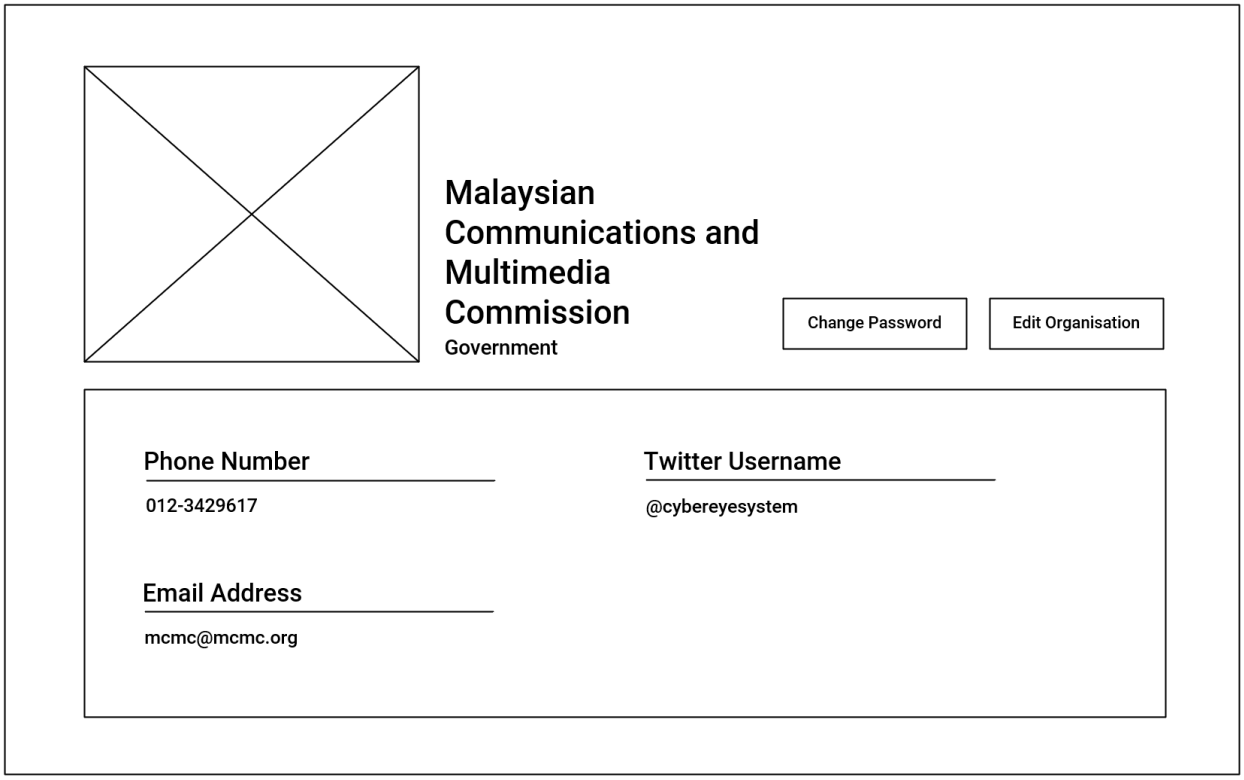


Figure 218: Wireframe – Organisation Page

The figure above displays the organisation page which contains the specific organisation's information such as name, type, phone number, email address and its Twitter username connected to the app. Apart from that, the system user can prompt up different modals to either change password or edit organisation details.

7.2.3.10 Change Password Modal

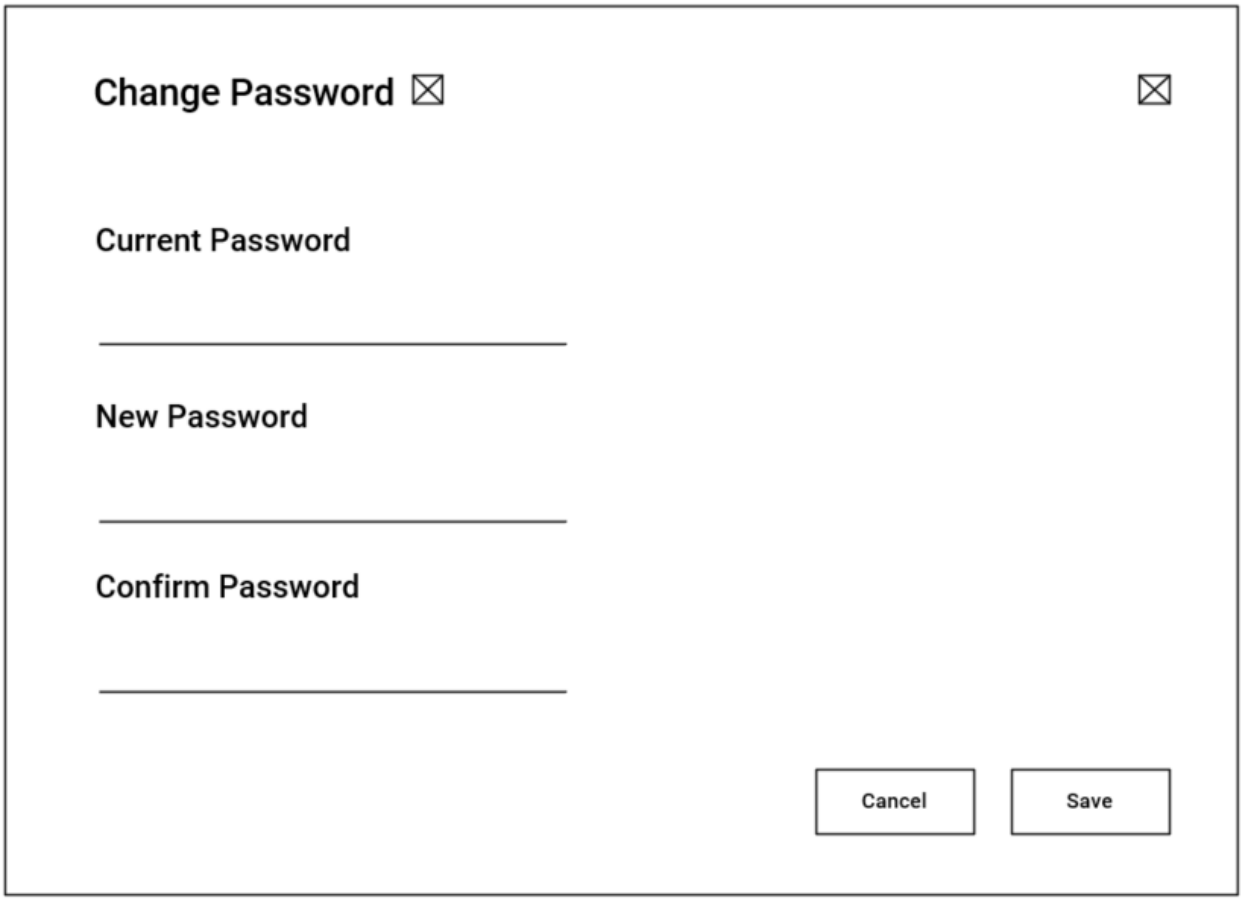


Figure 219: Wireframe - Change Password Modal

The figure above shows the change password modal wherein the system user can change their organisation's account password stored in the database through entering the current password and the new password.

7.2.3.11 Edit Organisation Modal

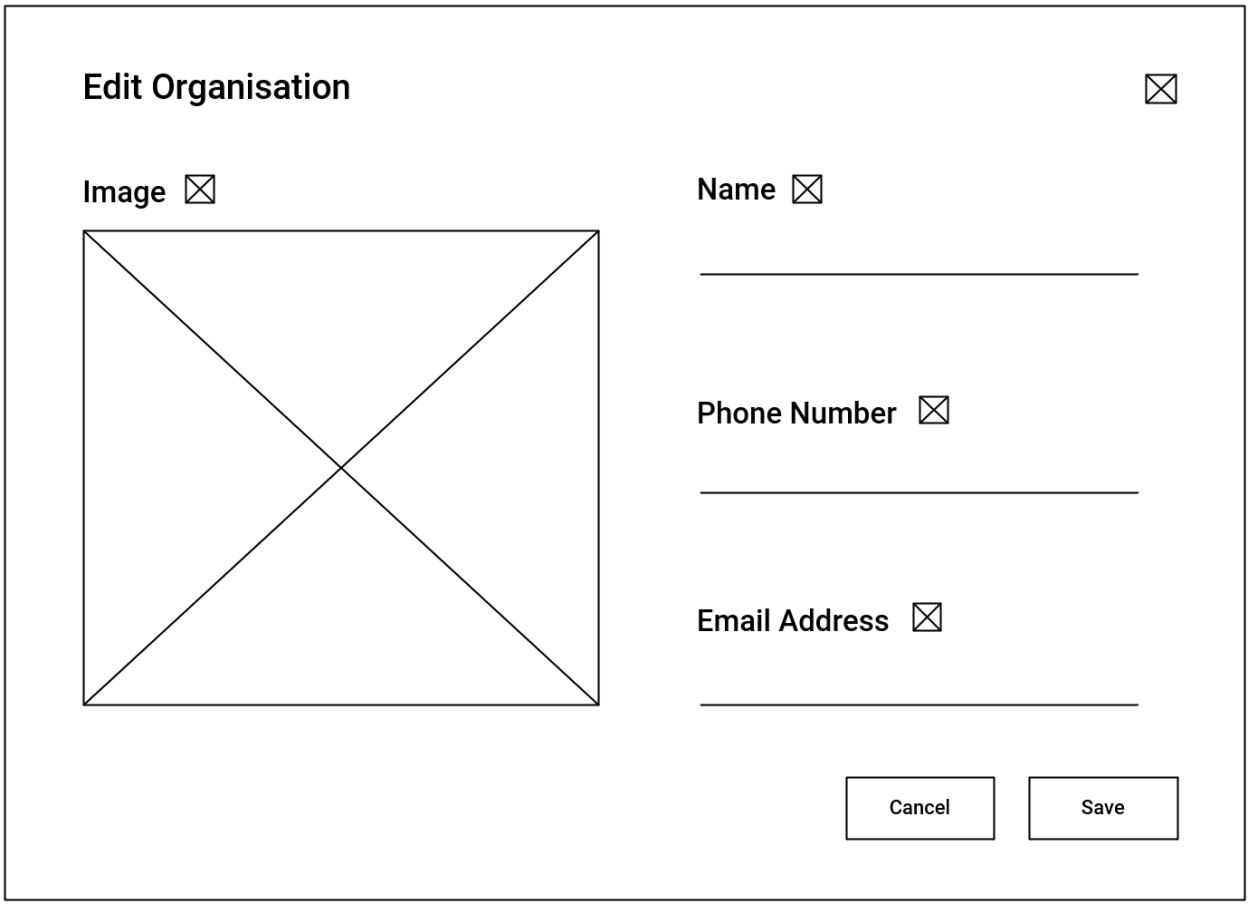


Figure 220: Wireframe - Edit Account Modal

The figure above displays the edit account modal wherein the system user shall be able to edit the organisation's image, name, phone number and email address.

7.2.3.12 Management Page - Organisations

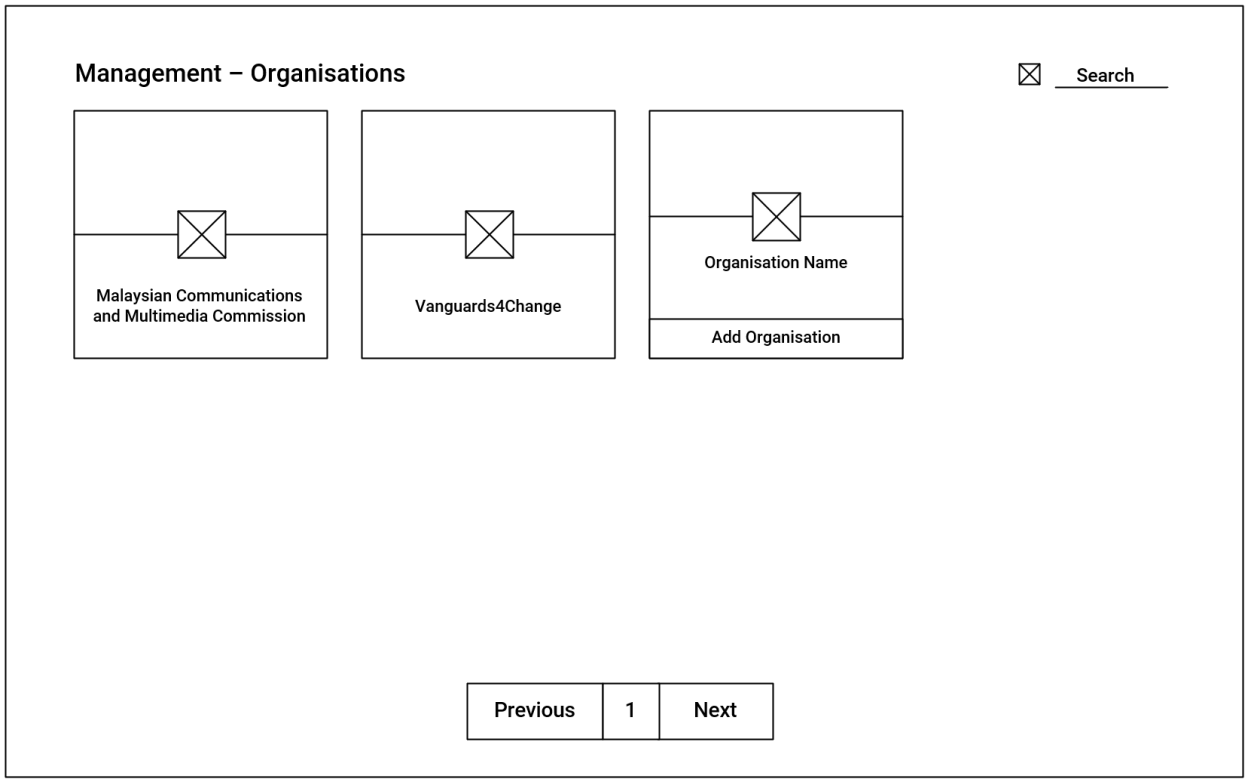


Figure 221: Wireframe - Management Page (Organisations)

The figure above shows the management page that contains organisations that have registered into the system, which are only viewable by the system users specifically from the government organisation. The search option as well as the pagination below helps filtering the organisations to be displayed. Apart from that, the system users from government organisation shall have the capability to prompt up a modal to add new organisation.

7.2.3.13 Management Page – Organisations (Backside)

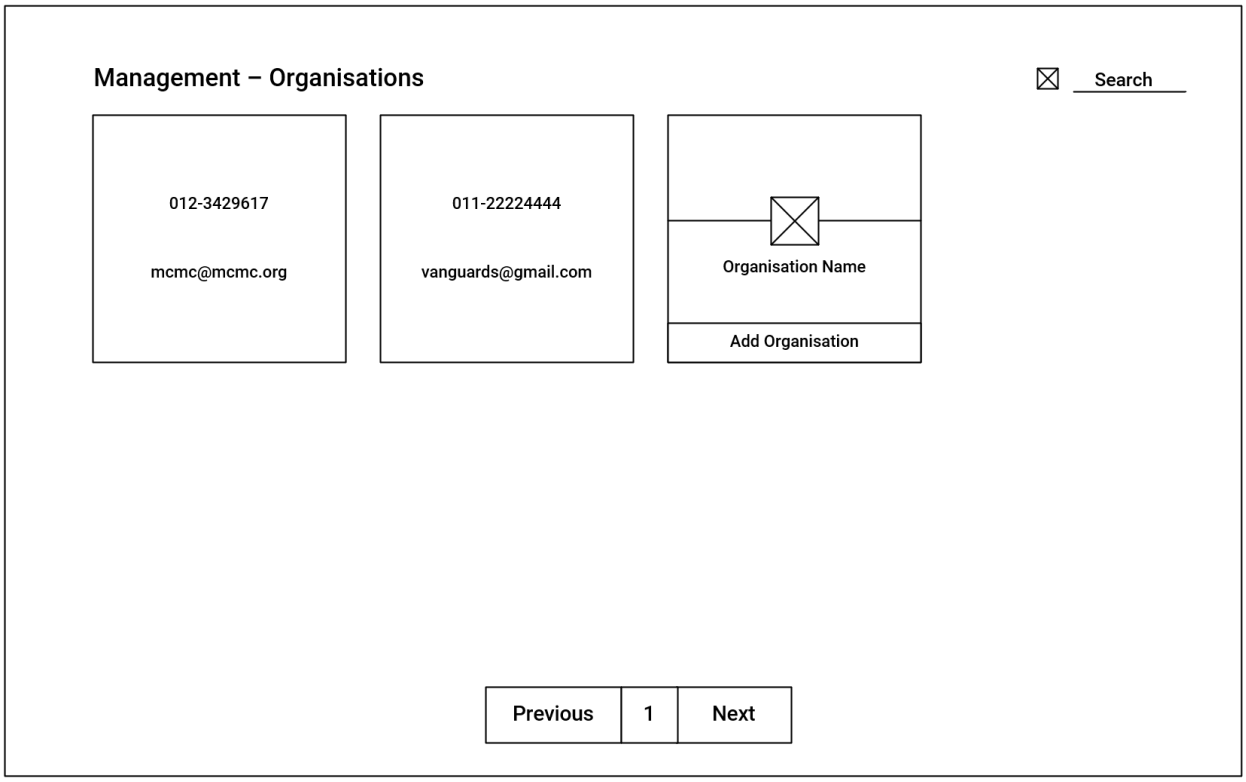


Figure 222: Wireframe - Management Page (Organisations - Backside)

Upon hovering the organisation, the organisation's phone number and email address will be displayed on the back as shown in the figure above.

7.2.3.14 Management – Add Organisation Modal

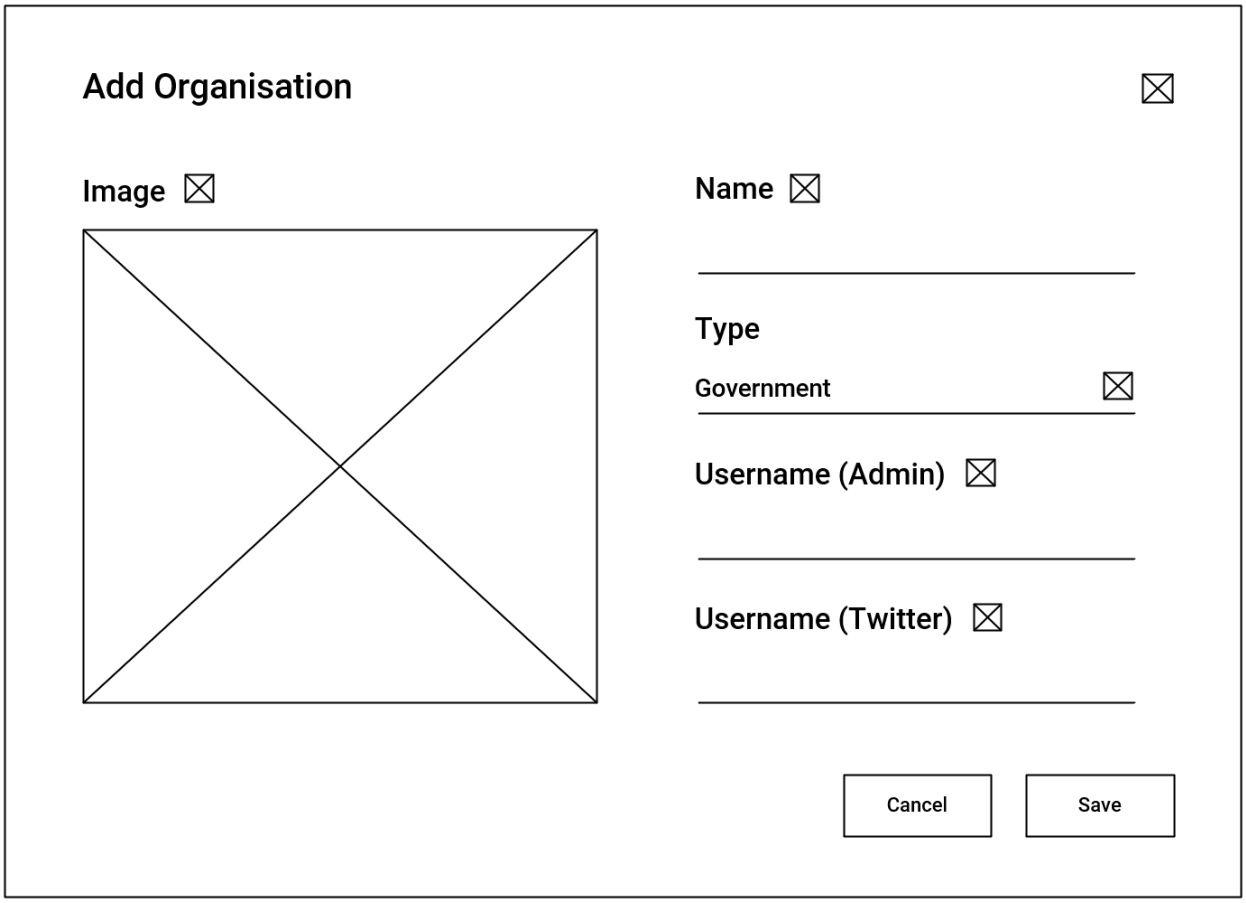


Figure 223: Wireframe - Add Organisation Modal

The figure above shows the add organisation modal wherein the system admin shall be able to add new organisation through providing the image, name, type of organisation, the username to access the system as well as the organisation's Twitter username.

7.2.3.15 Pop-up Message Modal

Figure 224: Wireframe - Pop-up Message Modal

The figure above shows the pop-up message component which will be shown upon the system whenever there are successful or irregular operations performed such as successful password modification or successful non-cyberbullying incidents removal.

Chapter 8: Project Plan

8.1 Details of Release Plan

8.1.1 Version 1.0

The first version of the proposed system will be released on the last week of March 2021. The first release would involve the main component, machine learning model that has been trained and tested against the formulated code-switching cyberbullying dataset with satisfactory prediction accuracy, readily available to be integrated with the system and deployed into the real-life environment to predict messages with cyberbullying connotation.

8.1.2 Version 2.0

The second version of the proposed system will be released on the third week of April 2021. The second version would include another main component wherein it is responsible in streaming tweets from Twitter, utilising the model trained to discern cyberbullying messages and saves the record in various aspects including messages and profiles into the database. The appropriate encryption and decryption algorithm and process will be researched and executed at this release to ensure the sensitive information are securely protected.

8.1.3 Version 3.0

The third version of the proposed system will be released on the third week of May 2021. The third version would involve the interactive dashboard page within the front-end wherein the system users shall be able to view statistics in different perspective that are calculated and retrieved from the server-side of the system. Additionally, the profiles page based on the cyberbullies and cybervictims identified from the server, equipped with the necessary filter options will be designed and released during this timeline as well, thus providing a quick and comprehensive view to the system users on who to prioritise when offering counselling support.

8.1.4 Version 4.0

The fourth version of the proposed system will be released on the first week of June 2021. The fourth version would involve the fundamental functionalities such as login and logout as well as features that grant the users permissions to remove misclassified incidents, send support message

through replying tweet or direct messaging as well as viewing past support messages sent by other organisations. Through these functionalities, the users shall be able to monitor on harmful cyberbullying activities meanwhile offering counselling support to the individuals through different approaches.

8.1.5 Version 5.0

The fifth version of the proposed system will be released on the third week of June 2021. The fifth version would include another two pages, organisation account page with basic organisation information with additional features to change their system password and organisation information as well as management page wherein the government-based organisation shall be able to view all the organisations that have access to the system and create access for new organisation to partake together in the journey in minimising cyberbullying incidents.

8.1.6 Version 6.0

The sixth version of the proposed system will be released on the last week of June 2021. The sixth version would involve optimising the system features and user interface to perform in tip-top shape, therefore ensure the system users have the utmost pleasure when utilising the system.

8.2 Test Plan

Without questions, testing is one of the most crucial process during the system development life cycle. Through testing, not only can the system be verified on whether the features as specified within the specification were delivered, but the system can be validated as well in terms of how well it delivers the objectives defined and satisfy customers' requirements. On top of that, with a proper testing procedure established, the testing process will become much more streamlined and comprehensive, thus guaranteeing even the simplest features were thoroughly tested to prevent unnecessary bugs that causes inconvenience towards the users. With that said, several extensive test plans will be formulated specifically for two distinct type of testing, unit testing and user acceptance testing.

Unit testing refers to the testing of individual software unit developed. For example, the developer will test whether the machine learning model can predict code-switching cyberbullying texts with decent performance.

User acceptance testing refers to the testing of the entire system by the clients themselves. This testing is conducted to ensure that the system functionalities and features meet the customers' requirements and expectations. As for this project, two members from NGOs and one member from the government agency will be performing the user acceptance testing and their feedbacks given shall guide the course of actions to further improve the system.

8.2.1 Unit Testing

8.2.1.1 Detect Cyberbullying Tweet

Table 90: Unit Test Plan - Detect Cyberbullying Tweet

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTA-001	Detect cyberbullying tweet through posting a non-cyberbullying tweet without tagging, replying to a tweet nor embedding a location.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		
UTA-002	Detect cyberbullying tweet through posting a cyberbullying tweet without tagging, replying to a tweet nor	- Must log into a Twitter account.	1. Enter a cyberbullying tweet in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		

	embedding a location.						
UTA-003	Detect cyberbullying tweet through posting a non-cyberbullying tweet with tagging a Twitter user but without embedding a location.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** @felix4524 Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		
UTA-004	Detect cyberbullying tweet through posting a cyberbullying tweet with tagging a Twitter user but	- Must log into a Twitter account.	1. Enter a cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed nothing in the location field.	**Tweet:** @felix4524 ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		

	without embedding a location.		3. Press the "Tweet" button.				
UTA-005	Detect cyberbullying tweet through posting a non-cyberbullying tweet with replying to a tweet but without embedding a location.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet replying to another tweet. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		
UTA-006	Detect cyberbullying tweet through posting a cyberbullying tweet with replying to a	- Must log into a Twitter account.	1. Enter a cyberbullying tweet replying to another tweet. 2. Embed nothing in the location field.	**Tweet:** ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.		

	tweet but without embedding a location.		3. Press the "Tweet" button.				
UTA-007	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a location but without tagging a user or replying to a tweet.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet in the tweet field. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a great day. **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system but the tweet or the profile are not stored into the database.		
UTA-008	Detect cyberbullying tweet through posting a non-cyberbullying	- Must log into a Twitter account.	1. Enter a cyberbullying tweet in the tweet field. 2. Embed a location in the location field.	**Tweet:** ei, you tak ada otak? why are u so brainless	The tweet is recognised by the system but the tweet or the profile are not		

	tweet with embedding a location but without tagging a user or replying to a tweet.		3. Press the "Tweet" button.	**Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	stored into the database.		
UTA-009	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a location and tagging a user.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** @felix4524 Today is a great day. **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system but the tweet or the profile are not stored into the database.		
UTA-010	Detect cyberbullying tweet through posting a	- Must log into a Twitter account.	1. Enter a cyberbullying tweet with tagging a	**Tweet:** @felix4524 ei, you tak ada otak?	The tweet is recognised by the system and the tweet as well		

	cyberbullying tweet with embedding a location and tagging a user.		Twitter user in the tweet field. 2. Embed a location in the location field. 3. Press the "Tweet" button.	why are u so brainless **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	as the profile are AES-256 encrypted and stored into the database.		
UTA-011	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a location and replying to a tweet.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet replying to another tweet. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a good day. **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system but the tweet and the profile are not stored into the database.		

UTA-012	Detect cyberbullying tweet through posting a cyberbullying tweet with embedding a location and replying to a tweet.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet replying to another tweet. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system and the tweet as well as the profile are AES-256 encrypted and stored into the database.		

8.2.1.2 Login

Table 91: Unit Test Plan - Login

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTB-001	Login with an empty username	- The organisation	1. Leave the username field empty.	**Username:** *empty*	1. The tooltip box for the		

	and an empty password.	must exist in the database.	2. Leave the password field empty. 3. Press the "Login" button.	**Password:** *empty*	username field is triggered. 2. The username field is coloured red. 3. The tooltip box for the password field is triggered. 4. The password field is coloured red.		
UTB-002	Login with an empty username and a valid password.	- The organisation must exist in the database.	1. Leave the username field empty. 2. Enter a valid password in the password field. 3. Press the "Login" button.	**Username:** *empty* **Password:** tp046085	1. The tooltip box for the username field is triggered. 2. The username field is coloured red.		

					3. The password field is coloured green.		
UTB-003	Login with an invalid username and a valid password.	- The organisation must exist in the database.	1. Enter an invalid username in the username field. 2. Enter a valid password in the password field. 3. Press the "Login" button.	**Username:** @hi **Password:** tp046085	1. The tooltip box for the username field is triggered. 2. The username field is coloured red. 3. The password field is coloured green.		
UTB-004	Login with an inexistent username and a valid password.	- The organisation must exist in the database.	1. Enter a valid but non-existent username in the username field. 2. Enter a valid password in the password field.	**Username:** anonymous **Password:** tp046085	1. The username field is coloured green. 2. The password field is coloured green.		

			3. Press the "Login" button.		3. The password is RSA encrypted. 4. The message "Wrong username or password." is shown in the error field.		
UTB-005	Login with a valid username and an empty password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Leave the password field empty. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** *empty*	1. The tooltip box for the password field is triggered. 2. The username field is coloured green. 3. The password field is coloured red.		

UTB-006	Login with a valid username and an invalid password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Enter an invalid password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** tp046	1. The tooltip box for the password field is triggered. 2. The username field is coloured green. 3. The password field is coloured red.		
UTB-007	Login with a valid username and an incorrect password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Enter an incorrect password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** wrongpw	1. The username field is coloured green. 2. The password field is coloured green. 3. The password is RSA encrypted.		

					4. The message "Wrong password." Is shown in the error field.		
UTB-008	Login with an existing username and the correct password for organisations who have yet authorise the app to access its organisation's Twitter account.	- The organisation must exist in the database.	1. Enter an existing username in the username field. 2. Enter a correct password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** tp046085	1. All the fields are coloured green. 2. The twitter login modal is prompted up.		
UTB-009	Login with an existing username and the correct password for	- The organisation must exist in the database.	1. Enter an existing username in the username field.	**Username:** mcmcadmin **Password:** tp046085	1. All the fields are coloured green. 2. The password is encrypted		

	organisations who have already authorise the app to access its organisation's Twitter account.		2. Enter a correct password in the password field. 3. Press the "Login" button.		using RSA algorithm. 3. The user is redirected to the dashboard page.		

8.2.1.3 Twitter Login

Figure 225: Unit Test Plan - Twitter Login

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTC-001	Cancel authorising app's access.	-	1. Press the "Cancel" button.	-	1. A pop-up modal with the message "Authorised unsuccessful. The authorisation		

					process was cancelled.” is displayed. 2. The Twitter login modal is closed.		
UTC-002	Authorise the app without inputting the PIN code.	-	1. Leave the PIN code field empty. 2. Press the “Submit” button.	**PIN Code:** *empty*	1. A pop-up modal with the message “Authorised unsuccessful. Invalid PIN Code. Please login again.” is displayed. 2. The Twitter login modal is closed.		
UTC-003	Authorise the app with	-	1. Press the link given.	-	1. A pop-up modal with the		

	inputting a valid PIN code except from a wrong Twitter account stored into the database.		2. Authorise the app using different Twitter account than previously saved into the database. 3. Paste the PIN Code in the PIN Code field.		message "Authorised unsuccessful. Please authorise the app using your organisation's Twitter account." is displayed. 2. The Twitter login modal is closed.		
UTC-004	Authorise the app with inputting a valid PIN code retrieved from the Twitter account that matches the	-	1. Press the link given. 2. Authorise the app using Twitter account with the same Twitter ID previously saved into the database.	-	1. The tokens are AES-256 encrypted. 2. The user is redirected to the dashboard page.		

	Twitter ID stored into the database.		3. Paste the PIN Code in the PIN Code field.				

8.2.1.4 Side Navigation

Table 92: Unit Test Plan - Side Navigation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTD-001	Redirect to dashboard page.	- The user must log into the system.	1. Press the "Dashboard" button.	-	The user is redirected to the dashboard page.		
UTD-002	Redirect to profile page.	- The user must log into the system.	1. Press the "Twitter Profile" button.	-	The user is redirected to the profile page.		
UTD-003	Refresh the notifications	-	1. Wait five minutes.	-	The notifications regarding number of newly		

	every five minutes.				detected incidents are updated to its latest.		
UTD-004	Redirect to organisation page.	- The user must log into the system.	1. Press the “Own Organisation” button.	-	The user is redirected to its organisation page.		
UTD-005	Redirect to management page.	- The user must log into the system. - The user’s organisation is government-based.	1. Press the “Management” button.	-	The user is redirected to the management page.		
UTD-006	Logout of the system.	- The user must log into the system.	1. Press the “Logout” button.	-	The user is redirected to the login page.		

8.2.1.5 Dashboard

Table 93: Unit Test Plan - Dashboard

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTE-001	Switch to bar chart-based statistics.	- There must be at least one incident recorded in the database.	1. Press the bar chart icon.	-	The bar chart-based statistics is displayed.		
UTE-002	Switch to map-based statistics.	- There must be at least one incident recorded in the database.	1. Press the earth icon.	-	The map-based statistics is displayed.		
UTE-003	Filter and display bar chart-based daily statistics.	- There must be at least one incident recorded in the database.	1. Press the switch icon between the label “Day” and “Month”.	-	The bar chart is refreshed and the daily statistics based on current		

		- The statistics mode is current set on bar chart view. - The time mode is currently set on “Month”.			date is displayed.		
UTE-004	Filter and display bar chart-based monthly statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on	1. Press the switch icon between the label “Day” and “Month”.	-	The bar chart is refreshed and the monthly statistics based on current year is displayed.		

		bar chart view. - The time mode is currently set on “Day”.					
UTE-005	Filter and display map-based daily statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view. - The time mode is currently set on “Month”.	1. Press the switch icon between the label “Day” and “Month”.	-	The map is refreshed and the daily statistics based on current date is displayed.		

UTE-006	Filter and display map-based monthly statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view. - The time mode is currently set on “Day”.	1. Press the switch icon between the label “Day” and “Month”.	-	The map is refreshed and the monthly statistics based on current year is displayed.		
UTE-007	Display box of years between earliest year of incident stored in the database and current year.	- There must be at least one incident recorded in the database.	1. Press the year or the arrow icon.	-	The box with year(s) between earliest incident stored in the database and		

		- The time mode is currently set on “Month”.			current year is displayed.		
UTE-008	Display box of months based on the distinct months of selected year of incidents stored in the database.	- There must be at least one incident recorded in the database. - The statistics mode is currently set on map view. - The time mode is currently set on “Month”.	1. Press the month or the arrow icon.	-	Th box with months according to the distinct months of selected year of incidents stored in the database is displayed.		
UTE-009	Filter and display bar	- There must be at least one	1. Press the year or the arrow icon.	-	The bar chart is refreshed and the		

	chart-based monthly statistics according to selected year.	incident recorded in the database. - The statistics mode is current set on bar chart view. - The time mode is currently set on “Month”.	2. Select a year.		monthly statistics based on the year selected is displayed.		
UTE-010	Filter and display map-based monthly statistics according to selected year.	- There must be at least one incident recorded in the database. - The statistics	1. Press the year or the arrow icon. 2. Select a year.	-	The map is refreshed and the monthly statistics based on the year selected is displayed.		

		mode is current set on map view. - The time mode is currently set on “Month”.					
UTE-011	Filter and display map-based monthly statistics according to selected month.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view. - The time mode is	1. Press the month or the arrow icon. 2. Select a month.	-	The map is refreshed and the monthly statistics based on the month selected is displayed.		

		currently set on “Month”.					
UTE-012	Display calendar based on dates between earliest date of incident stored in the database and current date.	- There must be at least one incident recorded in the database. - The time mode is currently set on “Day”.	1. Press the date or the arrow icon.	-	The calendar with dates between earliest date of incident stored in the database and current date is displayed.		
UTE-013	Filter and display bar chart-based daily statistics according to selected date.	- There must be at least one incident recorded in the database. - The time mode is currently set on “Day”.	1. Press the date or the arrow icon. 2. Select a date.	-	The bar chart is refreshed and the daily statistics based on the date selected is displayed.		

UTE-014	Filter and display map-based daily statistics according to selected date.	- There must be at least one incident recorded in the database. - The time mode is currently set on “Day”.	1. Press the date or the arrow icon. 2. Select a date.	-	The map is refreshed and the daily statistics based on the date selected is displayed.		
UTE-015	Refresh all the statistics every five minutes.	-	1. Wait five minutes.	-	The statistics including last week’s overall statistics as well as the daily or monthly bar chart-based statistics regarding number of cyberbullying incidents are		

					updated to its latest.		

8.3.1.6 Profile

Table 94: Unit Test Plan - Profile

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTF-001	Filter and display profiles based on empty search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter options are all ticked.	1. Enter an empty search keyword in the search field.	**Search Keyword:** *empty*	All the profiles exist within the database is displayed.		

		- The roles filter options are all ticked. - The toxicity filter options are all ticked.					
UTF-002	Filter and display profiles based on inexistent username search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter options are all ticked. - The roles filter options are all ticked.	1. Enter an inexistent username search keyword in the search field.	**Search Keyword:** anonymous	The message "No profiles were found." is displayed on the page.		

		- The toxicity filter options are all ticked.					
UTF-003	Filter and display profiles based on existing username search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter options are all ticked. - The roles filter options are all ticked. - The toxicity filter options are all ticked.	1. Enter an existing username search keyword in the search field.	**Search Keyword:** robot4213	The profile with the entered username is displayed on the page.		

UTF-004	Filter and display profiles based on zero selections on all options within the support status filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The roles filter options are all ticked. - The toxicity filter options are all ticked.	1. Deselect "Not Yet" option within the support status filter. 2. Deselect "Offered" option within the support status filter. 3. Deselect "Offered Yet Continues" option within the support status filter.	-	The message "No profiles were found." is displayed on the page.		
UTF-005	Filter and display profiles based on at least one option selected within	- The profile with at least one incident involved	1. Select either "Not Yet", "Offered" and/or "Offered Yet Continues" options	-	The profiles with the selected options within the support status filter are		

	the support status filter.	must exist in the database. - The search field is empty. - The roles filter options are all ticked. - The toxicity filter options are all ticked.	within the support status filter.		displayed on the page.		
UTF-006	Filter and display profiles based on zero selections on all options within the roles filter.	- The profile with at least one incident involved must exist in the database.	1. Deselect "Cyberbully" option within the roles filter. 2. Deselect "Cybervictim" option within the roles filter. 3. Deselect "Cyberbully-Victim"	-	The message "No profiles were found." is displayed on the page.		

		- The search field is empty. - The support status filter options are all ticked. - The toxicity filter options are all ticked.	option within the roles filter.				
UTF-007	Filter and display profiles based on at least one option selected within the roles filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty.	1. Select either "Cyberbully", "Cybervictim" and/or "Cyberbully-Victim" options within the roles filter.	-	The profiles with the selected options within the roles filter are displayed on the page.		

		- The support status filter options are all ticked. - The toxicity filter options are all ticked.					
UTF-008	Filter and display profiles based on zero selections on all options within the toxicity filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The support status filter options are all ticked.	1. Deselect "Low" option within the toxicity filter. 2. Deselect "Medium" option within the toxicity filter. 3. Deselect "High" option within the toxicity filter.	-	The cybervictims profiles are displayed on the page.		

		- The roles filter options are all ticked.					
UTF-009	Filter and display profiles based on at least one option selected within the toxicity filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The support status filter options are all ticked. - The roles filter options are all ticked.	1. Select either “Low”, “Medium” and/or “High” options within the toxicity filter.	-	The profiles with the selected options within the toxicity filter is displayed on the page.		

UTF-010	Display profiles of the subsequent page.	- There are two or more pages of profiles within the pagination bar.	1. Press the "Next" button.	-	The profiles of subsequent page are displayed on the page.		
UTF-011	Display profiles of the previous page.	- There are two or more pages of profiles within the pagination bar.	1. Press the "Previous" button.	-	The profiles of previous page are displayed on the page.		
UTF-012	Display profiles based on selected page number.	- There are two or more pages of profiles within the pagination bar.	1. Select a page number on the pagination bar.	-	The profiles of selected page number are displayed on the page.		

UTF-013	Display specific profile details.	- The profile with at least one incident involved must exist in the database.	1. Press the "View Incidents" button on a particular profile.	-	The profile details modal is displayed.		
UTF-014	Refresh all the profiles every five minutes.	-	1. Wait five minutes.	-	The profiles including notification regarding numbers of cyberbullying and cybervictim incidents involved are updated to its latest.		

8.3.1.7 Profile Details

Table 95: Unit Test Plan - Profile Details

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTG-001	Close modal.	-	1. Press the “X” icon.	-	The profile details modal is closed.		
UTG-002	Filter and display incidents based on cyberbullying incidents involved.	- The profile involved at least one cyberbullying incident.	1. Press the “Cyberbully” button.	-	1. The details of cyberbullying incidents involved are displayed. 2. The total number of cyberbullying incidents is displayed. 3. The notification status of cyberbullying		

					incidents are updated as read in the database. 4. The notification regarding number of cyberbullying incidents are updated in the user interface.		
UTG-003	Filter and display incidents based on cybervictim incidents involved.	- The profile involved at least one cybervictim incident.	1. Press the “Cybervictim” button.	-	1. The details of cybervictim incidents involved are displayed. 2. The total number of cybervictim		

					incidents is displayed. 3. The notification status of cybervictim incidents are updated as read in the database. 4. The notification regarding the numbers of cybervictim incidents are updated in the user interface.		
UTG-004	Remove one incident.	- The profile involved at	1. Press the "Not Cyberbullying" button.	-	A pop-up modal with the message "The incident has been		

		least one incident.			successfully deleted.” is displayed.		
UTG-005	Remove the last remaining incident.	- The profile only has one incident involved.	1. Press the “Not Cyberbullying” button.	-	A pop-up modal with the message “The incident has been successfully deleted. The profile will be removed from the system since there are no related incidents.” is displayed.		
UTG-006	Access reply tweet functionality.	- The profile involved at least one incident.	1. Press the “Reply Tweet” button.	-	The support message modal specifically for replying tweet is displayed.		

UTG-007	Access direct message functionality.	- The profile involved at least one incident.	1. Press the "Direct Message" button.	-	The support message modal specifically for direct message is displayed.		
UTG-008	Display history of support messages provided previously.	- The profile involved at least one incident.	1. Press the "Message History" button.	-	The support message history modal is displayed.		

8.3.1.8 Support Message – Reply Tweet

Table 96: Unit Test Plan - Support Message (Reply Tweet)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTH-001	Close modal.	-	1. Press the "X" icon.	-	The support message modal is closed.		

	Enable modification of pre-written counselling support message.	-	1. Press the “Modify” button.	-	The support message text box is enabled.		
UTH-002	Disable modification of pre-written counselling support message.	- The support message text box is currently enabled.	1. Press the “Cancel” button.	-	The support message text box is disabled.		
UTH-003	Modify pre-written counselling support message with invalid input.	-	1. Press the “Modify” button. 2. Enter invalid input. 3. Press the “Save” button.	**Message:** hi anonymous	The tooltip box for the support message text box is triggered.		

UTH-004	Modify pre-written counselling support message with valid input.	-	1. Press the "Modify" button. 2. Enter valid input. 3. Press the "Save" button.	**Message:** Hello, my name is Hoh Kok Young from Childline Foundation and I would like to help you.	1. The message is AES-256 encrypted. 2. A pop-up modal with the message "The message has been successfully saved." is displayed.		
UTH-005	Revert back to original message when modifying pre-written counselling support message.	-	1. Press the "Modify" button. 2. Enter input. 3. Press the "Cancel" button.	**Message:** Just some random input in the box.	1. The support message text box is disabled. 2. The message within the text box is reverted back to original message.		

UTH-006	Send counselling support message through replying to existing tweet.	- The tweet still exists in Twitter.	1. Press the "Send" button.	-	1. A pop-up modal with the message "The message has been successfully sent." is displayed. 2. The support message modal is closed.		
UTH-007	Send counselling support message through replying to deleted or private tweet.	- The tweet is deleted or private in Twitter.	1. Press the "Send" button.	-	1. A pop up modal with the message "You attempted to reply to a Tweet that is deleted or not visible to you. The incident will be deleted from the		

					system." is displayed. 2. The support message modal is closed.		
UTH-008	Send counselling support message through replying to existing tweet with the same message simultaneously.	- The tweet still exists in Twitter.	1. Press the "Send" button.	-	1. A pop up modal with the message "Status is a duplicate. Same text cannot be sent to the same tweet twice." is displayed. 2. The support message modal is closed.		
UTH-009	Send counselling support message	-	1. Press the "Send" button.	-	1. A pop-up modal with the message		

	through replying to tweet wherein the organisation's internally stored Twitter tokens have expired or became invalid.				"Invalid or expired token. Please authorise the app again with your organisation's Twitter account." is displayed. 2.. The twitter login modal is prompted up.		

8.3.1.9 Support Message – Direct Message

Table 97: Unit Test Plan - Support Message (Direct Message)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTI-001	Close modal.	-	1. Press the “X” icon.	-	The support message modal is closed.		
UTI-002	Enable modification of pre-written counselling support message.	-	1. Press the “Modify” button.	-	The support message text box is enabled.		
UTI-003	Disable modification of pre-written counselling support message.	- The support message text box is currently enabled.	1. Press the “Cancel” button.	-	The support message text box is disabled.		
UTI-004	Modify pre-written counselling support message	-	1. Press the “Modify” button. 2. Enter invalid input.	**Message:** hi anonymous	The tooltip box for the support message text box is triggered.		

	with invalid input.		3. Press the "Save" button.				
UTI-005	Modify pre-written counselling support message with valid input.	-	1. Press the "Modify" button. 2. Enter valid input. 3. Press the "Save" button.	**Message:** Hello, my name is Hoh Kok Young from Childline Foundation and I would like to help you.	A pop-up modal with the message "The message has been successfully saved." is displayed.		
UTI-006	Revert back to original message when modifying pre-written counselling support message.	-	1. Press the "Modify" button. 2. Enter input. 3. Press the "Cancel" button.	**Message:** Just some random input in the box.	1. The support message text box is disabled. 2. The message within the text box is reverted back to original message.		

UTI-007	Send counselling support message through direct messaging to existing Twitter account.	- The Twitter account is in activated status.	1. Press the "Send" button.	-	1. A pop-up modal with the message "The message has been successfully sent." is displayed. 2. The support message modal is closed.		
UTI-008	Send counselling support message through direct messaging to existing Twitter account with the feature of receiving direct message from	- The Twitter account is in activated status. - The feature of receiving direct message from outsiders in the Twitter	1. Press the "Send" button.	-	1. A pop-up modal with the message "You cannot send messages to this user. The user did not allow Direct Message (DM) from		

	outsiders deactivated.	account is deactivated.			outsiders.” is displayed. 2. The support message modal is closed.		
UTI-009	Send counselling support message through direct messaging to deactivated Twitter account.	- The Twitter account is in deactivated status.	1. Press the “Send” button.	-	1. A pop-up modal with the message “Cannot find specified user. The user's account has been deactivated. The profile will be removed from the system.” is displayed. 2. The support message modal is closed.		

					3. The profile will be removed from the user interface.		
UTI-010	Send counselling support message through direct messaging wherein the organisation's internally stored Twitter tokens have expired or became invalid.	-	1. Press the "Send" button.	-	1. A pop-up modal with the message "Invalid or expired token. Please authorise the app again with your organisation's Twitter account." is displayed. 2.. The twitter login modal is prompted up.		

8.3.1.10 Support Message History

Table 98: Unit Test Plan - Support Message History

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTJ-001	Close modal.	-	1. Press the "X" icon.	-	The support message history modal is closed.		

8.3.1.11 Organisation

Table 99: Unit Test Plan - Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTK-001	Access change password functionality.	-	1. Press the "Change Password" button.	-	The change password modal is displayed.		

UTK-002	Access edit organisation functionality.	-	1. Press the "Edit Organisation" button.	-	The edit organisation modal is displayed.		

8.3.1.12 Change Password

Table 100: Unit Test Plan - Change Password

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTL-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The change password modal is closed.		
UTL-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The change password modal is closed.		
UTL-003	Change password with empty field(s).	-	1. Leave the current password field, new password field and/or	**Current Password:** *empty*	1. The tooltip box for the		

			confirm password field empty. 2. Press the "Save" button.	**New Password:** *empty* **Confirm Password:** *empty*	password field is triggered. 2. The empty field(s) are coloured red.		
UTL-004	Change password with invalid password in either field.	-	1. Enter invalid password in either field. 2. Press the "Save" button.	**Current Password:** tp0460 **New Password:** 1234 **Confirm Password:** 1234	1. The tooltip box for the password field is triggered. 2. The invalid fields are coloured red.		
UTL-005	Change password with wrong current password and unmatching new	-	1. Enter incorrect password in the current password field.	**Current Password:** wrongpass	1. All the fields are coloured green.		

	password and confirm password.		2. Enter new password in the new password field. 3. Enter unmatching new password in the confirm password. 4. Press the "Save" button.	**New Password:** 1234abcd **Confirm Password:** 1234dcba	2. The message "The new password and confirm password do not match." is displayed in the error field.		
UTL-006	Change password with wrong current password and correct new password as well as confirm password.	-	1. Enter incorrect password in the current password field. 2. Enter new password in the new password field. 3. Enter matching new password in the confirm password. 4. Press the "Save" button.	**Current Password:** wrongpass **New Password:** 1234abcd **Confirm Password:** 1234abcd	1. All the fields are coloured green. 2. The current password and the new password are RSA encrypted. 3. The message "Wrong current password." is		

					displayed in the error field.		
UTL-007	Change password with correct current password and unmatching new password and confirm password.	-	1. Enter correct password in the current password field. 2. Enter new password in the new password field. 3. Enter unmatching new password in the confirm password. 4. Press the "Save" button.	**Current Password:** tp046085 **New Password:** 1234abcd **Confirm Password:** 1234dcba	1. All the fields are coloured green. 2. The message "The new password and confirm password do not match." is displayed in the error field.		
UTL-008	Change password with correct current password and matching new password and	-	1. Enter correct password in the current password field. 2. Enter new password in the new password field.	**Current Password:** tp046085 **New Password:** 1234abcd	1. All the fields are coloured green. 2. The current password and the new		

	confirm password.		3. Enter matching new password in the confirm password. 4. Press the "Save" button.	**Confirm Password:** 1234abcd	password are RSA encrypted. 3. A pop-up modal with the message "The password has been successfully changed." is displayed. 4. The change password modal is closed.		

8.3.1.13 Edit Organisation

Table 101: Unit Test Plan - Edit Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTM-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The edit organisation modal is closed.		
UTM-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The edit organisation modal is closed.		
UTM-003	Edit organisation with empty name in the name field.	-	1. Leave the name field empty. 2. Press the "Save" button.	**Name:** *empty*	1. The tooltip box for the name field is triggered. 2. The name field is coloured red.		
UTM-004	Preview image.	-	1. Press the "Camera" icon. 2. Select a file of png, jpg or jpeg exntensions.	**Image File:** image.png	1. The image selected is displayed. 2. The "X" icon is displayed.		

UTM-005	Remove image selected.	An image is selected.	1. Press the “X” icon in the image field.	-	1. The original image is displayed. 2. The “Camera” icon is displayed.		
UTM-006	Select an invalid image in the image field.	-	1. Press the “Camera” icon. 2. Select a file of not png, jpg or jpeg extensions.	**Image File:** file.pdf	The tooltip box for the image field is triggered.		
UTM-007	Edit organisation with invalid name in the name field.	-	1. Enter an invalid name in the name field. 2. Press the “Save” button.	**Name:** Chi!@ld Fo!@ation	1. The tooltip box for the name field is triggered. 2. The name field is coloured red.		

UTM-008	Edit organisation with invalid phone number in the phone number field.	-	1. Enter an invalid phone number in the phone number field. 2. Press the "Save" button.	**Phone Number:** 012-abcdefg	1. The tooltip box for the phone number field is triggered. 2. The phone number field is coloured red.		
UTM-009	Edit organisation with invalid email in the email address field.	-	1. Enter an invalid email in the email address field. 2. Press the "Save" button.	**Email Address:** kelvin@com	1. The tooltip box for the email address field is triggered. 2. The email address field is coloured red.		
UTM-010	Edit organisation with the same organisation name that has	- There must be an organisation with the same name	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field.	**Image:** image.png **Name:** BefriendersKL	1. All the fields are coloured green. 2. An error message "There		

	already registered within the database.	registered in the database.	3. Leave the phone number field empty. 4. Leave the email address field empty. 5. Press the "Save" button.	**Phone Number:** *empty* **Email Address:** *empty*	is already an organisation registered under the same name" is displayed.		
UTM-011	Edit organisation with valid image, name and.	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Leave the phone number field empty. 4. Leave the email address field empty. 5. Press the "Save" button.	**Image:** image.png **Name:** Childline Foundation **Phone Number:** *empty* **Email Address:** *empty*	1. All the fields are coloured green. 2. A pop-up modal with the message "The account has been successfully edited." is displayed. 3. The edit account modal is closed.		

UTM-012	Edit organisation with valid image, name, and phone number.	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Enter valid phone number in the phone number field. 4. Leave the email address field empty. 5. Press the "Save" button.	**Image:** image.png **Name:** Childline Foundation **Phone Number:** 03-21312221 **Email Address:** *empty*	1. All the fields are coloured green. 2. A pop-up modal with the message "The organisation has been successfully edited." is displayed. 3. The edit organisation modal is closed.		
UTM-013	Edit organisation with valid image, name, phone number	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field.	**Image:** image.png **Name:** Childline Foundation	1. All the fields are coloured green. 2. A pop-up modal with the message "The		

	and email address.		3. Enter valid phone number in the phone number field. 4. Enter valid email in the email address field. 5. Press the "Save" button.	**Phone Number:** 03-21312221 **Email Address:** mc@mcmc.org	organisation has been successfully edited." is displayed. 3. The edit organisation modal is closed.		

8.3.1.14 Management – Organisations

Table 102: Unit Test Plan - Management (Organisations)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTN-001	Filter and display organisations based on empty search keyword.	- The user must belong to a government organisation.	1. Enter an empty search keyword in the search field.	**Search Keyword:** *empty*	All the organisations exist within the database is displayed.		

		- There must at least be one organisation in the database.					
UTN-002	Filter and display organisations based on inexistent organisation name search keyword.	- The user must belong to a government organisation. - There must at least be one organisation in the database.	1. Enter an inexistent organisation name search keyword in the search field.	**Search Keyword:** mcdonald	The message "No organisations were found." is displayed on the page.		
UTN-003	Filter and display organisations based on existing organisation	- The user must belong to a government organisation.	1. Enter an existent organisation name search keyword in the search field.	**Search Keyword:** childline foundation	The organisation(s) with the entered organisation name is		

	name search keyword.	- There must at least be one organisation in the database.			displayed on the page.		
UTN-004	Display organisations of the subsequent page.	- There are two or more pages of organisations within the pagination bar.	1. Press the “Next” button.	-	The organisations of subsequent page are displayed on the page.		
UTN-005	Display organisations of the previous page.	- There are two or more pages of organisations within the pagination bar.	1. Press the “Previous” button.	-	The organisations of previous page are displayed on the page.		

UTN-006	Display organisations based on selected page number.	- There are two or more pages of organisations within the pagination bar.	1. Select a page number on the pagination bar.	-	The organisations of selected page number are displayed on the page.		
UTN-007	Display one organisation's phone number and email address when both the information is not set.	- The user must belong to a government organisation. - There must at least be one organisation in the database. - The targeteed organisation has no phone	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. No information of the organisation is displayed on its backside.		

		number or email address set.					
UTN-008	Display one organisation's phone number and email address when only the phone number is set.	- The user must belong to a government organisation. - There must at least be one organisation in the database. - The targeted organisation has no email address set.	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. Only phone number of the organisation is displayed on its backside.		
UTN-009	Display one organisation's phone number	- The user must belong to a	1. Hover on one organisation profile.	-	1. The organisation profile user		

	and email address when only the email address is set.	government organisation. - There must at least be one organisation in the database. - The targeted organisation has no phone number set.			interface is flipped. 2. Only email address of the organisation is displayed on its backside.		
UTN-010	Display one organisation's phone number and email address when both information has been set.	- The user must belong to a government organisation. - There must at least be one organisation	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. The phone number and the email address of the organisation		

		in the database. - The targeted organisation both phone number or email address set.			is displayed on its backside.		
UTN-011	Access add organisation functionality.	- The user must belong to a government organisation.	1. Press the "Add Organisation" button.	-	The add organisation modal is displayed.		

8.3.1.15 Add Organisation

Table 103: Unit Test Plan - Add Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTO-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The add organisation modal is closed.		
UTO-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The add organisation modal is closed.		
UTO-003	Add organisation with empty name in the organisation name field.	-	1. Leave the organisation name field empty. 2. Press the "Save" button.	**Name:** *empty*	1. The tooltip box for the organisation name field is triggered. 2. The organisation name field is coloured red.		
UTO-004	Add organisation with empty username in the	-	1. Leave the system username field empty.	**System Username:** *empty*	1. The tooltip box for the system		

	system username field.		2. Press the “Save” button.		username field is triggered. 2. The system username field is coloured red.		
UTO-005	Add organisation with empty username in the twitter username field.	-	1. Leave the twitter username field empty. 2. Press the “Save” button.	**Twitter Username:** *empty*	1. The tooltip box for the twitter username field is triggered. 2. The twitter username field is coloured red.		
UTO-006	Preview image.	-	1. Press the “Camera” icon. 2. Select a file of png, jpg or jpeg exntensions.	**Image File:** image.png	1. The image selected is displayed. 2. The “X” icon is displayed.		

UTO-007	Remove image selected.	An image is selected.	1. Press the "X" icon in the image field.	-	1. The original image is displayed. 2. The "Camera" icon is displayed.		
UTO-008	Select an invalid image in the image field.	-	1. Press the "Camera" icon. 2. Select a file of not png, jpg or jpeg extensions.	**Image File:** file.pdf	The tooltip box for the image field is triggered.		
UTO-009	Add organisation with invalid name in the organisation name field.	-	1. Enter an invalid name in the organisation name field. 2. Press the "Save" button.	**Name:** Bar!@ Foundation	1. The tooltip box for the organisation name field is triggered. 2. The organisation field is coloured red.		

UTO-010	Add organisation with invalid username in the system username field.	-	1. Enter an invalid username in the system username field. 2. Press the "Save" button.	**System Username:** as@!	1. The tooltip box for the system username field is triggered. 2. The system username field is coloured red.		
UTO-011	Add organisation with invalid username in the Twitter username field.	-	1. Enter an invalid username in the Twitter username field. 2. Press the "Save" button.	**Twitter Username:** @!fdwq	1. The tooltip box for the Twitter username field is triggered. 2. The system username field is coloured red.		
UTO-012	Switch organisation type.	-	1. Press the organisation type or the arrow icon.	-	The selected organisation is displayed in the		

			2. Select an organisation type.		organisation type field.		
UTO-013	Add organisation with a non-existent Twitter username.	- The Twitter username must not exist on Twitter.	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field. 3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid but non-existent username in the Twitter username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** vgadmin **Twitter Username:** sdqwdxsz1qqre12	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "The username did not exist on Twitter" is displayed.		
UTO-014	Add organisation with the same organisation name that has	- There must be an organisation with the same name	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field.	**Image:** *empty* **Name:** Childline Foundation	1. The organisation name, system username and the Twitter		

	already registered within the database.	registered in the database.	3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid username in the Twitter username field. 6. Press the "Save" button.	**Type:** Non-Government **System Username:** cfadmin **Twitter Username:** testcf5	username fields are coloured green. 2. An error message "There is already an organisation registered under the same name" is displayed.		
UTO-015	Add organisation with the same system username that has already registered within the database.	- There must be an organisation with the same system username registered in the database.	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Select an organisation type.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** mcmcadmin	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "There		

			4. Enter valid existing username in the system username field. 5. Enter valid username in the Twitter username field. 6. Press the "Save" button.	**Twitter Username:** testcf5	is already an organisation registered under the same system username" is displayed.		
UTO-016	Add organisation with the same Twitter username that has already registered within the database.	- There must be an organisation with the same system username registered in the database.	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Select an organisation type. 4. Enter valid username in the system username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** cfadmin	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "There is already an organisation		

			5. Enter valid existing username in the Twitter username field. 6. Press the "Save" button.	**Twitter Username:** testbefrienders	registered under the same Twitter username" is displayed.		
UTO-017	Add organisation with valid name, type, system username and twitter username.	-	1. Leave the image field empty. 2. Enter valid name in the organisation name field. 3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid username in the Twitter username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** cfadmin **Twitter Username:** testcf5	1. The organisation name, system username and the Twitter username fields are coloured green. 2. A pop-up modal with the message "The organisation has been successfully created. The password for the		

			6. Press the "Save" button.		organisation account is: {}." is displayed. (The curly bracket represents a randomly generated six-characters password.) 3. The add organisation modal is closed.		
UTO-018	Add organisation with valid image, name, type, system username and twitter username.	-	1. Enter valid image file in the image field. 2. Enter valid name in the organisation name field. 3. Select an organisation type.	**Image:** image.png **Name:** Vanguards **Type:** Non-Government	1. The organisation name, system username and the twitter username fields are coloured green.		

			4. Enter valid username in the system username field. 5. Enter valid username in the twitter username field. 6. Press the "Save" button.	**System Username:** cfadmin **Twitter Username:** testcf5	2. A pop-up modal with the message "The organisation has been successfully created. The password for the organisation account is: {}." is displayed. (The curly bracket represents a randomly generated six-characters password.) 3. The add organisation modal is closed.		

8.3.1.16 Pop-up Message

Table 104: Unit Test Plan - Pop-up Message

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTP-001	Close modal.	-	1. Press the "Continue" button.	-	The pop-up message modal is closed.		

8.3.2 User Acceptance Testing

Table 105: User Acceptance Test Plan

Code-Switching Cyberbullying Detection and Communication System					
Name:		**Date:**			
Role/Position:		**Time:**			
Name of category	**Score (1 = Very Poor, 5 = Very Well)**				
	1	**2**	**3**	**4**	**5**
Meet Objectives					
User Interface (Design)					
Security					
Performance (Speed)					
Easy and Convenient to Use					
Bug-free					
Input Validation					
Tester's Comment:					
Action taken by Developer:					
Signature (Tester): _____	Signature (Developer): _____				

Chapter 9: Implementation

9.1 Screenshots

9.1.1 Login Page

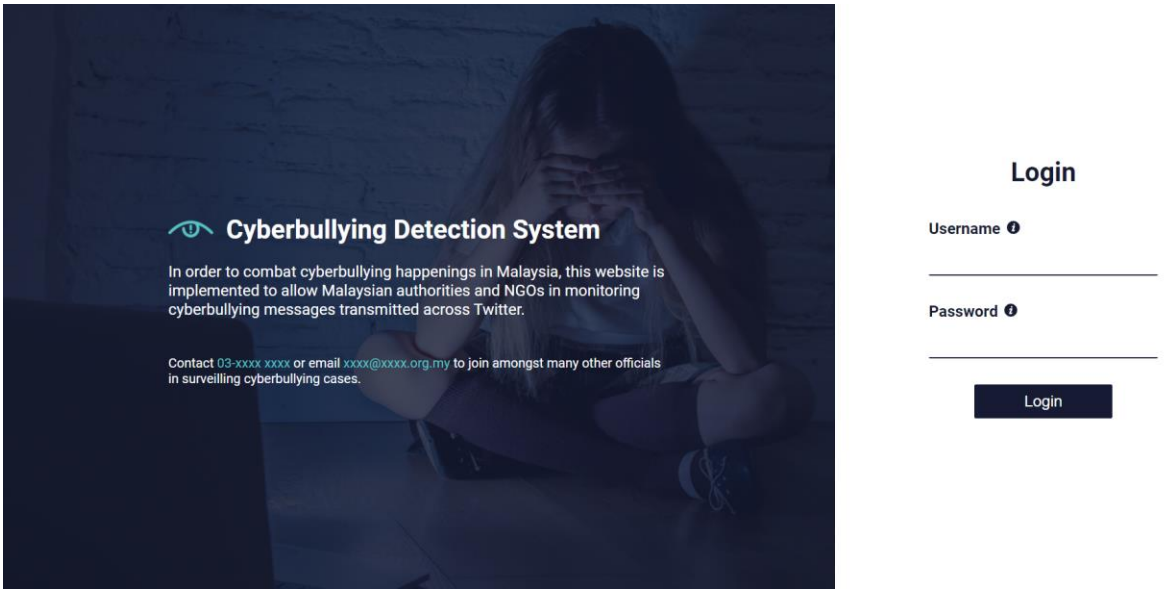


Figure 226: Screenshot - Login Page

The figure above shows the login page. By entering the correct credentials and clicking the "Login" button, the user shall be redirected to the dashboard page. There are tooltips that conveys valid input for each respective field when hovered. Fields with valid input will be indicated with green colour meanwhile invalid input will colour the field red.

9.1.1.2 Twitter Login Modal

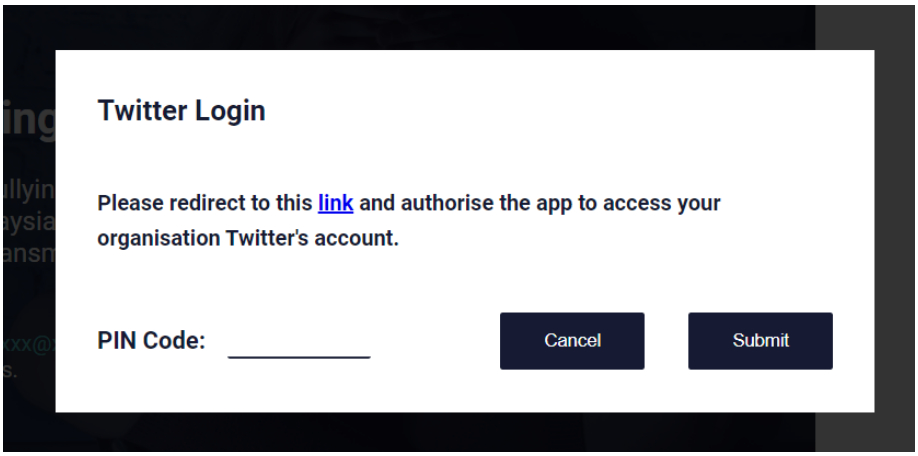


Figure 227: Screenshot - Twitter Login Modal

For the organisations who have yet authorise the app to access their Twitter account, they will be prompted the Twitter login modal as shown above in order to authorise app's access to their organisation's Twitter account.

9.1.2 Side Navigation

Figure 228: Screenshot - Side Navigation

As shown in the figure above, there are several navigation links on the left-sided navigation bar for the system users to interact with in order to access different pages. The coloured circles beside the profiles link are notifications that indicate the number of cyberbullying and cybervictim

incidents detected that are left unread, red ones represent cyberbullying incidents meanwhile the blue ones represent cybervictim incidents.

9.1.3 Dashboard Page

9.1.3.1 Bar Chart

9.1.3.1.1 Monthly Statistics

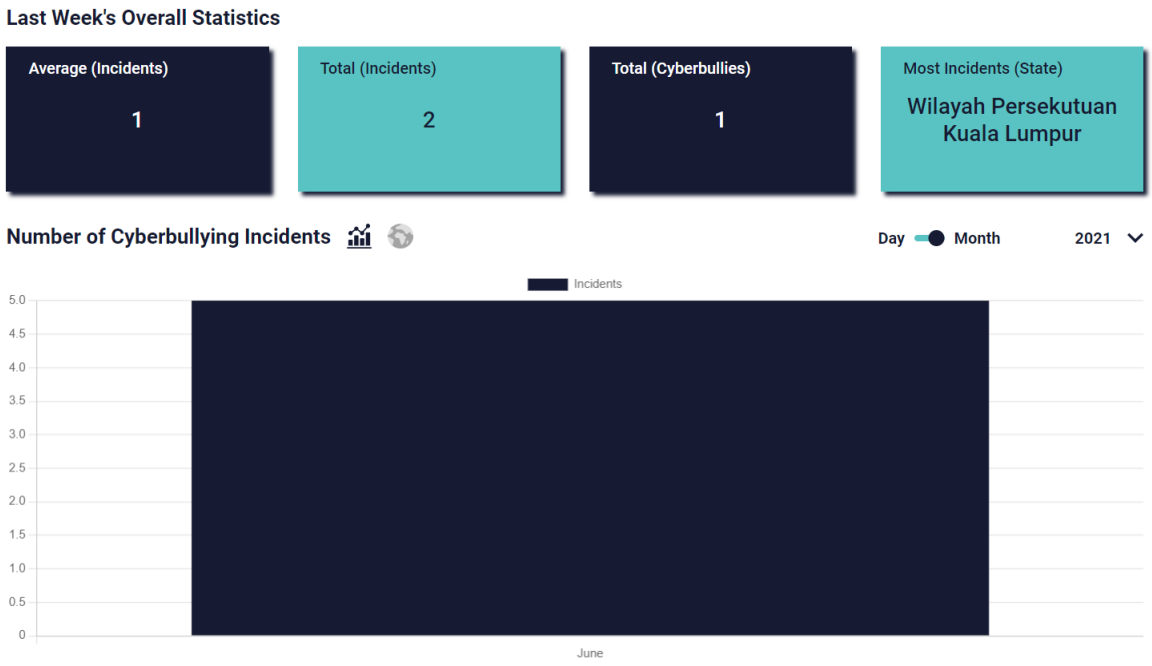


Figure 229: Screenshot - Dashboard Page (Bar Chart – Monthly Statistics)

The dashboard page displayed above illustrates last week's overall statistics of cyberbullying incidents including average cyberbullying incidents identified, total cyberbullying incidents detected, total cyberbullies involved as well as the Malaysian state with the highest cyberbullying incidents identified. Apart from that, as shown in the figure above, the statistics is in bar chart view which currently demonstrates the number of cyberbullying incidents detected in monthly basis specifically in the year 2021. The cyberbullying incidents are all extracted from the Twitter social media platform.

9.1.3.1.2 Daily Statistics

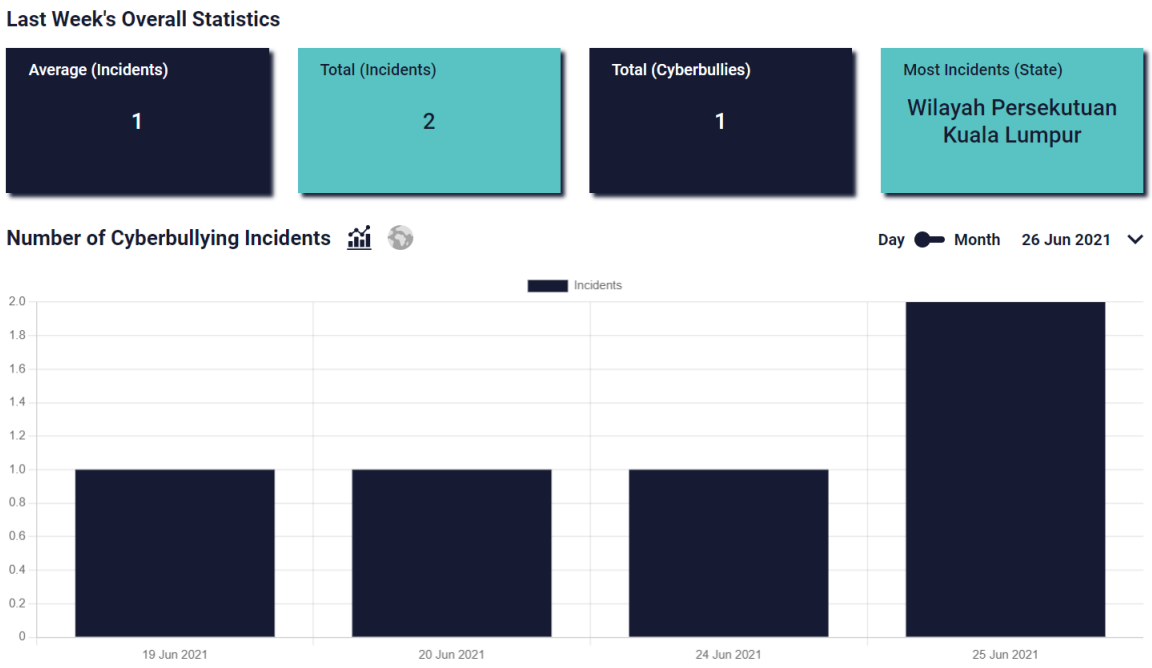


Figure 230: Screenshot - Dashboard Page (Bar Chart – Daily Statistics)

Upon switching the time mode, the bar chart-based statistics will be converted to display number of cyberbullying incidents in daily basis specifically starting from the current date up to seven dates ago. Through triggering the calendar right beside the switch, the user shall be able to view daily statistics of cyberbullying incidents from way older dates.

9.1.3.2 Map

9.1.3.2.1 Monthly Statistics

Figure 231: Dashboard Page (Map - Monthly Statistics)

Upon clicking the earth icon, the statistics will be changed from bar chart view into map view wherein Malaysia districts with cyberbullying incidents detected will be highlighted with different shades of red depending on the number of incidents relative to other districts. Currently, the map view is shown in monthly basis specifically the month of June in 2021 as shown in the figure above. As long as there are other cases detected in other months or years, the system users are free to select them whenever and the changes will be reflected on the map.

9.1.3.2.2 Daily Statistics

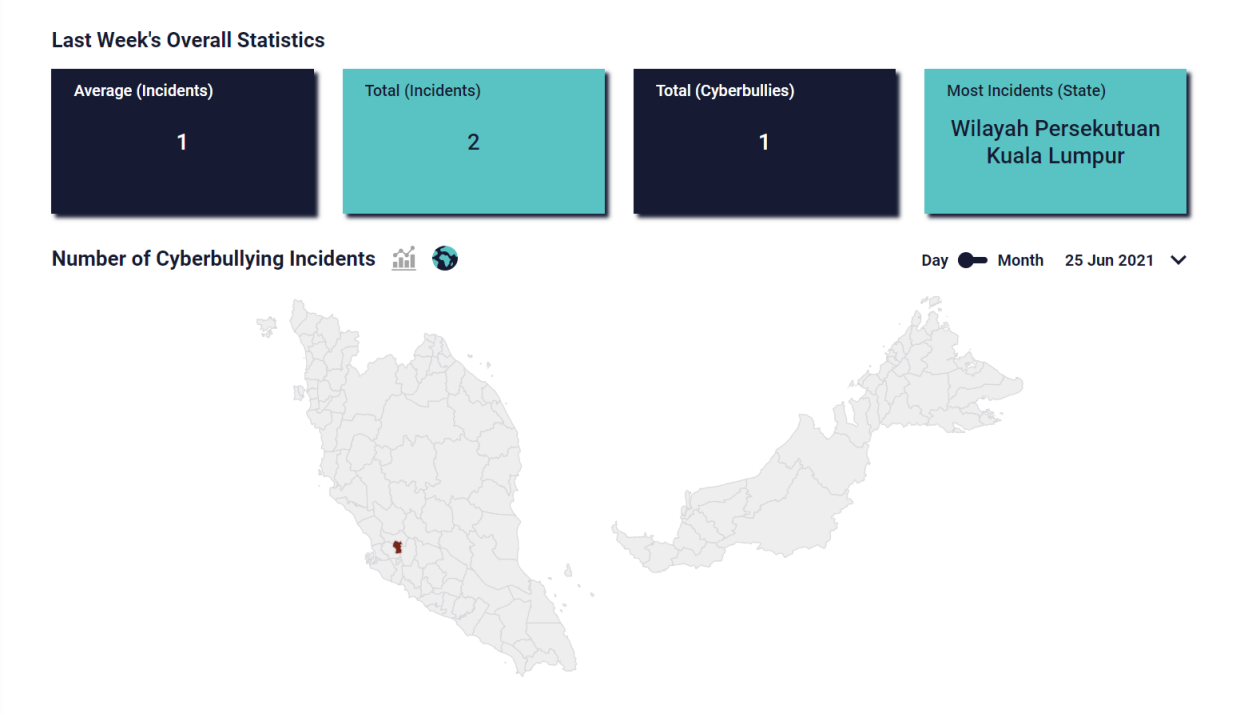


Figure 232: Dashboard Page (Map - Daily Statistics)

The figure displayed above works similarly except it display the statistics in daily basis, particularly the day selected from the calendar.

9.1.4 Profiles Page

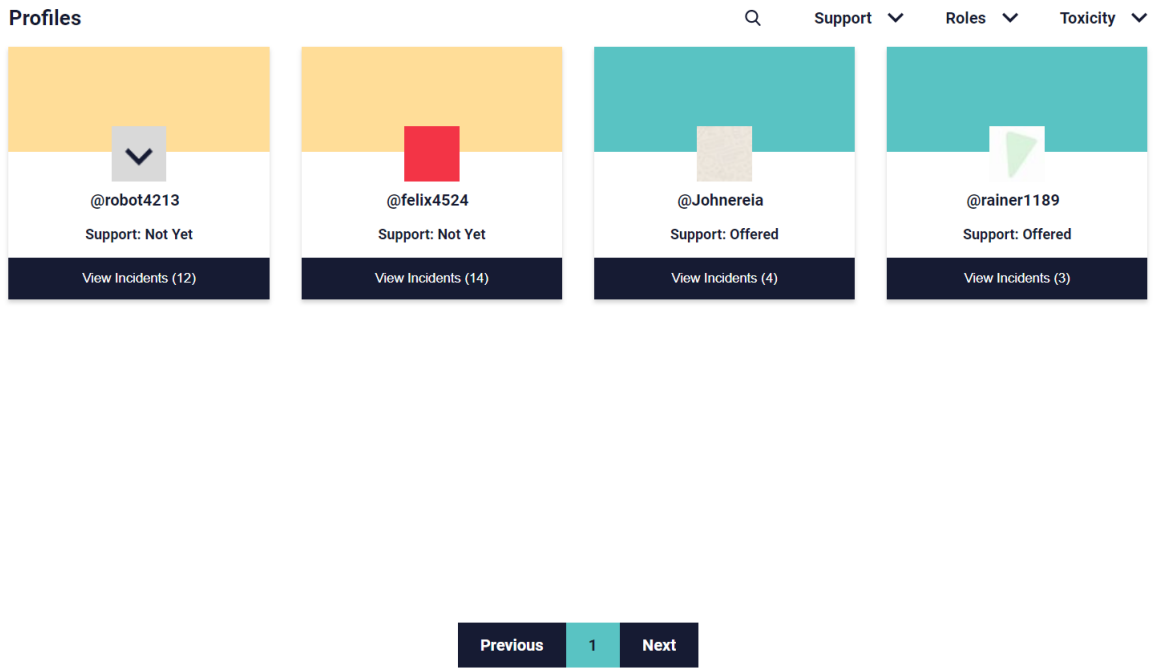


Figure 233: Screenshot - Profiles Page

The figure above shows the page filled with profiles that are identified as cyberbullies, cybervictims and even cyberbully-victims. The background colour above each profile indicates their toxicity level; The red indicates high toxicity, The orange indicates medium toxicity; The yellow indicates low toxicity meanwhile the blue indicates non-toxic, which are the cybervictims. There are also support statuses assigned to each profile that describes whether they have been offered support previously by the system users or not; Not yet indicates the profile have not been reached out; Offered indicates the profile have been given support meanwhile offered yet continues indicates the profile, despite given support, still cyberbullies others. There are also filters including search, support status, roles, toxicity and pagination that helps the system users to screen through profiles. Meanwhile, the button “View Incidents” will prompt up a modal showing the full details with regards to the incidents they were involved.

9.1.5 Profile Details Modal

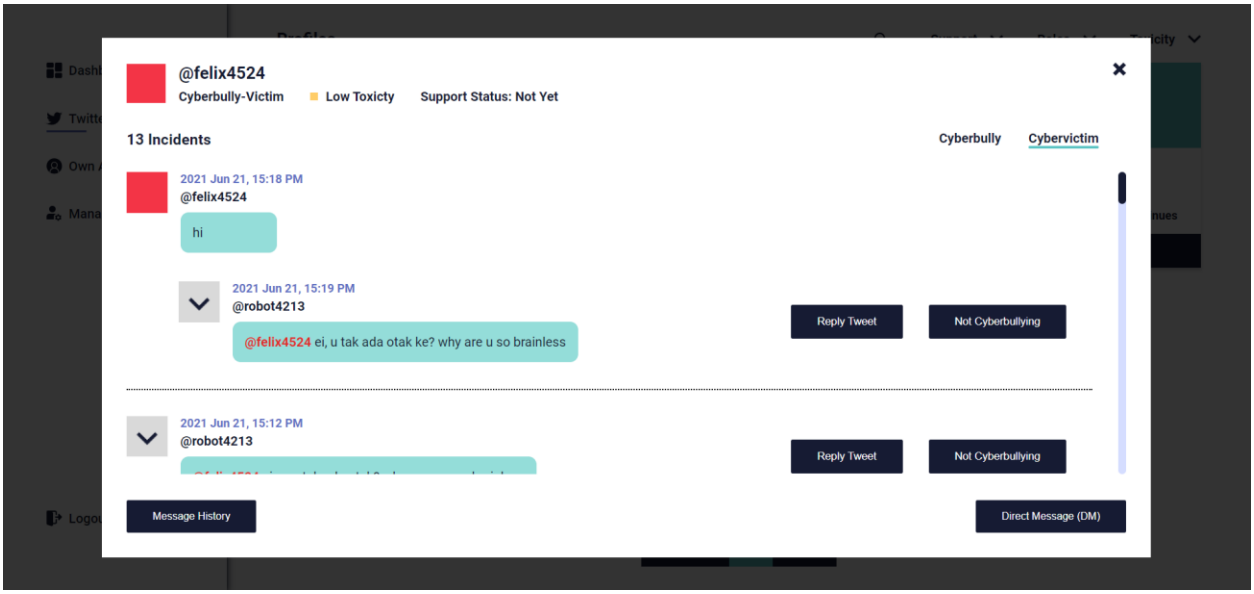


Figure 234: Screenshot - Profile Details Modal

The figure above displays the incidents the particular profile has involved in, specifically the cybervictim incidents, which can be switched to cyberbullying incidents from the filter given. On each incident, the system users are given "Not Cyberbullying" button to remove misclassified incidents as well as the "Reply Tweet" button to access functionality to offer counselling support through replying to the particular tweet directly. Meanwhile the "Direct Message (DM)" provides the system users to offer counselling support through messaging the Twitter profile privately. Moreover, the systems users can also view the history of support message provided to the profile previously.

9.1.6 Support Message Modal – Reply Tweet

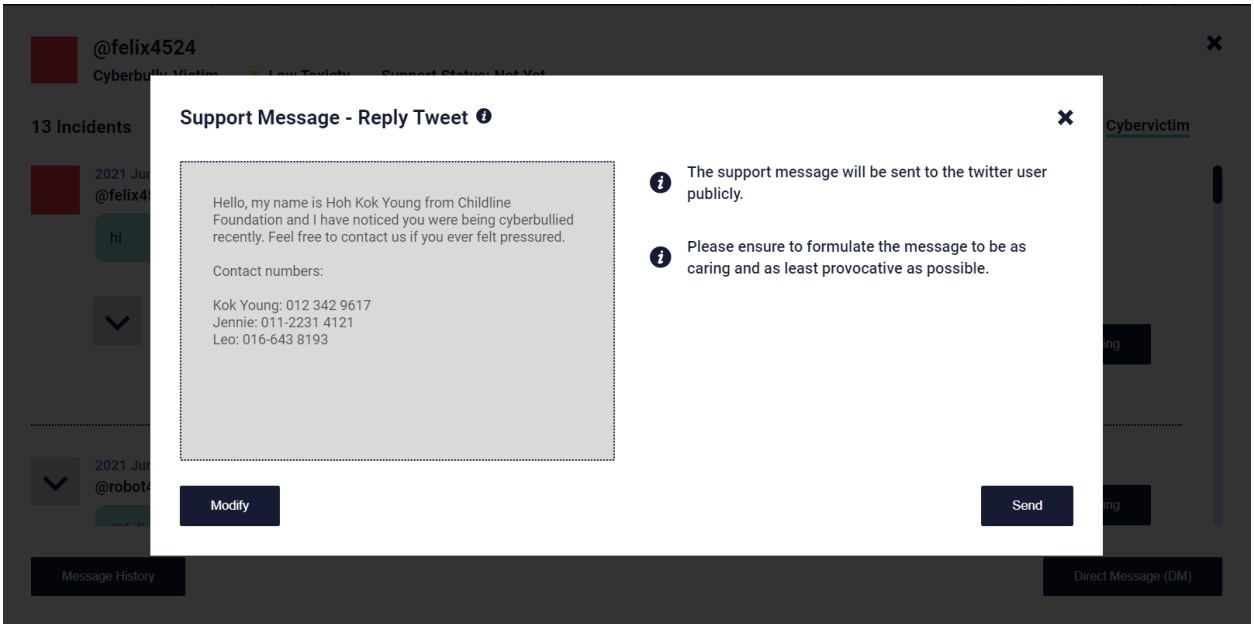


Figure 235: Screenshot - Support Message Modal (Reply Tweet)

Upon selecting reply tweet from previous interface, the user will be prompted the support message modal as shown in the figure above which grants the system users permission to either send the support message through replying to the tweet or even modify their support message to be sent. There is a tooltip that conveys valid input for the support message field when hovered.

9.1.7 Support Message Modal - Direct Message

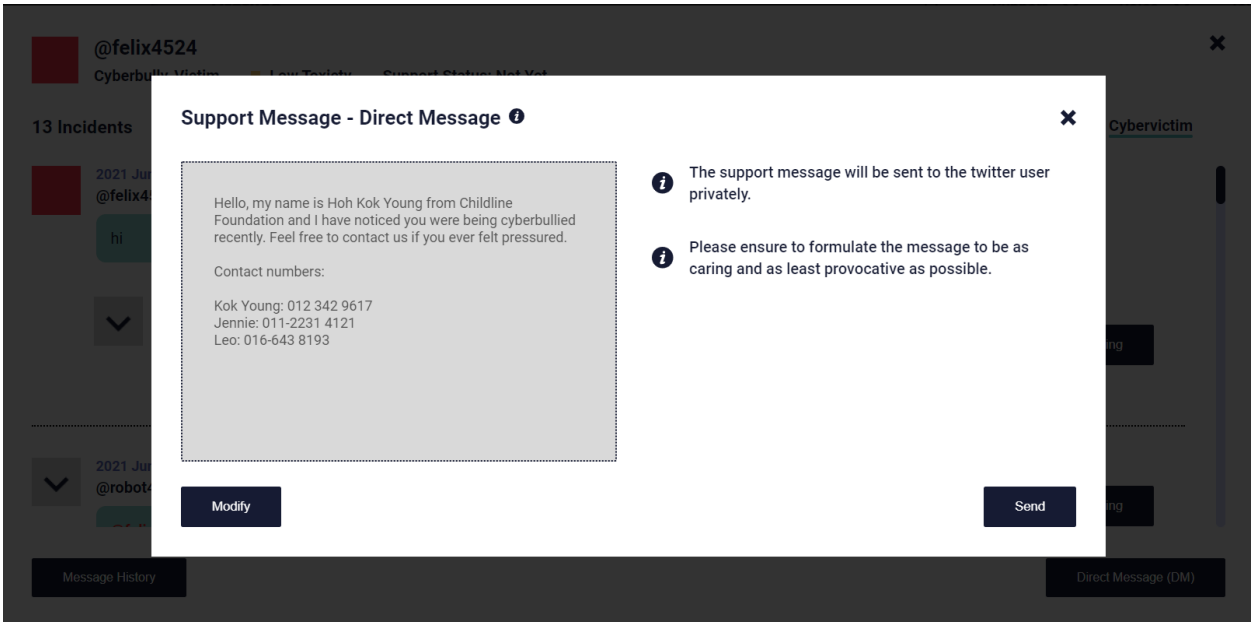


Figure 236: Screenshot - Support Message Modal (Direct Message)

The modal shown above functions the same manner as the previous figure except it is specifically for direct messaging.

9.1.8 Support Message History

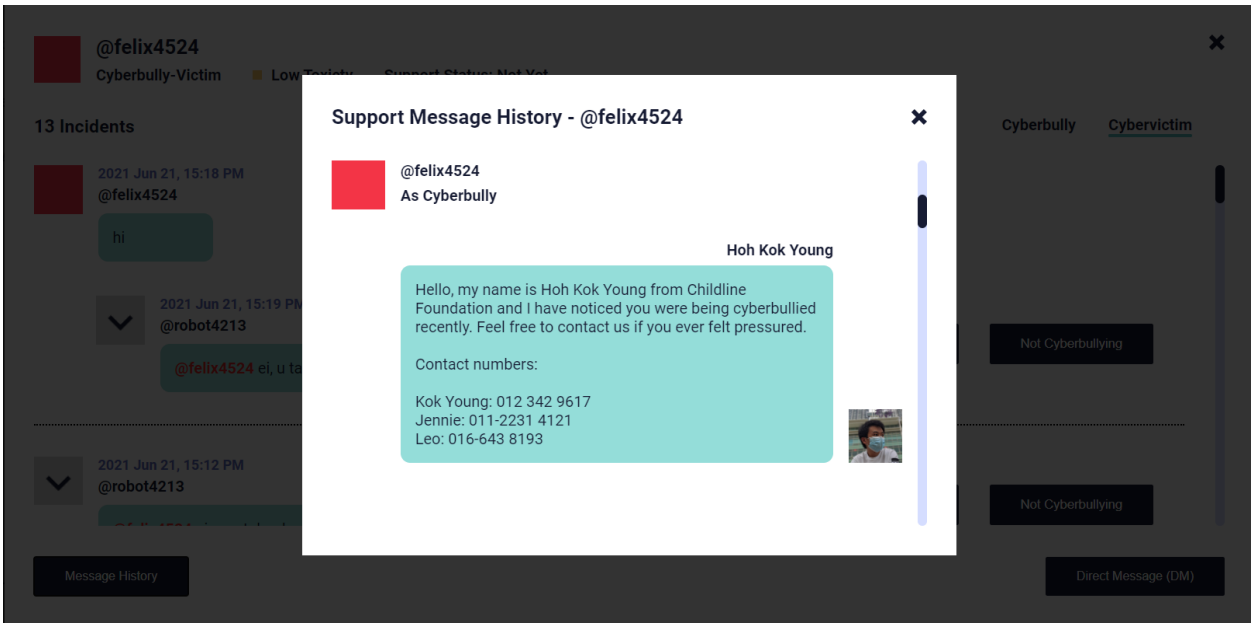


Figure 237: Screenshot - Support Message History

The figure above shows the support message history modal which contains all the support messages sent previously by the system users.

9.1.9 Organisation Page

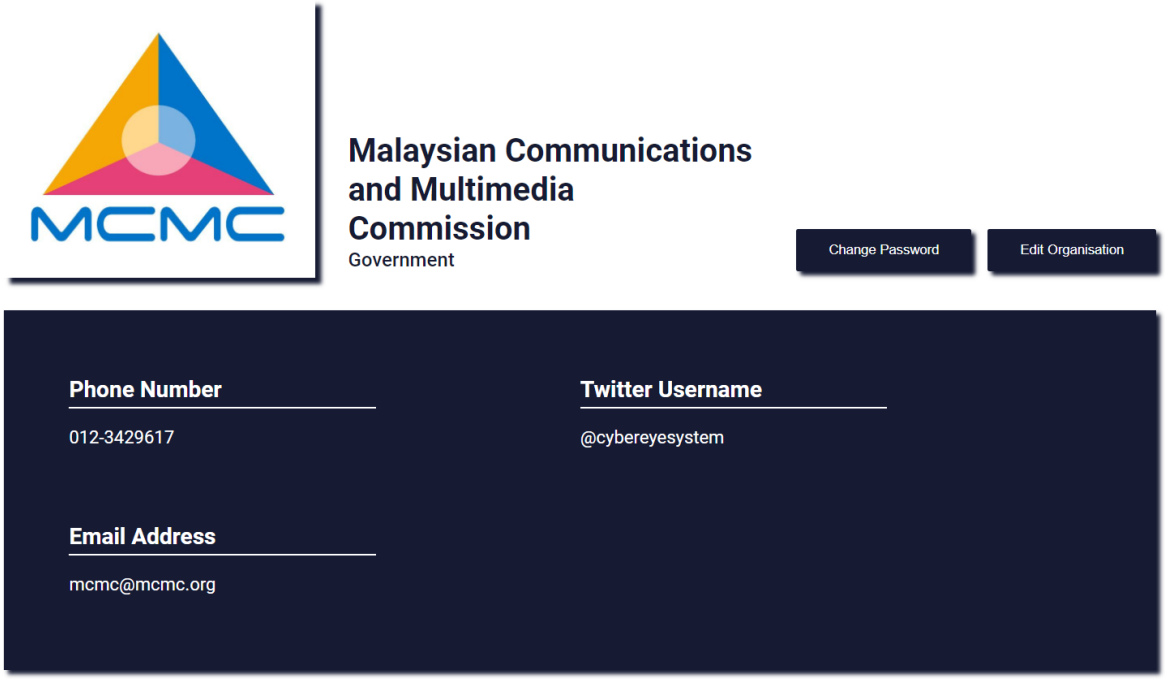


Figure 238: Screenshot - Organisation Page

The page shown above displays the authenticated organisation's information including name, type, phone number, email address and its Twitter username connected to the app. Apart from that, the system user can prompt up different modals to either change password or edit organisation details.

9.1.10 Change Password Modal

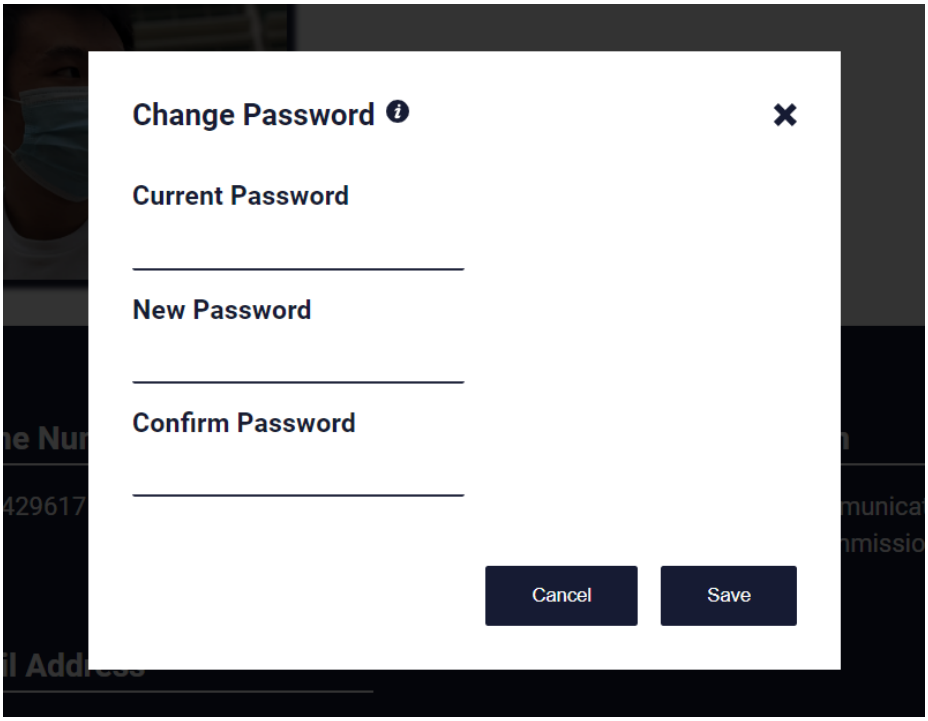


Figure 239: Screenshot - Change Password Modal

The figure above shows the change password modal wherein the system user can change their organisation password stored in the database through entering current organisation's password, new password and matching confirm password. The tooltip nearby the header conveys valid password input when hovered. Fields with valid input will be indicated with green colour meanwhile invalid input will colour the field red.

9.1.11 Edit Organisation Modal

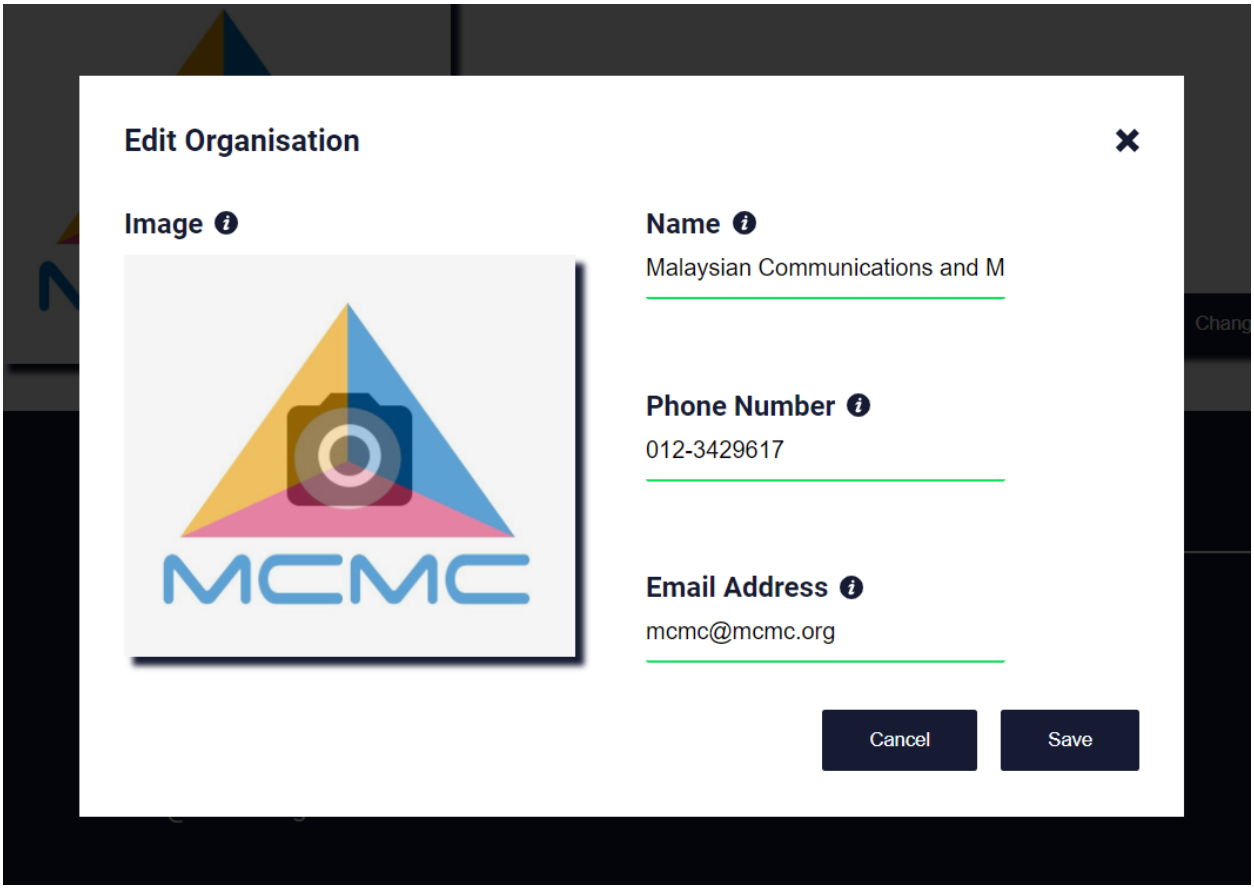


Figure 240: Screenshot - Edit Organisation Modal

The figure above displays the edit account modal wherein the system user shall be able to edit the organisation's image, name, phone number and email address. The available information is pre-loaded into the respective fields. There are tooltips that conveys valid input for each respective field when hovered. Fields with valid input will be indicated with green colour meanwhile invalid input will colour the field red.

9.1.12 Management – Organisations

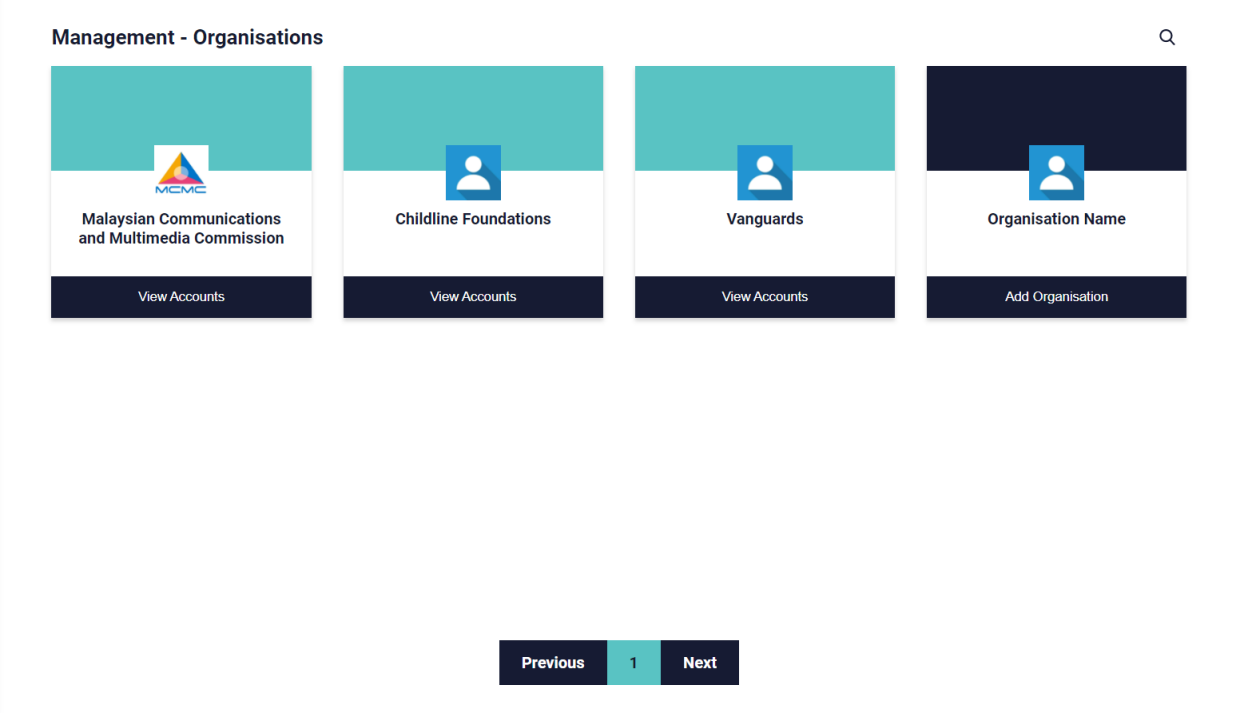


Figure 241: Screenshot - Management (Organisations)

The figure above shows the management page that contains organisations that have registered into the system, which are only viewable by the system users specifically from the government organisation. The search option as well as the pagination below helps filtering the organisations to be displayed. Apart from that, the system users from government organisation shall have the capability to prompt up a modal to add new organisation.

9.1.12.1 Management – Organisations (Backside)

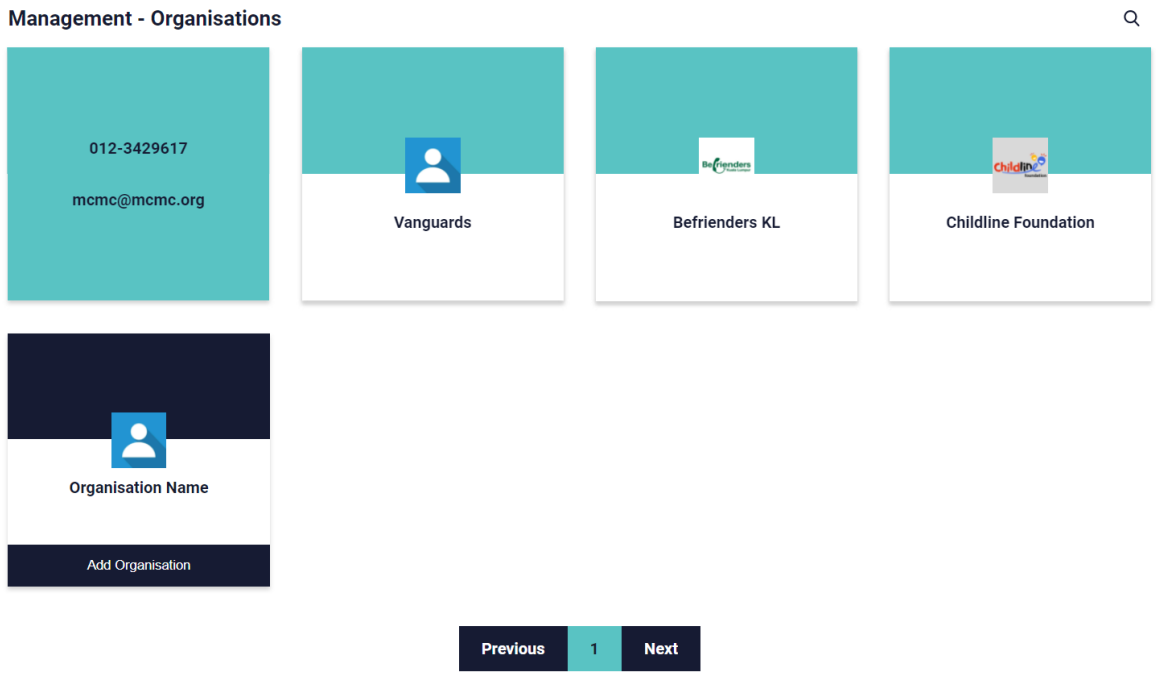


Figure 242: Screenshot - Management (Orgnisations - Backside)

Upon hovering the organisation, the organisation's phone number and email address will be displayed on the back as shown in the figure above.

9.1.13 Add Organisation Modal

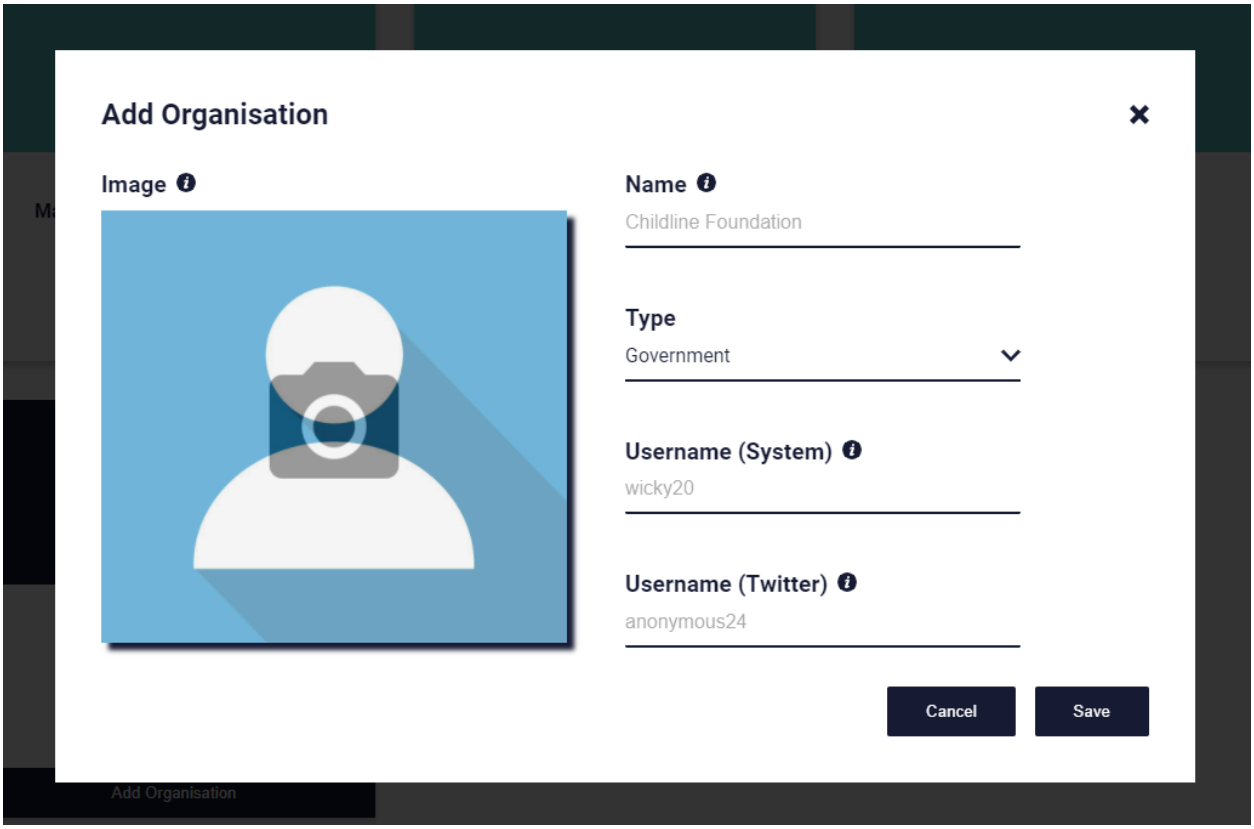


Figure 243: Screenshot - Add Organisation Modal

The figure above shows the add organisation modal wherein the system admin shall be able to add new organisation through providing the image, name, type of organisation, the username to access the system as well as the organisation's Twitter username. There are tooltips that conveys valid input for each respective field when hovered. Fields with valid input will be indicated with green colour meanwhile invalid input will colour the field red.

9.1.14 Pop-up Message

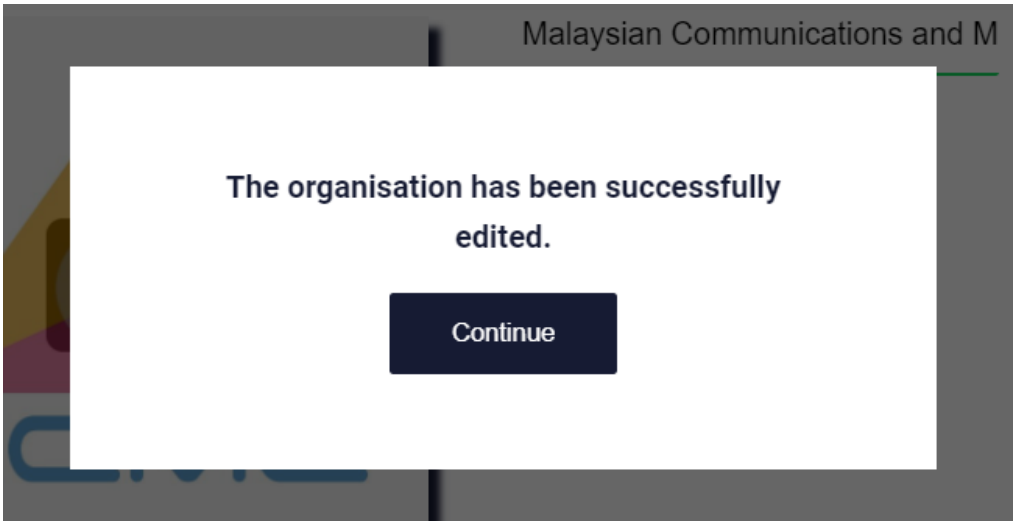


Figure 244: Screenshot - Pop-up Message

The figure above displays the pop-up message modal that was prompted up when the organisation has been successfully edited. Aside from just editing organisation, other operations including change password or send support message will prompt up similar pop-up modal as well, except only with different message depending on the status of the operation performed.

9.2 Sample Codes

9.2.1 Machine Learning Model Development

9.2.1.1 Dataset Preparation

Before a machine learning model can be trained let alone be utilised to detect cyberbullying messages, a well-defined dataset with sufficient data must first be prepared. Through thorough search, the developer has discovered an excellent dataset separated into individual json files from GitHub (Husein Zolkepli, 2021), which contains an enormous amount of data regarding toxicity within messages of code-switching languages between English and Malay. However, the dataset has also messages with language of purely English or Malay, which does not directly match the machine learning model purpose and should be removed. Therefore, prior to creating the model, the dataset underwent minor pre-processing.

First and foremost, to simplify reading the dataset later in the Colab environment, the json files are converted into csv files through online converter and then stored into the Google Drive.

```
[4] import pandas as pd
    import string
    import csv
    import re
```

Figure 245: Dataset Preparation - Import Python Libraries

Afterwards, within the Colab environment, the Python libraries as shown in the figure above are imported.

```
[2] from google.colab import drive
    drive.mount('/content/gdrive')

    Mounted at /content/gdrive
```

Figure 246: Dataset Preparation – Connect to Google Drive

Moreover, since the csv files are stored into the Google Drive, the code above are executed in order to establish a connection between Colab and Google Drive.

```
[ ] toxic_dataset_1 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-1.csv")
    toxic_dataset_2 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-2.csv")
    toxic_dataset_3 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-3.csv")
    toxic_dataset_4 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-4.csv")
    toxic_dataset_5 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-5.csv")
    toxic_dataset_6 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-6.csv")
    toxic_dataset_7 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-7.csv")
    toxic_dataset_8 = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/toxic-8.csv")
```

```
[ ] dataset = pd.concat([toxic_dataset_1, toxic_dataset_2, toxic_dataset_3, toxic_dataset_4, toxic_dataset_5, toxic_dataset_6, toxic_dataset_7, toxic_dataset_8])
```

```
[ ] dataset.head()
```

	message	toxic	severe toxic	obscene	threat	insult	identity hate
0	mengadu tentang tingkah laku mengganggu anda d...	0	0	0	0	0	0
1	, melainkan dia tidak tahu, atau cuba meletakk...	0	0	0	0	0	0
2	artikel balti anda boleh memberi pendapat meng...	0	0	0	0	0	0
3	xenophobe russian di sini tidak pernah berhent...	0	0	0	0	0	0
4	anda adalah anjing bodoh yang tidak berguna! S...	1	1	1	0	1	0

Figure 247: Data Preparation - Read and Concatenate Datasets

As shown in the figure above, the csv files within the Google Drive are read and converted into DataFrame object through the function *read_csv()*. After assigning each DataFrame object into individual variables, the next block of code is written to combine these objects into one using the function *concat()*, therefore streamlining the pre-processing endeavour later. On the other hand, the last block of code in the figure above with the method *head()* is called to view the first five rows of data, although not necessary, but it helps the developer to better understand how the data are structured and even identify whether the combination went wrong or not in which could potentially disrupt subsequent operations.

```
[ ] len(dataset)

151118
```

Figure 248: Data Preparation – Dataset Size

As displayed from the output above, the combined dataset has around 150 thousand of data. Such output provides insights to the developer in regard to the dataset size before and after the pre-processing, identifying whether the pre-processing could result in the dataset unusable or not due to too many data being removed.

```
[ ] cols_target = ["toxic", "severe toxic", "obscene", "threat", "insult", "identity hate"]
```

```
[ ] target_data = dataset[cols_target]

    dataset['score'] =dataset[cols_target].sum(axis=1)
    print(dataset['score'].value_counts())
    dataset['score'] = dataset['score'] > 0
    dataset['score'] = dataset['score'].astype(int)
    print(dataset['score'].value_counts())

    0    135692
    1      6043
    3      4003
    2      3304
    4      1680
    5       367
    6        29
    Name: score, dtype: int64
    0    135692
    1     15426
    Name: score, dtype: int64
```

Figure 249: Data Preparation - Combine Columns

Since the model will be focusing on detecting messages to be either cyberbullying and non-cyberbullying, the multiple columns or labels from the dataset are combined into one with the name "score", as shown in the code above. Thus, any messages with A score of one will be considered as cyberbullying and vice versa.

```
[ ] en_ms = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/en-ms.csv")
    en_ms.head()
```

	en	ms
0	and	dan
1	was	ws
2	for	untuk
3	that	bahawa
4	with	dgn

Figure 250: Data Preparation – Read English & Malay Word Lists

Due to the fact that the machine learning model focuses on code-switching messages, the dataset to be trained and tested should contain only code-switching messages. For the purpose of filtering the dataset to be restricted within the specified condition, the method employed would be identifying whether every single instance of message includes both English and Malay language

at the same time or not (e.g., “Hello, hari ini memang baik right?”). With that said, a plethora of English and Malay words must be obtained beforehand. Thankfully, the same source in GitHub (Husein Zolkepli, 2019), provides said requirement in which was again downloaded, converted into csv format and stored into Google Drive for implementing the method within the Colab environment. As shown in the figure above, the word lists are loaded from Google Drive in a similar fashion of applying *read_csv()* function.

```
[ ] english = False
    malay = False
    code_switching_dataset = []
    for index, row in dataset.iterrows():
      for en in en_ms["en"]:
        if en in str(row["message"]).lower().split():
          english = True
          break

      for ms in en_ms["ms"]:
        if ms in str(row["message"]).lower().split():
          malay = True
          break

      if english and malay:
        print(row)
        code_switching_dataset.append({'message': row["message"], 'score': row["score"]})

      english = False
      malay = False
```

Figure 251: Data Preparation - Filter Dataset

The block of code displayed above is written to execute the mentioned method, wherein every single instance of message within the dataset are checked based on the word lists retrieved earlier to identify whether it is code-switching or not.

```
[ ] len(code_switching_dataset)

    125324
```

Figure 252: Filtered Dataset

As shown from the output above, the filtered code-switching dataset size still contains as much as 120 thousand of data, which are more than sufficient in training the machine learning model.

```
[ ] with open('dataset.csv', 'w') as filehandler:
        write = csv.writer(filehandler)
        for listitem in code_switching_dataset:
            # filehandler.write(listitem)
            write.writerow([listitem["message"], listitem["score"]])
```

Figure 253: Data Preparation - Saving Dataset

The code written above are responsible in saving the filtered dataset under the name “dataset.csv” for the purpose of creating the machine learning model later on. The dataset saved was also downloaded and stored inside Google Drive.

	A	B
1	**message**	**score**
2	, melainkan dia tidak tahu, atau cuba meletakkan seseora	0
3	xenophobe russian di sini tidak pernah berhenti memukau	0
4	anda adalah anjing bodoh yang tidak berguna! Saya berm	1
5	kini saya memahami . saya fikir merangsang vandalisme b	0
6	untuk memberi ulasan berat sebelah yang wajar, mungkir	0
7	apa yang anda bercakap tentang apa artikel yang anda m	0
8	a block ohhhhhhhhhhhhh nooooooooooo saya soooo	1
9	hi there, saya perhatikan beberapa minggu kemudian and	0
10	terima kasih, john, untuk jawapan cepat. tetapi saya tidal	0
11	biasanya perkara yang buruk untuk mengedit pengguna p	0
12	dan cahill pasti menulis mengenai sejarah, dan menganali	0
13	vandalisme sila menahan daripada menambahkan karut k	0
14	john, anda adalah badut wikipedia dan troll. sila jangan b	1
15	saya boleh mencadangkan forum yang sesuai untuk anda	0
16	meraikan ucapan terima kasih atas kata-kata baik anda, p	0
17	Sebenarnya, saya tidak pernah membuat apa-apa kesimp	0

Figure 254: Data Preparation - Overview of Dataset

The figure above shows the overview of the dataset created after the filtering process.

9.2.1.2 Machine Learning Model Development

```
!pip install malaya
!pip install PySastrawi
!pip install -U -q PyDrive
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import io, re, random, string, nltk, malaya, pickle
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
nltk.download('stopwords')
nltk.download('wordnet')

#Machine Learning
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn import preprocessing
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier

#Deep Learning
import tensorflow as tf
from keras import layers
from keras.models import Sequential
from tensorflow.keras.layers import LSTM, MaxPool1D, Dropout, Dense, GlobalMaxPooling1D, Embedding, Activation
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
from keras.callbacks import ModelCheckpoint
from keras import backend as K

#Connect to Google Drive
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Requirement already satisfied: tensorflow>=1.15 in /usr/local/lib/python3.7/dist-packages (from malaya) (2.5.0)
Requirement already satisfied: ftfy in /usr/local/lib/python3.7/dist-packages (from malaya) (6.0.3)
Requirement already satisfied: sentencepiece in /usr/local/lib/python3.7/dist-packages (from malaya) (0.1.96)
```

Figure 255: Machine Learning Model Development – Import Python Libraries & Connect to Google Drive

First and foremost, the Python libraries necessary for data pre-processing, machine learning model development as well as deep learning model development are imported as shown above. In addition to that, the last two lines of code are included to establish connection with Google Drive, which grants the permission to read files directly from the platform later on. When developing the model for the cyberbullying detection system, employing only one algorithm towards the dataset is insufficient as comparing with other models and selecting the best ones would be must more reasonable. Therefore, during the development, there are attempts on not only machine learning

techniques but also deep learning techniques. The most reliable ones will be selected, saved and be integrated into the system.

```
[3] dataset = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/dataset.csv")
    dataset.head()
```

	message	score
0	, melainkan dia tidak tahu, atau cuba meletakk...	0
1	xenophobe russian di sini tidak pernah berhent...	0
2	anda adalah anjing bodoh yang tidak berguna! S...	1
3	kini saya memahami . saya fikir merangsang van...	0
4	untuk memberi ulasan berat sebelah yang wajar,...	0

Figure 256: Machine Learning Model Development – Read Dataset

Before the dataset can undergo pre-processing stage, the dataset stored within the Google Drive is firstly read using the *read_csv()* function and assigned to the variable *dataset*. To ensure the correct dataset was imported, the *head()* method was invoked as well to display the first five records within the dataset.

9.2.1.2.1 Data Pre-processing

```
[4] # Convert all messages to lower case
    dataset['message'] = dataset['message'].str.lower()

    # Replace email addresses with 'email'
    dataset['message'] = dataset['message'].str.replace(r'^.+@[^\.].*\.[a-z]{2,}$',
                                 'emailaddress')

    # Replace URLs with 'webaddress'
    dataset['message'] = dataset['message'].str.replace(r'^http\://[a-zA-Z0-9\-\.]+\.[a-zA-Z]{2,3}(/\S*)?$',
                                  'webaddress')

    # Replace money symbols with 'moneysymb' (£ can by typed with ALT key + 156)
    dataset['message'] = dataset['message'].str.replace(r'£|\$', 'dollers')

    # Replace 10 digit phone numbers (formats include paranthesis, spaces, no spaces, dashes) with 'phonenumber'
    dataset['message'] = dataset['message'].str.replace(r'^\(?[\d]{3}\)?[\s-]?[\d]{3}[\s-]?[\d]{4}$',
                                  'phonenumber')


    # Replace numbers with 'number'
    dataset['message'] = dataset['message'].str.replace(r'\d+(\.\d+)?', 'number')

    # Remove other symbols
    dataset['message'] = dataset['message'].apply(lambda x: ' '.join(
        term for term in x.split() if term not in string.punctuation))
```

Figure 257: Data Pre-processing – Removal & Conversion

To ensure the machine learning model is able to predict code-switching cyberbullying messages with greater consistency and effectiveness, the data being trained, tested or even predicted must go through pre-processing. As shown in the figure above, the process involves lower casing all the words within individual messages, simplifying email addresses, web URLs, money symbols, phone numbers and numbers to consistent keywords as well as removing other irrelevant symbols. Without these pre-processing, the machine learning could recognise “Hello” and “heLLO” or even “012-3429999” and “012-3429961” as different words, therefore making the prediction highly inaccurate.

```
[ ] stop_words = set(stopwords.words('english') + ['u', 'ü', 'ur', '4', '2', 'im', 'dont', 'doin', 'ure'])
    dataset['message'] = dataset['message'].apply(lambda x: ' '.join(
        term for term in x.split() if term not in stop_words))

    lem=WordNetLemmatizer()
    dataset['message'] = dataset['message'].apply(lambda x: ' '.join(
     lem.lemmatize(t, 'v') for t in x.split()))
```

Figure 258: Data Pre-processing - English Stop Words and Lemmatisation

Apart from that, the stop words, which are words that contributes zero meaning to the message such as “the” or “he” are removed as well through the help of *nltk* library. In addition to that, when dealing with text processing, the words must be lemmatised to further improve the machine learning model consistency. Lemmatisation involves converting the words to its original form meanwhile maintaining its original context such as “woke” to “wake”, “slept” to “sleep” or even “better” to “good”, unlike stemming, despite having the same objective, it performs it in a brute force manner which could lead to inaccuracies such as “troubled” to “troubl” or “changing” to “chang”. By incorporating the *WordNetLemmatizer()* instance from the *nltk* library, the lemmatisation process can be executed with ease. However, the removal of stop words and lemmatisation code shown above prioritises only on the English language. Since the machine learning model focuses on code-switching messages, the same pre-processing must be applied on the Malay language.

```
[ ] sastrawi = malaya.stem.sastrawi()
    dataset['message'] = dataset['message'].apply(lambda x: ' '.join(
     sastrawi.stem(t) for t in x.split()))

    stopwords_ms = pd.read_csv("/content/gdrive/My Drive/Datasets/Code-switching Cyberbullying Detection System/stopwords-ms.csv")
    stopwords_ms = stopwords_ms["words"].values.tolist() + ["anda", "awak", "benar", "kamu"]

    dataset['message'] = dataset['message'].apply(lambda x: ' '.join(
        term for term in x.split() if term not in stopwords_ms))
```

Figure 259: Malay Stop Words and Lemmatisation

Through the *sastrawi()* method imported from the *malaya* library, the Malay words within the messages are lemmatised individually. On the other hand, the removal of Malay stop words is performed based on the myriad of Malay stop words archived by another source in GitHub (Diaz, 2016), which was downloaded, converted into csv file and stored into Google Drive. After reading the stop words file from the Google Drive through the *read_csv()* function and assigning the DataFrame object to the *stopwords_ms* variable, the stop words are converted into list data type with several additions of Malay stop words such as“ anda” and “awak”. Only then the rows of data within the dataset are looped through to remove Malay stop words appearning in any instance of messages.

9.2.1.2.2 Exploratory Data Analysis

```
[7] from wordcloud import WordCloud
    hams = dataset['message'][dataset['score']==1]
    spam_cloud = WordCloud(width=600,height=400,background_color='black',max_words=50).generate(' '.join(hams))
    plt.figure(figsize=(10,8),facecolor='k')
    plt.imshow(spam_cloud)
    plt.axis('off')
    plt.tight_layout(pad=0)
    plt.show()
```

Figure 260: Exploratory Data Analysis – WordCloud

In order to identify whether the dataset especially the toxic messages have anomalies or inconsistencies or not, the initial stage of exploratory data analysis (EDA) is performed wherein the 50 words that appears the most amongst all the toxic messages are plotted into a diagram using the *WordCloud* instance from the *wordcloud* library. Through the clouds of words shown, several English and Malay stop words were unearthed to have not removed yet, which contributes to the addition of a few stop words mentioned within pre-processing stage.

```
[40] sns.countplot(dataset['score'])

     # Add labels
     plt.title('Count of Score')
     plt.xlabel('Score')
     plt.ylabel('Cyberbullying')
     plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:
  FutureWarning
```

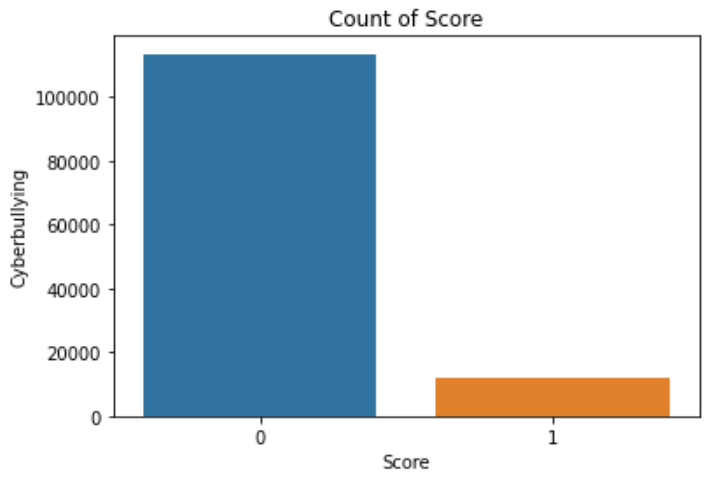


Figure 261: Exploratory Data Analysis - Imbalanced Dataset

Upon further investigations, it was discovered that the ratio of non-cyberbullying and cyberbullying messages within the dataset is immensely imbalance with roughly a 11 to 1 ratio. By feeding an imbalance training dataset towards the machine learning classifier, the model in the end will indefinitely be biased towards the majority class, in this case the model would be more likely to predict any messages as non-cyberbullying. Such occurrence is extremely not ideal because it implies that the chances of cyberbullying messages being misclassified as non-cyberbullying are higher, possibly leading to unfortunate consequences and making the model practically useless. Henceforth, to prevent such incidents from happening, the training dataset must without a doubt be balanced meanwhile the testing dataset can still be maintained regardless of its imbalance as it represents the real-life scenario much closer. There are several techniques that could be applied to resolve this issue, following in-depth research, the developer has rationalised that the technique, undersampling wherein it involves chopping down the numbers of majority class of data to match the minority ones, would be the most suitable method. However, before the undersampling technique can be performed, the entire dataset must be split first.

9.2.1.2.3 Split Training & Testing Dataset

```
[ ] X = dataset['message']
    y = dataset['score']
    X_train, X_test, y_train, y_test = train_test_split(X,y,random_state=56,test_size=.2)
```

Figure 262: Split Training & Testing Dataset

When training the machine learning model, the entire dataset must not be utilised as training set. This is due to the fact that the model must be evaluated with test data to identify its effectiveness and further be optimised or even be compared with other model that employs different technique later. Hence, As shown in the code above, the dataset is split using the *train_test_split()* function based on the variable *X* and *y* wherein 20% of the dataset are segregated as test set.

9.2.1.2.4 Undersampling

```
[10] def sample_together(n, X, y):
         rows = random.sample(np.arange(0,len(X.index)).tolist(),n)
         return X.iloc[rows,], y.iloc[rows,]

     def undersample(X, y, under = 0):
         y_min = y[y == 1]
         y_max = y[y == 0]
         X_min = X.filter(y_min.index,axis = 0)
         X_max = X.filter(y_max.index,axis = 0)

         X_under, y_under = sample_together(len(y_min.index), X_max, y_max)

         X = pd.concat([X_under, X_min])
         y = pd.concat([y_under, y_min])
         return X, y

     X_train, y_train = undersample(X_train, y_train)
```

Figure 263: Undersampling – undersample() Function

Right after the dataset was split, the undersampling technique can then be performed. As shown in the figure above, the function, *undersample()* to execute undersampling has been formulated. By passing the training dataset including the messages as well as its respective scores to the *undersample()* function, the training dataset would then be balanced in terms of the scores.

```
[11] sns.countplot(y_train)

     # Add labels
     plt.title('Count of Score')
     plt.xlabel('Score')
     plt.ylabel('Cyberbullying')
     plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py
  FutureWarning
```

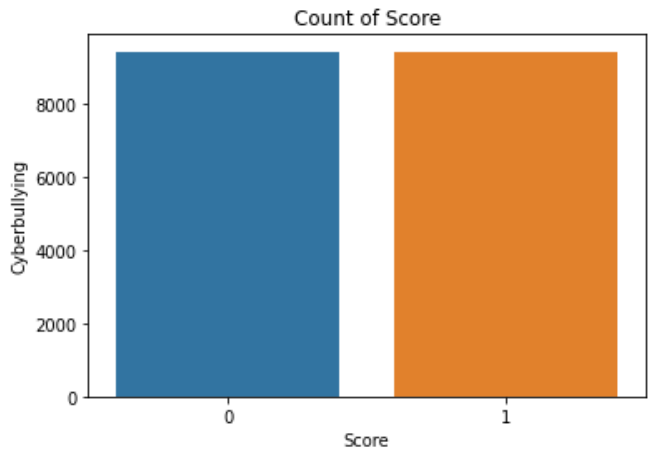


Figure 264: Undersampling – Result

As shown in the seaborn plot above, both the non-cyberbullying data and the cyberbullying data within the training dataset are properly balanced, despite numerous data being removed, the trained model will undoubtedly perform more effectively.

9.2.1.2.5 Word Vectorization

Within the natural language processing context, word vectorization refers to the encoding of texts into vector of numbers, basically array of numbers. Such process is absolutely necessary because machine learning can only process numerical data.

```
[ ] tf_vec = TfidfVectorizer(max_features = 5000)
    X_train = tf_vec.fit_transform(X_train)
    X_test = tf_vec.transform(X_test)
```

Figure 265: Word Vectorization - TF-IDF

There are several techniques when vectorizing the texts such as Bag-of-Words (BoW) or TF-IDF. For the machine learning model, the TF-IDF technique was employed against the training-based messages using the *fit_transform()* method as shown above, with a maximum features or dimensions of five thousand words. The *fit_transform()* method consists of two operations, fitting and transforming as implied in its name. Fitting involves learning and creating the vocabulary dictionary of all the tokens amongst the data meanwhile transforming maps the tokens of data to the position learned earlier. The tokens referred here belongs to the fundamental process known as tokenisation, wherein the messages are split into individual words, which was inherently performed during the invocation of *fit_transform()* and *transform()* method. In addition to that, the said threshold was defined to prevent the machine learning model from overfitting, a phenomenon where the model handles the training dataset too closely it cannot generalise on other data reliably. Subsequently, the testing dataset is transformed using the trained vectorizer as well so that both training and testing dataset can be applied amongst a variety of machine learning algorithms.

9.2.1.2.6 Machine Learning Model

```
[14] # LogisticRegression
     lg = LogisticRegression(C=1, max_iter = 3000, random_state=42)

     lg.fit(X_train, y_train)

     y_pred_train = lg.predict(X_train)
     print('Training accuracy is {}'.format(accuracy_score(y_train, y_pred_train)))
     y_pred_test = lg.predict(X_test)
     print('Test accuracy is {}'.format(accuracy_score(y_test,y_pred_test)))
     print(confusion_matrix(y_test,y_pred_test))
     print(classification_report(y_test,y_pred_test))
```

```
Training accuracy is 0.8889006566405423
Test accuracy is 0.8825453820067823
[[20204  2555]
 [  389  1917]]
              precision    recall  f1-score   support

           0       0.98      0.89      0.93     22759
           1       0.43      0.83      0.57      2306

    accuracy                           0.88     25065
   macro avg       0.70      0.86      0.75     25065
weighted avg       0.93      0.88      0.90     25065
```

Figure 266: Logistic Regression

```
[16] dt = DecisionTreeClassifier(max_depth=1000)

     dt.fit(X_train, y_train)
     y_pred_train = dt.predict(X_train)
     print('Training accuracy is {}'.format(accuracy_score(y_train, y_pred_train)))
     y_pred_test = dt.predict(X_test)
     print('Test accuracy is {}'.format(accuracy_score(y_test,y_pred_test)))
     print(confusion_matrix(y_test,y_pred_test))
     print(classification_report(y_test,y_pred_test))
```

```
Training accuracy is 0.9966108875238296
Test accuracy is 0.7735487731897067
[[17637  5122]
 [  554  1752]]
              precision    recall  f1-score   support

           0       0.97      0.77      0.86     22759
           1       0.25      0.76      0.38      2306

    accuracy                           0.77     25065
   macro avg       0.61      0.77      0.62     25065
weighted avg       0.90      0.77      0.82     25065
```

Figure 267: Decision Tree

```
[17] rf = RandomForestClassifier(max_depth = 1000)

     rf.fit(X_train, y_train)
     y_pred_train = rf.predict(X_train)
     print('Training accuracy is {}'.format(accuracy_score(y_train, y_pred_train)))
     y_pred_test = rf.predict(X_test)
     print('Test accuracy is {}'.format(accuracy_score(y_test,y_pred_test)))
     print(confusion_matrix(y_test,y_pred_test))
     print(classification_report(y_test,y_pred_test))
```

```
Training accuracy is 0.9966108875238296
Test accuracy is 0.8825453820067823
[[20332  2427]
 [  517  1789]]
              precision    recall  f1-score   support

           0       0.98      0.89      0.93     22759
           1       0.42      0.78      0.55      2306

    accuracy                           0.88     25065
   macro avg       0.70      0.83      0.74     25065
weighted avg       0.92      0.88      0.90     25065
```

Figure 268: Random Forest

```
[18] ada=AdaBoostClassifier(n_estimators=100)
     ada.fit(X_train, y_train)
     y_pred_train = ada.predict(X_train)
     print('Training accuracy is {}'.format(accuracy_score(y_train, y_pred_train)))
     y_pred_test = ada.predict(X_test)
     print('Test accuracy is {}'.format(accuracy_score(y_test,y_pred_test)))
     print(confusion_matrix(y_test,y_pred_test))
     print(classification_report(y_test,y_pred_test))
```

```
Training accuracy is 0.8293793687778013
Test accuracy is 0.8802712946339517
[[20332  2427]
 [  574  1732]]
              precision    recall  f1-score   support

           0       0.97      0.89      0.93     22759
           1       0.42      0.75      0.54      2306

    accuracy                           0.88     25065
   macro avg       0.69      0.82      0.73     25065
weighted avg       0.92      0.88      0.89     25065
```

Figure 269: AdaBoost

```
[19] mnb = MultinomialNB(alpha=0.5)
     mnb.fit(X_train, y_train)
     y_pred_train = mnb.predict(X_train)
     print('Training accuracy is {}'.format(accuracy_score(y_train, y_pred_train)))
     y_pred_test = mnb.predict(X_test)
     print('Test accuracy is {}'.format(accuracy_score(y_test,y_pred_test)))
     print(confusion_matrix(y_test,y_pred_test))
     print(classification_report(y_test,y_pred_test))
```

```
Training accuracy is 0.8752912518534209
Test accuracy is 0.8578096947935369
[[19557  3202]
 [  362  1944]]
              precision    recall  f1-score   support

           0       0.98      0.86      0.92     22759
           1       0.38      0.84      0.52      2306

    accuracy                           0.86     25065
   macro avg       0.68      0.85      0.72     25065
weighted avg       0.93      0.86      0.88     25065
```

Figure 270: Multinomial Naïve Bayes

As mentioned previously, in order to attain the most effective and accurate model to be utilised in predicting cyberbullying messages streamed from Twitter, multiple techniques must be applied. As such, several algorithms imported from the *sklearn* library including logistic regression, decision tree, random forest, AdaBoost and multinomial naïve bayes were employed onto the

training dataset to fit the model. Each model are then evaluated using the *confusion_matrix()* and the *classification_report()* functions which displays information such as true false positives and negatives as well as the precision, recall and f1-score of the prediction. After studying and researching on matters regarding the machine learning field for a while, the developer has realised that the accuracy of the models does not directly translate that the model is effective, especially when identifying cyberbullying cases being the main objective of the model and predicting the test dataset with huge differences between cyberbullying and non-cyberbullying data. For instance, assuming there are 99 non-cyberbullying messages and 1 cyberbullying message within the test dataset and the model predicted all of those messages as non-cyberbullying, the accuracy of the model still remains as high as 99%, making the model utterly useless despite having such high accuracy. The main category to prioritise when assessing the model would be the recall score. Recall in a literal sense is defined as the number of true positives divided by the total number of true positives and false negatives. For example, there are 100 cyberbullying messages and 1 non-cyberbullying message within the test dataset and the model correctly predicts 80 of the messages were cyberbullying while 21 of the messages as non-cyberbullying, there recall score based on its definition would be calculated as 80 / (80 + 20), making the model being as accurate as 80% of the time in predicting cyberbullying messages. Basically, high recall score means model is capable to predict the relevant class accurately. Sometimes, greater recall score could be a trade-off for lower precision score, the total number of true positives divided by the total number of total positives and false positives, because in this context, the model would be more prone to predict non-cyberbullying messages as cyberbullying. However, with the objectives in mind, the said trade-off is undoubtedly more than tolerable and reasonable. As the statistics regarding the effectiveness of the machine learning has been retrieved, the deep learning techniques will be applied on the dataset as well to identify in overall which model performs the best and be integrated into the system.

9.2.1.2.7 Deep Learning Model

```
[20] max_words = 5000
     max_len = 200

     X = dataset['message']
     y = dataset['score']
     X_train, X_test, y_train, y_test = train_test_split(X,y,random_state=56,test_size=.2)
     X_train, y_train = undersample(X_train, y_train)

     # Fit/Train tokenizer based on train dataset
     tokenizer = Tokenizer(num_words=max_words)
     tokenizer.fit_on_texts(X_train)
     sequences = tokenizer.texts_to_sequences(X_train)
     X_train = pad_sequences(sequences, maxlen=max_len)

     # Transform X_test based on fitted tokenizer
     sequences = tokenizer.texts_to_sequences(X_test)
     X_test = pad_sequences(sequences, maxlen=max_len)
```

Figure 271: Split, Undersample & Tokenize Dataset

Similar to previous steps, first and foremost, the original dataset is split using the *train_test_split()* function. The train dataset is then balanced using the formerly created *undersample()* function to prevent bias within the deep learning model. However, instead of vectorizing immediately, the messages within the dataset only have to be tokenized at the initial stage, which was performed using the *Tokenizer* instance. Similar to vectorizer and models, the tokenizer needs to be fitted against the train dataset before transforming them into individual tokens. Using the same hyperparameter as the previous vectorizer of maximum five thousand words, the tokenizer is then fitted based on the train dataset. One the tokenizer has been fitted, the training dataset and testing dataset are tokenized using the tokenizer alongside its method, *texts_to_sequences()*. Apart from that, the function *pad_sequences()* was applied to the respective tokenized dataset to ensure each data possess the same length before being utilised for training and testing.

```
[12] model = Sequential()
     model.add(layers.Embedding(max_words, 256))
     model.add(layers.LSTM(128,dropout=0.5))
     model.add(layers.Dense(16, activation='relu'))
     model.add(layers.Dropout(0.8))
     model.add(layers.Dense(8, activation='relu'))
     model.add(layers.Dropout(0.8))
     model.add(layers.Dense(1,activation='sigmoid'))
     model.compile(optimizer='adam',loss='binary_crossentropy', metrics=['accuracy', tf.keras.metrics.Recall() , tf.keras.metrics.Precision()])
     checkpoint = ModelCheckpoint("model.hdf5", monitor='val_accuracy', verbose=1,save_best_only=True, mode='auto', period=1,save_weights_only=False)
     history = model.fit(X_train, y_train, epochs=10, validation_data=(X_test, y_test),callbacks=[checkpoint])

     WARNING:tensorflow:`period` argument is deprecated. Please use `save_freq` to specify the frequency in number of batches seen.
     Epoch 1/10
     591/591 [==============================] - 242s 379ms/step - loss: 0.6767 - accuracy: 0.5506 - recall: 0.6992 - precision: 0.5232 - val_loss: 0.4

     Epoch 00001: val_accuracy improved from -inf to 0.86152, saving model to model.hdf5
     Epoch 2/10
     591/591 [==============================] - 227s 384ms/step - loss: 0.6072 - accuracy: 0.6629 - recall: 0.8420 - precision: 0.5260 - val_loss: 0.4
```

Figure 272: LSTM Deep Learning Model

The figure above displays the inner architecture of the deep learning model using specifically the technique long short-term memory (LSTM), a recurrent neural network-based model together with the Adam optimizer, a stochastic gradient descent algorithm to minimise its loss function. The deep learning model then, through the *fit()* method, learns the training dataset across 10 epochs or iterations meanwhile the *ModelCheckpoint()* object instantiated will be saving the model with the highest accuracy achieved amongst the epochs executed.

```
[17] y_pred = model.predict(X_test, batch_size=64, verbose=1)
     y_pred_bool = []
     for item in y_pred:
       if item[0] > 0.5:
         y_pred_bool.append(1)
       else:
         y_pred_bool.append(0)
     print(confusion_matrix(y_test, rofl))
     print(classification_report(y_test, rofl))

     392/392 [==============================] - 50s 129ms/step
     [[18089  4670]
      [  249  2057]]
                   precision    recall  f1-score   support

                0       0.99      0.79      0.88     22759
                1       0.31      0.89      0.46      2306

            accuracy                           0.80     25065
           macro avg       0.65      0.84      0.67     25065
        weighted avg       0.92      0.80      0.84     25065
```

Figure 273: Confusion Matrix & Classification Report of Deep Learning Model

To gauge the performance of the deep learning model in a more succinct and clearer manner. the same functions, *confusion_matrix()* and *classification_report()* previously applied to the machine learning models are utilised. By restricting a threshold of 0.5, any predicted value from the deep

learning model using the *predict()* method surpasses the threshold shall be declared as cyberbullying and vice versa. After comparing the machine learning models as well as the deep learning models, the logistic regression model was determined as the most suitable model to be integrated into the system. Despite the emphasis on the recall score earlier and the deep learning model having to achieve the highest recall score, its precision score unfortunately was exceedingly low. Although trade-offs are necessary, the deep learning model predicts way too many non-cyberbullying messages as cyberbullying, which can be an annoyance and hassle for the system users to view all of them, let alone removing them. However, since the logistic regression model was able to achieve a satisfactory recall score meanwhile maintaining a reasonable precision score, the model will be employed within the system to predict future cyberbullying messages streaming from Twitter.

```
[25] # saving
     with open('tf_vec.pkl', 'wb') as handle:
         pickle.dump(tf_vec, handle, protocol=pickle.HIGHEST_PROTOCOL)

     with open('model.pkl', 'wb') as handle:
         pickle.dump(lg, handle, protocol=pickle.HIGHEST_PROTOCOL)
```

Figure 274: Save Tokenizer & Model

Since the logistic regression model was ultimately decided as the best model in predicting cyberbullying messages, the model including the fitted vectorizer will be saved using the *pickle* library as shown in the figure above, downloaded and to be integrated into the system later.

9.2.2 Detect Cyberbullying Tweets

The proposed system as mentioned previously should, by default, automatically Malaysia-based tweets from Twitter in real-time and detect whether any code-switching cyberbullying tweets are being posted. The current section describes how the feature was exactly built.

```
67  auth = tweepy.OAuthHandler(app.config["CONSUMER_KEY"], app.config["CONSUMER_SECRET_KEY"])
68  auth.set_access_token(app.config["ACCESS_TOKEN"], app.config["ACCESS_SECRET_TOKEN"])
69
70  api = tweepy.API(auth)
```

Figure 275: Detect Cyberbullying Tweets - Obtain Twitter API Access

For starters, in order to access the Twitter API for the system to perform actions such as retrieving tweets or direct messaging other accounts, the system must first obtain the permission through providing the necessary authentication information. In line 67, the consumers keys acquired from the Twitter Developer Portal which was stored under the *.env* file, was imported using the *app.config* code, passed into the *OAuthHandler()* instance and then assigned to the *auth* variable. Immediately after, further authentication information was required wherein a particular Twitter account, in this case, the *@cybereyesystem* account's access tokens are provided as arguments to the *set_access_token()* method, called by the *auth* variable. Finally, the system shall be able to employ the Twitter API by instantiating the *API()* object with the complete authentication details.

```
194  class StreamListener(tweepy.StreamListener):
195      def on_status(self, data):
196          #Filter tweets with only mentioned users.
197          mentioned_user_ids = [user_mention["id"] for user_mention in data.entities["user_mentions"]]
198
199          if mentioned_user_ids:
```

Figure 276: Stream Listener – Check Mentioned Tweet

Before the tweets are streamed, the operations run internally are overwritten beforehand through inheriting the *StreamListener* class from *tweepy* library and modifying the *on_status()* method so that the tweets can be recorded into the database under certain conditions achieved. Upon receiving a tweet, the tweet will not be considered as harmful nor cyberbullying at all if the tweet did not mention or tag any other Twitter users, which was imposed in line 197 and line 199. If the tweet does mention anyone, the machine learning model trained previously will be responsible in identifying whether the tweet message is cyberbullying or not. This implies that the tweet must first be pre-processed and vectorized to ensure the model can predict more reliably.

```python
def preprocess_text(message):
    message = message.lower()
    message = message.replace(r"^.+@[^\.].*\.[a-z]{2,}$",
                              "emailaddress")
    message = message.replace(r"^http\://[a-zA-Z0-9\-\.]+\.[a-zA-Z]{2,3}(/\S*)?$",
                              "webaddress")
    # Replace numbers with "numbr"
    message = message.replace(r"\d+(\.\d+)?", "number")


    message = " ".join(term for term in message.split() if term not in string.punctuation)

    stop_words = set(stopwords.words("english") + ["u", "ü", "ur", "4", "2", "im", "dont", "doin", "ure"])
    message = " ".join(term for term in message.split() if term not in stop_words)

    lem=WordNetLemmatizer()
    message = " ".join(lem.lemmatize(t, "v") for t in message.split())

    sastrawi = malaya.stem.sastrawi()
    message =  " ".join(sastrawi.stem(t) for t in message.split())

    stopwords_ms = pandas.read_csv(os.path.join(app.root_path, 'stopwords-ms.csv'))
    stopwords_ms = stopwords_ms["words"].values.tolist() + ["anda", "awak", "benar", "kamu"]

    message = " ".join(term for term in message.split() if term not in stopwords_ms)
    return message
```

Figure 277: preprocess_text() Function

The figure above shows the *preprocess_text()* function wherein it is liable in pre-processing the tweet message. The pre-processing steps are similar during the training of the model which includes conversion of symbols to keywords, removal of symbols and stop words as well as lemmatisation in both English and Malay context.

```python
        #!Machine learning model predicts cyberbullying tweets.
        #Text Preprocessing
        message = preprocess_text(data.text)

        with open(os.path.join(app.root_path, 'tf_vec.pkl'), 'rb') as handle:
            tf_vec = pickle.load(handle)
        message = tf_vec.transform([message])

        # with open(os.path.join(app.root_path, 'tokenizer.pickle'), 'rb') as handle:
        # tokenizer = pickle.load(handle)

        # sequence = tokenizer.texts_to_sequences([message])
        # message = pad_sequences(sequence, maxlen=200)
        with open(os.path.join(app.root_path, 'model.pkl'), 'rb') as handle:
            model = pickle.load(handle)
        prediction = model.predict(message)[0]
```

Figure 278: Stream Listener – Pre-process, Vectorize & Predict Tweet Message

Right after the tweet message was pre-processed using the *preprocess_text()* function, the vectorizer that was previously fitted against the training set was loaded using the *pickle* library so that it can vectorize the pre-processed tweet message as shown in line 207. At last, the logistic regression machine learning model trained previously was loaded using the *pickle* library again so that it can predict whether tweet message is cyberbullying or not. The prediction result retrieved from executing the *predict()* method is stored in the *prediction* variable.

```
220            if prediction == 1:
221            # if True:
222                #Convert milliseconds of timestamps to local date.
223                date = convert_to_date(int(data.timestamp_ms) / 1000)
224
225                print(json.dumps(data._json, indent=4, sort_keys=True))
226
227                cyberbullying_incident = {
228                    "id": data.id,
229                    "type": "cyberbullying",
230                    "message": data.text,
231                    "created_at": date,
232                }
```

Figure 279: Stream Listener – Format Date & Cyberbullying Incident

```
86  def convert_to_date(timestamp):
87      return datetime.datetime.fromtimestamp(timestamp)
```

Figure 280: convert_to_date() Function

If the tweet message was predicted to have cyberbullying connotation which was indicated through the value, one, several data will be processed to be stored in the database later. As show in line 223 and the *convert_to_date()* function implementation, the timestamp retrieved was converted into local date. Afterwards, the tweet's Twitter ID, message, date its self-defined type are stored as dictionary in the *cyberbullying_incident* variable. Each tweet instance is referred as an incident within the proposed system's context.

```
place = data.place
if place:
    place_id = data.place.id
    place = api.geo_id(place_id).contained_within[0]

    cyberbullying_incident.update({
        "district": place.name,
        "state": place.full_name.rsplit(", ", 1)[1]
    })
```

Figure 281: Stream Listener - Format Place

Moreover, the location where the tweet was posted in terms of district and state are retrieved as well through the help of *geo_id()* method so that some of the statistics on the front-end could be calculated and displayed. The location is updated in the *cyberbullying_incident* variable.

```
244 replied_status_id = data.in_reply_to_status_id
245 replied_incident = {}
246
247 if replied_status_id:
248     url = "https://api.twitter.com/2/tweets?ids={}&tweet.fields=conversation_id,created_at,author_id,referenced_tweets"
249     url = url.format(replied_status_id)
250     replied_data = requests.get(url, headers={"Authorization": "Bearer {}".format(app.config["BEARER_TOKEN"])}).json()["data"][0]
251
252     replied_incident = {
253         "id": replied_status_id,
254         "type": "replied",
255         "message": replied_data["text"],
256         "created_at": convert_to_date(datetime.datetime.timestamp(datetime.datetime.fromisoformat(replied_data["created_at"][:-1]))) + datetime.timedelta(hours=8)
257     }
```

Figure 282: Stream Listener - Replied Information

Since the cyberbullying tweet could be targeted towards another tweet, to help the system users to gain better grasp towards the situation, the tweet being replied as well as the profile will be stored into the database as well. Therefore, by utilising the URL defined in line 248, which is the new Twitter API endpoint and is currently not supported in the *tweepy* library, the replied tweet information similar to the *cyberbullying_incident* variable including its Twitter ID, self-defined type, message text and the date was stored into the variable *replied_incident*.

```
259                 incidents = []
260                 incidents.append(cyberbullying_incident)
261                 if bool(replied_incident): incidents.append(replied_incident)
262
263                 connection = establish_connection()
264                 cursor = connection.cursor()
265                 query = "INSERT INTO incidents (incident_twitter_id, incident_message, incident_date, incident_district, incident_state) VALUES (%s, %s, %s, %s, %s)"
266
267                 with open("aes_key.txt") as file:
268                     key = bytes(file.readlines()[0], "utf-8")
269                 # master_key = b'1234567890123456'
270
271                 encoder = PKCS7Encoder()
272
273                 incident_ids = []
274                 for incident in incidents:
275                     encoded_id = encoder.encode(str(incident["id"]))
276                     encoded_message = encoder.encode(str(incident["message"]))
277                     iv = Random.new().read( 16 )
278                     cipher = AES.new(key, AES.MODE_CBC, iv)
279                     # # return
280                     # return cipher
281                     encrypted_id = base64.b64encode(iv + cipher.encrypt(encoded_id.encode("utf-8")))
282                     encrypted_id = encrypted_id.decode('ascii')
283
284                     iv = Random.new().read( 16 )
285                     cipher = AES.new(key, AES.MODE_CBC, iv)
286
287                     encrypted_message = base64.b64encode(iv + cipher.encrypt(encoded_message.encode("utf-8")))
288                     encrypted_message = encrypted_message.decode('ascii')
289
290
291                     value = (encrypted_id, encrypted_message, incident["created_at"], incident.get("district", None), incident.get("state", None))
292                     cursor.execute(query, value)
293                     connection.commit()
294                     incident_ids.append(cursor.lastrowid)
295
296                 connection.close()
```

Figure 283: Stream Listener - Encrypt & Store Incidents

Within the block of code shown in the figure above, it involves encrypting as well as storing the previously mentioned incidents variable into the database. First and foremost, the connection with the database is established using the pre-defined *establish_connection()* function. For each incident including the cyberbullying and the replied tweet, its Twitter ID and message text is encrypted using the 256 bits-based AES encryption algorithm under the CBC mode, which was instantiated in line 278 with the code *AES.new()* from the *PyCrypto* library utilising the AES 32 bytes encryption key read in line 267 and line 268. The AES encryption is employed within this scenario instead of RSA is due to its better performance meanwhile able to maintain satisfactory security. Apart from that, each encryption is paired with a newly randomised 16-bytes initialisation vector (IV), therefore ensuring different ciphertexts will always be generated even with the same plaintext. The incident's Twitter ID and message text is particularly chosen to be encrypted because through either these two information, the original Twitter user can be traced back easily, which could lead to greater shame to the Twitter user if said information was leaked. Prior to encrypting the incidents, each incident's Twitter was firstly encoded using the *PKCS7Encoder()* instance. Right after the IV was randomly generated, the information was encrypted using the *encrypt()* method called by the *AES.new()* instance, followed by the append of IV from the front of the encrypted output as displayed in line 281 and line 287. Right after when each ciphertext is decoded into ASCII format

to accommodate the data type within the database, the necessary information including the ciphertexts are then inserted into the database through the *execute()* and the *commit()* method. The database connection was then closed in line 296.

```
300                 #Cybervictim
301                 role = {
302                     "id": 2,
303                     "title": "cybervictim",
304                     # "identified_at": date,
305                 }
306
307                 if data.in_reply_to_user_id not in mentioned_user_ids:
308                     mentioned_user_ids.append(data.in_reply_to_user_id)
309
310                 #Remove @ to itself
311                 mentioned_user_ids = [mentioned_user_id for mentioned_user_id in mentioned_user_ids if mentioned_user_id != data.user.id]
312                 searched_twitter_profiles = api.lookup_users(user_ids=mentioned_user_ids)
313
314                 cybervictim_ids = []
315
316                 replied_profile_id = None
317
318                 for searched_twitter_profile in searched_twitter_profiles:
319                     cybervictim_id = update_profile(searched_twitter_profile.id, searched_twitter_profile.screen_name, searched_twitter_profile.profile_image_url, role, key)
320                     cybervictim_ids.append(cybervictim_id)
321                     if data.in_reply_to_user_id == searched_twitter_profile.id:
322                         replied_profile_id = cybervictim_id
323
324                 #Cyberbully
325                 role = {
326                     "id": 1,
327                     "title": "cyberbully",
328                     # "identified_at": date,
329                 }
330
331                 cyberbully_id = update_profile(data.user.id, data.user.screen_name, data.user.profile_image_url, role, key)
332
333                 replied_profile_id = None if data.in_reply_to_status_id is None else cyberbully_id if replied_profile_id is None else replied_profile_id
```

Figure 284: Stream Listener - Format Profile

After successfully storing the incidents, the involved profiles are stored. The sender of the cyberbullying tweet will be declared as cyberbully meanwhile the replied user or the tagged user will be declared as cybervictim instead. Since the stream of tweets does not provide the necessary information regarding the cybervictim profile such as Twitter ID, name and image that are required for the database, the method *lookup_users()* is utilised to retrieve the information. Then, the cybervictims' information including the encryption key are individually passed to the *update_profile()* function as arguments as shown in line 319.

```
85  def update_profile(id, username, image, role, key):
86      connection = establish_connection()
87      cursor = connection.cursor(dictionary=True)
88
89      query = "SET block_encryption_mode = 'aes-256-cbc'"
90      cursor.execute(query)
91
92      query = """SELECT profile_id, role_title, support_status FROM profiles
93                 INNER JOIN roles ON profiles.role_id = roles.role_id
94                 INNER JOIN supports ON profiles.support_id = supports.support_id
95                 WHERE AES_DECRYPT(SUBSTRING(FROM_BASE64(profiles.profile_twitter_id), 17), %s,
96                 SUBSTRING(FROM_BASE64(profiles.profile_twitter_id), 1, 16)) = %s"""
97      value = (key, id)
98
99      cursor.execute(query, value)
100
101     profile = cursor.fetchone()
```

Figure 285: update_profile() Function – First Part

Before the profiles are stored individually into the database, the profile is first retrieved and checked whether it has been existed within the database already or not, on the basis of the profile Twitter ID as they are unique. However, since the Twitter IDs stored in the database are encrypted, the query constructed to retrieve the profile information must decrypt the profile Twitter ID beforehand. Hence, as shown in line 89 and line 90, the query to set the AES encryption configuration is written and executed. Afterwards, as displayed in the query starting from line 92 till line 96, the profile information is retrieved based on the profile Twitter ID from the parameter in accordance to the decrypted profile Twitter ID stored from the database using the *AES_DECRYPT()* function. The profile information is then retrieved using *cursor.fetchone()* code.

```
105     if profile is not None:
106         # roles = ["cyberbully", "cybervictim"]
107 
108         profile_id = profile["profile_id"]
109         profile_role = profile["role_title"]
110         profile_support_status = profile["support_status"]
111 
112         if profile_support_status == "offered" and (profile_role == "cyberbully" or profile_role == "cyberbully-victim") and role["title"] == "cyberbully":
113             support_status_id = 3
114         elif profile_support_status == "offered" and (profile_role == "cyberbully" or profile_role == "cyberbully-victim") and role["title"] == "cybervictim":
115             support_status_id = 2
116         elif profile_support_status == "offered" and (profile_role == "cybervictim" or profile_role == "none"):
117             support_status_id = 2
118         elif profile_support_status == "offered yet continues":
119             support_status_id = 3
120         else:
121             support_status_id = 1
122 
123         query = ("UPDATE profiles SET role_id = %s, support_id = %s WHERE profile_id = %s")
124 
125         if profile_role == "none":
126             value = (role["id"], support_status_id, profile_id)
127 
128         elif profile_role != role["title"]:
129             value = (3, support_status_id, profile_id)
130 
131         else:
132             value = (role["id"], support_status_id, profile_id)
133 
134         cursor.execute(query, value)
135         connection.commit()
```

Figure 286: Stream Listener - Update Profile

In line 105, an if statement is written to check whether the profile has already been stored into the database before. The block of code shown in the figure above are statements that will be executed to update profile only if the profile exists within the database. From line 112 till line 121, the if-else statements are written to identify support status to be updated on the profile in the database. If the profile within the database is a cyberbully, offered support previously and involved in cyberbullying incident again, the support status will be updated to “offered yet continues” later, meaning the cyberbully continues cyberbullying despite being warned or supported. Meanwhile other support status will remain the same as previously stored. Subsequently, another if-else statement is written from line 125 till line 132 to decide whether the profile’s role needs to be updated or not. If the profile ‘s role within the database is in the status “none”, which could happen when all incidents related to the profile is removed, the profile will be assigned the role depends on whether he or she sends or receive the cyberbullying tweet. If the profile’s role in the database has the opposite status with the current incident detected, the profile will be assigned the role as “cyberbully-victim”, which means the cyberbully experienced cyberbullying from others as well. On the other hand, if nothing else matches conditions, the profile role remains as previously assigned in the database. Finally the profile will be updated through calling the *execute()* method as well as the *commit()* based on the query written in line 123.

```
137     else:
138         query = "INSERT INTO profiles (profile_twitter_id, profile_username, profile_image, role_id, support_id) VALUES (%s, %s, %s, %s, %s)"
139
140         encoder = PKCS7Encoder()
141
142         encoded_twitter_id = encoder.encode(str(id))
143         encoded_username = encoder.encode(str(username))
144
145         iv = Random.new().read( 16 )
146         cipher = AES.new(key, AES.MODE_CBC, iv)
147
148         encrypted_twitter_id = base64.b64encode(iv + cipher.encrypt(encoded_twitter_id.encode("utf-8")))
149         encrypted_twitter_id = encrypted_twitter_id.decode('ascii')
150
151         iv = Random.new().read( 16 )
152         cipher = AES.new(key, AES.MODE_CBC, iv)
153
154         encrypted_username = base64.b64encode(iv + cipher.encrypt(encoded_username.encode("utf-8")))
155         encrypted_username = encrypted_username.decode('ascii')
156
157         value = (encrypted_twitter_id, encrypted_username, image, role["id"], 1)
158
159         cursor.execute(query, value)
160
161         connection.commit()
162
163         profile_id = cursor.lastrowid
164
165     connection.close()
166     return profile_id
```

Figure 287: Stream Listener - Insert Profile

Similar to incidents, the profile will be encrypted using 256 bits-based AES encryption as well before inserted into the database, except the elements that will be encrypted in this case will be the profile's Twitter ID and its username since through either information, the user can be traced back, which could be catastrophic when such information regarding its involvement towards cyberbullying were to be leaked. Again, by running the *execute()* and the *commit()* method against the query written in line 138, the profile information such as its image, role, support status including the encrypted Twitter ID and username will be inserted into the database. Finally the database connection will be closed as shown in line 165 and the database auto-generated profile's ID will be returned at the end of *update_profile()* function so that the ID can be inserted into the junction entity later on.

```
325                 #Cyberbully
326                 role = {
327                     "id": 1,
328                     "title": "cyberbully",
329                     # "identified_at": date,
330                 }
331
332                 cyberbully_id = update_profile(data.user.id, data.user.screen_name, data.user.profile_image_url, role, key)
333
334                 replied_profile_id = None if data.in_reply_to_status_id is None else cyberbully_id if replied_profile_id is None else replied_profile_id
335
336                 connection = establish_connection()
337                 cursor = connection.cursor()
338
339                 query = """INSERT INTO incidents_associations (cyberbullying_id, replied_id, cyberbully_id, cybervictim_id, replied_profile_id,
340                         cyberbully_notification, cybervictim_notification) VALUES (%s, %s, %s, %s, %s, %s, %s)"""
341
342                 values = []
343
344                 for cybervictim_id in cybervictim_ids:
345                     values.append((cyberbullying_id, replied_id[0] if replied_id else None, cyberbully_id, cybervictim_id, replied_profile_id, "unread", "unread"))
346
347                 print(values)
348                 cursor.executemany(query, values)
349                 connection.commit()
350                 connection.close()
```

Figure 288: Stream Listener - Insert into Junction Table

After done updating profile for the cybervictims, the cyberbully profile is updated into the database as well as shown in line 332 through another invocation of *update_profile()* function. The if-else statement in line 334 was written to check whether the cyberbully reply to its own tweet, such scenario could happen as the cyberbully might want to lengthen its rant towards the cybervictims as each tweet is restricted to contain only 280 characters. Afterwards, to link the connection between the cyberbully, cybervictims and their respective incidents, their database-based auto-generated IDs are inserted into the junction entity *incidents_associations* through the query written in line 339 till line 340. For each mentioned users or cybervictim in this context are involved, one record will be inserted into the *incidents_associations* entity. At last, the database connection is closed and that marks the end of the overriding *on_status()* method from the *StreamListener* class.

```
if os.environ.get("WERKZEUG_RUN_MAIN") != "true":
    stream_listener = StreamListener()
    stream = tweepy.Stream(auth=auth, listener=stream_listener)

    while True:
        try:
            # follow = ["1346168138212077569"]
            # stream.filter(follow=follow)
            #Petaling and Kuala Lumpur District Only
            # stream.filter(locations=[101.62031, 3.070566, 101.682108, 3.121647])

            #Entire Country
            stream.filter(locations=[100.085756871, 0.773131415201, 119.181903925, 6.92805288332])
        except (ProtocolError, AttributeError, IncompleteRead):
            continue
```

Figure 289: Stream Tweets

As soon as the server boots up, the server will be tasked to start streaming tweets from Twitter. For starters, an instance of the inherited *StreamListener()* class is assigned to the variable *stream_listener* variable. To obtain streaming permission, the authentication details including the listener are passed as arguments into the *Stream()* instance from *tweepy* library, which was then assigned to the variable *stream*. To initiate streaming tweets, the *filter()* method is invoked. The argument, *locations* with the bounding box around Malaysia is passed into the *filter()* method as well in order to stream tweets coming from Malaysia. Apart from that, to prevent the streams from getting disconnected, the *filter()* method was called within a while loop and a try catch block, therefore ensuring the streams will run consistently.

9.2.3 Send Support Message – Reply Tweet

Another main feature proposed within the system would be providing counselling support to the Twitter accounts through replying to the tweet publicly. This feature works in tandem between the front-end and the back-end of the system.

```
173     const replyTweet = () => {
174
175         let url = `${api}/reply_tweet`;
176         fetch(url, {
177             method: "POST",
178             headers: {
179                 "Accept": "application/json",
180                 "Content-Type": "application/json",
181                 "Authorization": "Bearer " + token,
182             },
183             body: JSON.stringify({
184                 profile_id: profile.id,
185                 profile_role: profile.role,
186                 profile_role_id: profile.role_id,
187                 tweet_id: tweetID,
188                 encrypted_message: message.encrypted_message,
189                 timestamp: Number(new Date()),
190                 incidents_association_id: incident.incidents_association_id,
191                 chosen_filter: chosenFilter,
192                 method: tweetID ? "reply tweet" : "direct message",
193                 cyberbullying_id: incident.cyberbullying_id,
194             })
195         })
196             .then(response => response.json())
197             .then(result => {
198                 if (result.error) setRefreshData(true);
199                 setCloseModal(true);
200                 setPopupMessage(result.message);
201                 loadProfiles();
202                 if (result.close_profile) setCloseBothModalStatus(true);
203             })
204     }
```

Figure 290: Front-End – replyTweet() Function

Upon clicking the "Send" button at the support message modal, the function *replyTweet()* on the front-end as shown above will be executed. First of all, the back-end API URL endpoint is defined and assigned to the *url* variable. The *api* variable passed into the formatted string is a constant string initialised in the configuration file that provides the initial endpoint URL for communicating

with the back-end. Staring from line 176, the *fetch()* method is invoked with the *url* variable alongside several configurations including HTTP method, HTTP headers as well as the HTTP body so that a correct HTTP request can be transmitted to the API endpoint. Since the function of replying to a tweet require several information from the front-end such as profile's ID, the tweet's Twitter ID, and more, as shown in the HTTP body json string, the HTTP method was necessary to be declared as "POST". Apart from that, within the HTTP headers, a variable named *token* is funnelled into the authorization header too. The variable in actuality is storing a JWT token acquired whenever a user logged into the system. Through token-based authentication, a restriction can be imposed where only authenticated users are able to make HTTP requests from the system, therefore significantly strengthens the security of the system. Once the server-side has finish the necessary processing, the JSON-based response will be retrieved using the *json()* method. Afterwards, based on the result retrieved, the client-side can then perform the rest of the operations such as displaying a message regarding whether the message has been successfully sent or not.

```
200 @message.route("/api/reply_tweet", methods=["POST"])
201 @jwt_required()
202 def reply_tweet():
203     profile_id = request.get_json()["profile_id"]
204
205     encrypted_message = request.get_json()["encrypted_message"]
206
207     response = {
208         "message": "The message has been successfully sent."
209     }
210
211     try:
212         connection = establish_connection()
213         # cursor = connection.cursor(dictionary=True, buffered=True)
214         cursor = connection.cursor()
215
216         auth = tweepy.OAuthHandler(current_app.config["CONSUMER_KEY"], current_app.config["CONSUMER_SECRET_KEY"])
217         organisation_id = get_jwt_identity()
218         query = "SELECT organisation_twitter_token, organisation_twitter_secret_token FROM organisations WHERE organisation_id = (%s)"
219         value = (organisation_id, )
220         cursor.execute(query, value)
221         tokens = cursor.fetchone()
```

Figure 291: Back-End - reply_tweet() Function - Part 1

As shown in the diagram above, the API endpoint HTTP method was declared as "POST" because it receives data from the client-side. Apart from that, the decorator *jwt_required()* was written to ensure that the endpoint can only be accessed by users with valid JWT token. When reaching the *reply_tweet()* function, several information such as profile_id as well as the encrypted messages sent from the client-side is assigned to the variable variable *profile_id* and *encrypted_message* respectively. There is also a dictionary assigned to the variable *response* with the default message which will be passed back to the client-side to indicate to the users regarding the fact on the support

message has been successfully. Upon encountering the try block, the database connection with the instantiation of *Cursor* object was first established in order to acquire the organisation account's Twitter tokens stored so that the tokens can be passed into the *OAuthHandler* object instantiated in line 216 and therefore allows the organisation's Twitter account to reply support message to the specific tweet directly.

```
59  def unpadPkcs7(data):
60      return data[:-data[-1]] #Python 3
```

Figure 292: Back-End - unpadPkcs7() Function

```
223     with open("aes_key.txt") as file:
224         key = bytes(file.readlines()[0], "utf-8")
225
226     decrypted_tokens = []
227     for _, token in tokens.items():
228         string_token = base64.b64decode(token)
229         iv = string_token[:16]
230         string_token = string_token[16:]
231         cipher = AES.new(key, AES.MODE_CBC, iv)
232         decrypted_token = cipher.decrypt(string_token)
233         decrypted_token = unpadPkcs7(decrypted_token).decode("utf-8")
234         decrypted_tokens.append(decrypted_token)
235
236     auth.set_access_token(decrypted_tokens[0], decrypted_tokens[1])
237
238     api = tweepy.API(auth)
```

Figure 293: Back-End - reply_tweet() Function - Part 2

Since the Twitter tokens stored are AES-256 encrypted under the CBC mode, these tokens must be decrypted before the Twitter API can even be accessed. The decryption starts off with the *b64decode()* method to decode the tokens into base64 format. From then, the first sixteen characters within the ciphertext was extracted and assigned to the variable *iv* meanwhile the rest of the characters within the ciphertext is assigned to the same variable *string_token*. Immediately after, an AES instance with the CBC mode was instantiated using the statement *AES.new()* with a few arguments including the key read in line 223 and line 224 as well as the IV. Through calling the *decrypt()* method on the ciphertext, the tokens are decrypted. However, the decrypted tokens will still appear abnormally due to the fact that during encryption, plain text tokens were encoded using PKCS7Encoder(). Therefore, in line 233, the tokens are decrypted individually into normal plain text tokens using the *unpadPkcs7()* function and the UTF-8 encoding scheme. Only then, the configuration on the *OAuthHanlder* object is set and the *auth* instance is passed as an argument to

the *API()* instance for the purpose of accessing the Twitter API as the particular organisation account.

```
240        string_message = base64.b64decode(encrypted_message)
241
242        iv = string_message[:16]
243        string_message = string_message[16:]
244        cipher = AES.new(key, AES.MODE_CBC, iv)
245        decrypted_message = cipher.decrypt(string_message)
246        message = unpadPkcs7(decrypted_message).decode("utf-8")
247
248        api.update_status(message, in_reply_to_status_id = request.get_json()["tweet_id"] , auto_populate_reply_metadata=True)
```

Figure 294: Back-End - reply_tweet() Function – Part 3

However, apart from the tokens, the support message itself received from the client-side must be decrypted as well. Therefore, by applying the same principles, the support message is decrypted as shown from line 240 till line 248. As the message has been successfully decrypted, the plain text message will then finally be sent to the particular tweet specifically from the organisation's Twitter account by calling the *update_status()* method from the *api* instance with the decrypted message as well as the tweet's Twitter ID retrieved from the client-side as arguments.

```
250        query = """INSERT INTO messages_histories
251                (messages_history_text, messages_history_date, messages_history_method, organisation_id, profile_id, profile_role_id)
252                VALUES (%s, %s, %s, %s, %s, %s)"""
253        value = (encrypted_message, datetime.datetime.fromtimestamp(request.get_json()["timestamp"] / 1000),
254                request.get_json()["method"], organisation_id, profile_id, request.get_json()["profile_role_id"])
255
256        cursor.execute(query, value)
257
258        connection.commit()
259
260        query = "UPDATE profiles SET support_id = %s WHERE profile_id = %s"
261        value = (2, profile_id)
262
263        cursor.execute(query, value)
264
265        connection.commit()
```

Figure 295: Back-End - reply_tweet() Function - Part 4

In spite of all that, the implementation does not end there as the message sent should be recorded for future reference as to verify whether the profile has been provided support previously or not as well as who provided the support. Hence, based on the database auto-generated account ID retrieved using the *get_jwt_identity()* method previously in line 217 wherein it returns the organisation's ID from the token generated, the record of the support message was recorded with several values provided including the message text, the current date, the means (reply tweet or direct message) of providing support, the organisation ID, the profile ID as well as the profile's role ID through executing the query written from line 250 till line 252. Furthermore, another query

written in line 260 is also executed to update the profile support status as “offered”, implying that they have been offered support from an organisation.

```
267     except tweepy.TweepError as tweep_error:
268         response["message"] = tweep_error.args[0][0]["message"]
269         error_code = tweep_error.args[0][0]["code"]
270         print(error_code)
271         print(response["message"])
272
273         if error_code == 89:
274             response["message"] = "Invalid or expired token. Please authorise the app again with your organisation’s Twitter account."
275             response["twitter_login_required"] = True
276             auth = tweepy.OAuthHandler(current_app.config["CONSUMER_KEY"], current_app.config["CONSUMER_SECRET_KEY"])
277             url = auth.get_authorization_url()
278             response["request_token"] = auth.request_token
279             response["twitter_login_url"] = url
280             return Response(json.dumps(response), mimetype="application/json", status=200)
```

Figure 296: Back-End - reply_tweet() Function - Part 5

However, there are multitude of issues that could be incurred when sending replies to the tweets. As shown above, the exception block was created to handle the issues known to the developer. Firstly, the organisation’s Twitter tokens stored within the database could have expired or become invalid after some time. Thence, to prevent said issue from crashing the system or disabling the organisation from ever capable to send support message, the server will send a URL generated by *tweepy* as displayed in line 277 that permits the client to redirect, login their organisation’s Twitter account and updates the new tokens into the database, which in the end allows the users from the organisation to send support message as always.

```
282         if error_code == 187:
283             response["message"] = response["message"] + " Same text message cannot be sent to the same tweet twice."
284
285         if error_code == 385:
286             response["message"] = response["message"] + " The incident will be deleted from the system."
287
288             response["error"] = True
```

Figure 297: Back-End - reply_tweet() Function - Part 6

Furthermore, Twitter prevents users from sending the same message to the same tweet twice, which was indicated with the error code of 187. Thus, the *response* variable with the message initialised earlier was overwritten with new message from the internal Twitter error message concatenated with the self-created error that provides clearer response to the system users. Apart from that, the tweet could have been deleted or marked as private, which makes sending replies impossible and provide support through that channel impossible. Hence, the error was handle as well starting from line 285. On a side note, the *response* variable was added with new key named *error* with the value of *True*, which would later be used as trigger on the client-side.

```
290            chosen_filter = request.get_json()["chosen_filter"]
291
292            # if chosen_filter == "cyberbully":
293            query = "SELECT incidents_association_id, cyberbullying_id, replied_id FROM incidents_associations WHERE incidents_associations.cyberbullying_id = (%s)"
294            value = (request.get_json()["cyberbullying_id"], )
295            cursor.execute(query, value)
296            incidents_associations = cursor.fetchall()
297
298            if chosen_filter == "cyberbully":
299                query = "SELECT cybervictim_id AS associated_id FROM incidents_associations WHERE incidents_associations.incidents_association_id = (%s)"
300            else:
301                query = "SELECT cyberbully_id AS associated_id FROM incidents_associations WHERE incidents_associations.incidents_association_id = (%s)"
302
303            if chosen_filter == "cyberbully":
304                values = [(incidents_association["incidents_association_id"], ) for incidents_association in incidents_associations]
305            else:
306                incidents_association_ids = [request.get_json()["incidents_association_id"]]
307                values = [(incidents_association_ids[0], )]
```

Figure 298: Back-End - reply_tweet() Function - Part 7

To handle said error, the incidents stored must be deleted meanwhile the relevant profiles must be updated as well. Since one cyberbullying message could include several individuals, the junction table may store same instance of incidents multiple times except linking with different profile. Therefore, the query in line 293 was executed to retrieve all the IDs including the incidents in the *incidents_associations* entity so not only can the incidents be deleted from the database but the relevant profiles can be updated accordingly as well, which their respective profile IDs were obtained from the query defined in line 299 or line 301, depending on the profile the client is looking at. The profile IDs are assigned into the variable *associated_ids*.

```
            query = "DELETE FROM incidents_associations WHERE incidents_associations.incidents_association_id = (%s)"

            values = [(incidents_association["incidents_association_id"], ) for incidents_association in incidents_associations]
            # if chosen_filter == "cyberbully" else [(incidents_association, ) for incidents_association in incidents_association_ids]
            cursor.executemany(query, values)

            connection.commit()

            query = "DELETE FROM incidents WHERE incident_id = (%s)"
            values = []
            for incident_association in incidents_associations:
                values.append((incident_association["cyberbullying_id"], ))
                if incident_association.get("replied_id"):
                    values.append((incident_association["replied_id"], ))

            cursor.executemany(query, values)
            connection.commit()
```

Figure 299: Back-End - reply_tweet() Function - Part 8

Before updating the profiles, the incidents appeared in both the *incidents* and the *incidents_associations* entities are deleted from the database through the block of code shown above.

```
333            associated_cyberbully_query = "SELECT * FROM incidents_associations WHERE cyberbully_id = (%s)"
334            associated_cybervictim_query = "SELECT * FROM incidents_associations WHERE cybervictim_id = (%s)"
335            query = "UPDATE profiles SET role_id = (%s) WHERE profile_id = (%s)"
336
337            for associated_id in associated_ids:
338                associated_value = (associated_id["associated_id"], )
339                cursor.execute(associated_cyberbully_query, associated_value)
340                associated_cyberbully_incidents = cursor.fetchone()
341                cursor.execute(associated_cybervictim_query, associated_value)
342                associated_cybervictim_incidents = cursor.fetchone()
343
344                role_id = None
345
346                if associated_cyberbully_incidents == None and associated_cybervictim_incidents == None:
347                    role_id = 0
348
349                elif associated_cyberbully_incidents == None:
350                    role_id = 2
351
352                elif associated_cybervictim_incidents == None:
353                    role_id = 1
354
355                if role_id != None:
356                    value = (role_id, associated_id["associated_id"])
357                    cursor.execute(query, value)
358                    connection.commit()
```

Figure 300: Back-End - reply_tweet() Function - Part 9

The code displayed above mainly responsible to update the profiles related to the incidents being removed due to deleted tweet particularly their roles, based on whether are there any more cyberbullying or cybervictim incidents related to the profiles. If there are zero cyberbullying and cybervictim incidents involved, their role will be updated as “none” and the profile will not appear on the client-side. However, if there are only zero cyberbullying incidents involved, their role will be updated as “cybervictim” meanwhile if there are zero cybervictim incidents involved, their role will be updated as “cyberbully instead”. These checks are based on the if-else statements from line 346 till line 353. If the profile’s role is currently “cyberbully-victim”, and the profile has still involvement in both cyberbullying and cybervictim incidents, the profile will not be updated.

```
            cyberbully_query = "SELECT * FROM incidents_associations WHERE cyberbully_id = (%s)"

            cybervictim_query = "SELECT * FROM incidents_associations WHERE cybervictim_id = (%s)"

            value = (profile_id, )

            cursor.execute(cyberbully_query, value)
            cyberbully_incidents = cursor.fetchone()

            cursor.execute(cybervictim_query, value)
            cybervictim_incidents = cursor.fetchone()

            role_id = None

            if cyberbully_incidents == None and cybervictim_incidents == None:
                role_id = 0
                response["close_profile"] = True
                response["message"] = response["message"] + " The profile will be removed from the system since there are no related incidents."

            elif cyberbully_incidents == None:
                role_id = 2

            elif cybervictim_incidents == None:
                role_id = 1

            if role_id != None:
                response["refresh_profile"] = True
                value = (role_id, profile_id)
                cursor.execute(query, value)
                connection.commit()
            # return Response(json.dumps(response), mimetype="application/json", status=200)

    connection.close()
    return Response(json.dumps(response), mimetype="application/json", status=200)
```

Figure 301: Back-End - reply_tweet() Function - Part 7

The block of code shown above processes the same operation as the code above except it is updating the cyberbullying profile instead. Once the update was completed, the database connection will be closed and the *reply_tweet()* function will return a JSON object with the message and other key values assigned to the *response* variable.

Chapter 10: System Validation

10.1 Unit Testing

10.1.1 Detect Cyberbullying Tweet

Table 106: Unit Testing - Detect Cyberbullying Tweet

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTA-001	Detect cyberbullying tweet through posting a non-cyberbullying tweet without tagging, replying to a tweet nor embedding a location.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass

UTA-002	Detect cyberbullying tweet through posting a cyberbullying tweet without tagging, replying to a tweet nor embedding a location.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass
UTA-003	Detect cyberbullying tweet through posting a non-cyberbullying tweet with tagging a Twitter user but without	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** @felix4524 Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass

	embedding a location.						
UTA-004	Detect cyberbullying tweet through posting a cyberbullying tweet with tagging a Twitter user but without embedding a location.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** @felix4524 ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass
UTA-005	Detect cyberbullying tweet through posting a non-cyberbullying tweet with replying to a tweet but	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet replying to another tweet. 2. Embed nothing in the location field.	**Tweet:** Today is a great day.	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass

	without embedding a location.		3. Press the "Tweet" button.				
UTA-006	Detect cyberbullying tweet through posting a cyberbullying tweet with replying to a tweet but without embedding a location.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet replying to another tweet. 2. Embed nothing in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless	The tweet is not recognised by the system and the tweet or the profile are not stored into the database.	Same as expected result.	Pass
UTA-007	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet in the tweet field. 2. Embed a location in the location field.	**Tweet:** Today is a great day. **Location:** Petaling, Wilayah Persekutuan	The tweet is recognised by the system but the tweet or the profile are not stored into the database.	Same as expected result.	Pass

	location but without tagging a user or replying to a tweet.		3. Press the "Tweet" button.	Kuala Lumpur			
UTA-008	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a location but without tagging a user or replying to a tweet.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet in the tweet field. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system but the tweet or the profile are not stored into the database.	Same as expected result.	Pass
UTA-009	Detect cyberbullying tweet through posting a non-	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet with tagging a Twitter user in the tweet field.	**Tweet:** @felix4524 Today is a great day.	The tweet is recognised by the system but the tweet or the	Same as expected result.	Pass

	cyberbullying tweet with embedding a location and tagging a user.		2. Embed a location in the location field. 3. Press the "Tweet" button.	**Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	profile are not stored into the database.		
UTA-010	Detect cyberbullying tweet through posting a cyberbullying tweet with embedding a location and tagging a user.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet with tagging a Twitter user in the tweet field. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** @felix4524 ei, you tak ada otak? why are u so brainless **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system and the tweet as well as the profile are AES-256 encrypted and stored into the database.	Same as expected result.	Pass

UTA-011	Detect cyberbullying tweet through posting a non-cyberbullying tweet with embedding a location and replying to a tweet.	- Must log into a Twitter account.	1. Enter a non-cyberbullying tweet replying to another tweet. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** Today is a good day. **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system but the tweet and the profile are not stored into the database.	Same as expected result.	Pass
UTA-012	Detect cyberbullying tweet through posting a cyberbullying tweet with embedding a location and replying to a tweet.	- Must log into a Twitter account.	1. Enter a cyberbullying tweet replying to another tweet. 2. Embed a location in the location field. 3. Press the "Tweet" button.	**Tweet:** ei, you tak ada otak? why are u so brainless **Location:** Petaling, Wilayah Persekutuan Kuala Lumpur	The tweet is recognised by the system and the tweet as well as the profile are AES-256 encrypted and stored into the database.	Same as expected result.	Pass

10.1.2 Login

Table 107: Unit Testing - Login

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTB-001	Login with an empty username and an empty password.	- The organisation must exist in the database.	1. Leave the username field empty. 2. Leave the password field empty. 3. Press the "Login" button.	**Username:** *empty* **Password:** *empty*	1. The tooltip box for the username field is triggered. 2. The username field is coloured red. 3. The tooltip box for the password field is triggered. 4. The password field is coloured red.	Same as expected result.	Pass

UTB-002	Login with an empty username and a valid password.	- The organisation must exist in the database.	1. Leave the username field empty. 2. Enter a valid password in the password field. 3. Press the "Login" button.	**Username:** *empty* **Password:** tp046085	1. The tooltip box for the username field is triggered. 2. The username field is coloured red. 3. The password field is coloured green.	Same as expected result.	Pass
UTB-003	Login with an invalid username and a valid password.	- The organisation must exist in the database.	1. Enter an invalid username in the username field. 2. Enter a valid password in the password field. 3. Press the "Login" button.	**Username:** @hi **Password:** tp046085	1. The tooltip box for the username field is triggered. 2. The username field is coloured red.	Same as expected result.	Pass

					3. The password field is coloured green.		
UTB-004	Login with an inexistent username and a valid password.	- The organisation must exist in the database.	1. Enter a valid but non-existent username in the username field. 2. Enter a valid password in the password field. 3. Press the "Login" button.	**Username:** anonymous **Password:** tp046085	1. The username field is coloured green. 2. The password field is coloured green. 3. The password is RSA encrypted. 4. The message "Wrong username or password." is shown in the error field.	Same as expected result.	Pass

UTB-005	Login with a valid username and an empty password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Leave the password field empty. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** *empty*	1. The tooltip box for the password field is triggered. 2. The username field is coloured green. 3. The password field is coloured red.	Same as expected result.	Pass
UTB-006	Login with a valid username and an invalid password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Enter an invalid password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** tp046	1. The tooltip box for the password field is triggered. 2. The username field is coloured green.	Same as expected result.	Pass

					3. The password field is coloured red.		
UTB-007	Login with a valid username and an incorrect password.	- The organisation must exist in the database.	1. Enter a valid username in the username field. 2. Enter an incorrect password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** wrongpw	1. The username field is coloured green. 2. The password field is coloured green. 3. The password is RSA encrypted. 4. The message "Wrong password." Is shown in the error field.	Same as expected result.	Pass

UTB-008	Login with an existing username and the correct password for organisations who have yet authorise the app to access its organisation's Twitter account.	- The organisation must exist in the database.	1. Enter an existing username in the username field. 2. Enter a correct password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** tp046085	1. All the fields are coloured green. 2. The twitter login modal is prompted up.	Same as expected result.	Pass
UTB-009	Login with an existing username and the correct password for organisations who have already authorise the app to access its	- The organisation must exist in the database.	1. Enter an existing username in the username field. 2. Enter a correct password in the password field. 3. Press the "Login" button.	**Username:** mcmcadmin **Password:** tp046085	1. All the fields are coloured green. 2. The password is encrypted using RSA algorithm.	Same as expected result.	Pass

	organisation's Twitter account.				3. The user is redirected to the dashboard page.		

10.1.3 Twitter Login

Figure 302: Unit Testing - Twitter Login

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTC-001	Cancel authorising app's access.	-	1. Press the "Cancel" button.	-	1. A pop-up modal with the message "Authorised unsuccessful. The authorisation process was	Same as expected result.	Pass

					cancelled." is displayed. 2. The Twitter login modal is closed.		
UTC-002	Authorise the app without inputting the PIN code.	-	1. Leave the PIN code field empty. 2. Press the "Submit" button.	**PIN Code:** *empty*	1. A pop-up modal with the message "Authorised unsuccessful. Invalid PIN Code. Please login again." is displayed. 2. The Twitter login modal is closed.	Same as expected result.	Pass
UTC-003	Authorise the app with inputting a valid	-	1. Press the link given. 2. Authorise the app using different Twitter	-	1. A pop-up modal with the message	Same as expected result.	Pass

	PIN code except from a wrong Twitter account stored into the database.		account than previously saved into the database. 3. Paste the PIN Code in the PIN Code field.		"Authorised unsuccessful. Please authorise the app using your organisation's Twitter account." is displayed. 2. The Twitter login modal is closed.		
UTC-004	Authorise the app with inputting a valid PIN code retrieved from the Twitter account that matches the Twitter ID	-	1. Press the link given. 2. Authorise the app using Twitter account with the same Twitter ID previously saved into the database. 3. Paste the PIN Code in the PIN Code field.	-	1. The tokens are AES-256 encrypted. 2. The user is redirected to the dashboard page.	Same as expected result.	Pass

	stored into the database.						

10.1.4 Side Navigation

Table 108: Unit Testing - Side Navigation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTD-001	Redirect to dashboard page.	- The user must log into the system.	1. Press the "Dashboard" button.	-	The user is redirected to the dashboard page.	Same as expected result.	Pass
UTD-002	Redirect to profile page.	- The user must log into the system.	1. Press the "Twitter Profile" button.	-	The user is redirected to the profile page.	Same as expected result.	Pass
UTD-003	Refresh the notifications every five minutes.	-	1. Wait five minutes.	-	The notifications regarding number of newly detected incidents are	Same as expected result.	Pass

					updated to its latest.		
UTD-004	Redirect to organisation page.	- The user must log into the system.	1. Press the “Own Organisation” button.	-	The user is redirected to its organisation page.	Same as expected result.	Pass
UTD-005	Redirect to management page.	- The user must log into the system. - The user’s organisation is government-based.	1. Press the “Management” button.	-	The user is redirected to the management page.	Same as expected result.	Pass
UTD-006	Logout of the system.	- The user must log into the system.	1. Press the “Logout” button.	-	The user is redirected to the login page.	Same as expected result.	Pass

10.1.5 Dashboard

Table 109: Unit Testing - Dashboard

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTE-001	Switch to bar chart-based statistics.	- There must be at least one incident recorded in the database.	1. Press the bar chart icon.	-	The bar chart-based statistics is displayed.	Same as expected result.	Pass
UTE-002	Switch to map-based statistics.	- There must be at least one incident recorded in the database.	1. Press the earth icon.	-	The map-based statistics is displayed.	Same as expected result.	Pass
UTE-003	Filter and display bar chart-based daily statistics.	- There must be at least one incident recorded in the database.	1. Press the switch icon between the label “Day” and “Month”.	-	The bar chart is refreshed and the daily statistics based on current	Same as expected result.	Pass

		- The statistics mode is current set on bar chart view. - The time mode is currently set on “Month”.			date is displayed.		
UTE-004	Filter and display bar chart-based monthly statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on	1. Press the switch icon between the label “Day” and “Month”.	-	The bar chart is refreshed and the monthly statistics based on current year is displayed.	Same as expected result.	Pass

		bar chart view. - The time mode is currently set on “Day”.					
UTE-005	Filter and display map-based daily statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view. - The time mode is currently set on “Month”.	1. Press the switch icon between the label “Day” and “Month”.	-	The map is refreshed and the daily statistics based on current date is displayed.	Same as expected result.	Pass

UTE-006	Filter and display map-based monthly statistics.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view. - The time mode is currently set on “Day”.	1. Press the switch icon between the label “Day” and “Month”.	-	The map is refreshed and the monthly statistics based on current year is displayed.	Same as expected result.	Pass
UTE-007	Display box of years between earliest year of incident stored in the database and current year.	- There must be at least one incident recorded in the database.	1. Press the year or the arrow icon.	-	The box with year(s) between earliest incident stored in the database and	Same as expected result.	Pass

		- The time mode is currently set on “Month”.			current year is displayed.		
UTE-008	Display box of months based on the distinct months of selected year of incidents stored in the database.	- There must be at least one incident recorded in the database. - The statistics mode is currently set on map view. - The time mode is currently set on “Month”.	1. Press the month or the arrow icon.	-	Th box with months according to the distinct months of selected year of incidents stored in the database is displayed.	Same as expected result.	Pass

UTE-009	Filter and display bar chart-based monthly statistics according to selected year.	- There must be at least one incident recorded in the database. - The statistics mode is current set on bar chart view. - The time mode is currently set on “Month”.	1. Press the year or the arrow icon. 2. Select a year.	-	The bar chart is refreshed and the monthly statistics based on the year selected is displayed.	Same as expected result.	Pass
UTE-010	Filter and display map-based monthly statistics	- There must be at least one incident recorded in the database.	1. Press the year or the arrow icon. 2. Select a year.	-	The map is refreshed and the monthly statistics based on the year	Same as expected result.	Pass

	according to selected year.	- The statistics mode is current set on map view. - The time mode is currently set on “Month”.			selected is displayed.		
UTE-011	Filter and display map-based monthly statistics according to selected month.	- There must be at least one incident recorded in the database. - The statistics mode is current set on map view.	1. Press the month or the arrow icon. 2. Select a month.	-	The map is refreshed and the monthly statistics based on the month selected is displayed.	Same as expected result.	Pass

		- The time mode is currently set on “Month”.					
UTE-012	Display calendar based on dates between earliest date of incident stored in the database and current date.	- There must be at least one incident recorded in the database. - The time mode is currently set on “Day”.	1. Press the date or the arrow icon.	-	The calendar with dates between earliest date of incident stored in the database and current date is displayed.	Same as expected result.	Pass
UTE-013	Filter and display bar chart-based daily statistics according to selected date.	- There must be at least one incident recorded in the database. - The time mode is	1. Press the date or the arrow icon. 2. Select a date.	-	The bar chart is refreshed and the daily statistics based on the date selected is displayed.	Same as expected result.	Pass

		currently set on “Day”.					
UTE-014	Filter and display map-based daily statistics according to selected date.	- There must be at least one incident recorded in the database. - The time mode is currently set on “Day”.	1. Press the date or the arrow icon. 2. Select a date.	-	The map is refreshed and the daily statistics based on the date selected is displayed.	Same as expected result.	Pass
UTE-015	Refresh all the statistics every five minutes.	-	1. Wait five minutes.	-	The statistics including last week’s overall statistics as well as the daily or monthly bar chart-based statistics regarding number of	Same as expected result.	Pass

					cyberbullying incidents are updated to its latest.		

10.1.6 Profile

Table 110: Unit Testing - Profile

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTF-001	Filter and display profiles based on empty search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter	1. Enter an empty search keyword in the search field.	**Search Keyword:** *empty*	All the profiles exist within the database is displayed.	Same as expected result.	Pass

		options are all ticked. - The roles filter options are all ticked. - The toxicity filter options are all ticked.					
UTF-002	Filter and display profiles based on inexistent username search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter options are all ticked.	1. Enter an inexistent username search keyword in the search field.	**Search Keyword:** anonymous	The message "No profiles were found." is displayed on the page.	Same as expected result.	Pass

		- The roles filter options are all ticked. - The toxicity filter options are all ticked.					
UTF-003	Filter and display profiles based on existing username search keyword.	- The profile with at least one incident involved must exist in the database. - The support status filter options are all ticked. - The roles filter options are all ticked.	1. Enter an existing username search keyword in the search field.	**Search Keyword:** robot4213	The profile with the entered username is displayed on the page.	Same as expected result.	Pass

		- The toxicity filter options are all ticked.					
UTF-004	Filter and display profiles based on zero selections on all options within the support status filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The roles filter options are all ticked. - The toxicity filter options are all ticked.	1. Deselect "Not Yet" option within the support status filter. 2. Deselect "Offered" option within the support status filter. 3. Deselect "Offered Yet Continues" option within the support status filter.	-	The message "No profiles were found." is displayed on the page.	Same as expected result.	Pass

UTF-005	Filter and display profiles based on at least one option selected within the support status filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The roles filter options are all ticked. - The toxicity filter options are all ticked.	1. Select either "Not Yet", "Offered" and/or "Offered Yet Continues" options within the support status filter.	-	The profiles with the selected options within the support status filter are displayed on the page.	Same as expected result.	Pass
UTF-006	Filter and display profiles based on zero selections on all	- The profile with at least one incident involved	1. Deselect "Cyberbully" option within the roles filter.	-	The message "No profiles were found." is displayed on the page.	Same as expected result.	Pass

	options within the roles filter.	must exist in the database. - The search field is empty. - The support status filter options are all ticked. - The toxicity filter options are all ticked.	2. Deselect "Cybervictim" option within the roles filter. 3. Deselect "Cyberbully-Victim" option within the roles filter.				
UTF-007	Filter and display profiles based on at least one option selected within the roles filter.	- The profile with at least one incident involved must exist in the database.	1. Select either "Cyberbully", "Cybervictim" and/or "Cyberbully-Victim" options within the roles filter.	-	The profiles with the selected options within the roles filter are displayed on the page.	Same as expected result.	Pass

		- The search field is empty. - The support status filter options are all ticked. - The toxicity filter options are all ticked.					
UTF-008	Filter and display profiles based on zero selections on all options within the toxicity filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty.	1. Deselect "Low" option within the toxicity filter. 2. Deselect "Medium" option within the toxicity filter. 3. Deselect "High" option within the toxicity filter.	-	The cybervictims profiles are displayed on the page.	Same as expected result.	Pass

		- The support status filter options are all ticked. - The roles filter options are all ticked.					
UTF-009	Filter and display profiles based on at least one option selected within the toxicity filter.	- The profile with at least one incident involved must exist in the database. - The search field is empty. - The support status filter options are all ticked.	1. Select either “Low”, “Medium” and/or “High” options within the toxicity filter.	-	The profiles with the selected options within the toxicity filter is displayed on the page.	Same as expected result.	Pass

		- The roles filter options are all ticked.					
UTF-010	Display profiles of the subsequent page.	- There are two or more pages of profiles within the pagination bar.	1. Press the “Next” button.	-	The profiles of subsequent page are displayed on the page.	Same as expected result.	Pass
UTF-011	Display profiles of the previous page.	- There are two or more pages of profiles within the pagination bar.	1. Press the “Previous” button.	-	The profiles of previous page are displayed on the page.	Same as expected result.	Pass
UTF-012	Display profiles based on	- There are two or more pages of profiles	1. Select a page number on the pagination bar.	-	The profiles of selected page number are	Same as expected result.	Pass

	selected page number.	within the pagination bar.			displayed on the page.		
UTF-013	Display specific profile details.	- The profile with at least one incident involved must exist in the database.	1. Press the "View Incidents" button on a particular profile.	-	The profile details modal is displayed.	Same as expected result.	Pass
UTF-014	Refresh all the profiles every five minutes.	-	1. Wait five minutes.	-	The profiles including notification regarding numbers of cyberbullying and cybervictim incidents involved are updated to its latest.	Same as expected result.	Pass

10.1.7 Profile Details

Table 111: Unit Testing - Profile Details

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTG-001	Close modal.	-	1. Press the "X" icon.	-	The profile details modal is closed.	Same as expected result.	Pass
UTG-002	Filter and display incidents based on cyberbullying incidents involved.	- The profile involved at least one cyberbullying incident.	1. Press the "Cyberbully" button.	-	1. The details of cyberbullying incidents involved are displayed. 2. The total number of cyberbullying incidents is displayed. 3. The notification	Same as expected result.	Pass

					status of cyberbullying incidents are updated as read in the database. 4. The notification regarding number of cyberbullying incidents are updated in the user interface.		
UTG-003	Filter and display incidents based on cybervictim incidents involved.	- The profile involved at least one cybervictim incident.	1. Press the "Cybervictim" button.	-	1. The details of cybervictim incidents involved are displayed. 2. The total number of cybervictim	Same as expected result.	Pass

					incidents is displayed. 3. The notification status of cybervictim incidents are updated as read in the database. 4. The notification regarding the numbers of cybervictim incidents are updated in the user interface.		
UTG-004	Remove one incident.	- The profile involved at	1. Press the "Not Cyberbullying" button.	-	A pop-up modal with the message "The incident has been	Same as expected result.	Pass

		least one incident.			successfully deleted.” is displayed.		
UTG-005	Remove the last remaining incident.	- The profile only has one incident involved.	1. Press the “Not Cyberbullying” button.	-	A pop-up modal with the message “The incident has been successfully deleted. The profile will be removed from the system since there are no related incidents.” is displayed.	Same as expected result.	Pass
UTG-006	Access reply tweet functionality.	- The profile involved at least one incident.	1. Press the “Reply Tweet” button.	-	The support message modal specifically for replying tweet is displayed.	Same as expected result.	Pass

UTG-007	Access direct message functionality.	- The profile involved at least one incident.	1. Press the "Direct Message" button.	-	The support message modal specifically for direct message is displayed.	Same as expected result.	Pass
UTG-008	Display history of support messages provided previously.	- The profile involved at least one incident.	1. Press the "Message History" button.	-	The support message history modal is displayed.	Same as expected result.	Pass

10.1.8 Support Message – Reply Tweet

Table 112: Unit Testing - Support Message (Reply Tweet)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTH-001	Close modal.	-	1. Press the "X" icon.	-	The support message modal is closed.	Same as expected result.	Pass

	Enable modification of pre-written counselling support message.	-	1. Press the “Modify” button.	-	The support message text box is enabled.	Same as expected result.	Pass
UTH-002	Disable modification of pre-written counselling support message.	- The support message text box is currently enabled.	1. Press the “Cancel” button.	-	The support message text box is disabled.	Same as expected result.	Pass
UTH-003	Modify pre-written counselling support message with invalid input.	-	1. Press the “Modify” button. 2. Enter invalid input. 3. Press the “Save” button.	**Message:** hi anonymous	The tooltip box for the support message text box is triggered.	Same as expected result.	Pass

UTH-004	Modify pre-written counselling support message with valid input.	-	1. Press the "Modify" button. 2. Enter valid input. 3. Press the "Save" button.	**Message:** Hello, my name is Hoh Kok Young from Childline Foundation and I would like to help you.	1. The message is AES-256 encrypted. 2. A pop-up modal with the message "The message has been successfully saved." is displayed.	Same as expected result.	Pass
UTH-005	Revert back to original message when modifying pre-written counselling support message.	-	1. Press the "Modify" button. 2. Enter input. 3. Press the "Cancel" button.	**Message:** Just some random input in the box.	1. The support message text box is disabled. 2. The message within the text box is reverted back to original message.	Same as expected result.	Pass

UTH-006	Send counselling support message through replying to existing tweet.	- The tweet still exists in Twitter.	1. Press the "Send" button.	-	1. A pop-up modal with the message "The message has been successfully sent." is displayed. 2. The support message modal is closed.	Same as expected result.	Pass
UTH-007	Send counselling support message through replying to deleted or private tweet.	- The tweet is deleted or private in Twitter.	1. Press the "Send" button.	-	1. A pop up modal with the message "You attempted to reply to a Tweet that is deleted or not visible to you. The incident will be deleted from the	Same as expected result.	Pass

					system." is displayed. 2. The support message modal is closed.		
UTH-008	Send counselling support message through replying to existing tweet with the same message simultaneously.	- The tweet still exists in Twitter.	1. Press the "Send" button.	-	1. A pop up modal with the message "Status is a duplicate. Same text cannot be sent to the same tweet twice." is displayed. 2. The support message modal is closed.	Same as expected result.	Pass
UTH-009	Send counselling support message	-	1. Press the "Send" button.	-	1. A pop-up modal with the message	Same as expected result.	Pass

	through replying to tweet wherein the organisation's internally stored Twitter tokens have expired or became invalid.				"Invalid or expired token. Please authorise the app again with your organisation's Twitter account." is displayed. 2.. The twitter login modal is prompted up.		

10.1.9 Support Message – Direct Message

Table 113: Unit Testing - Support Message (Direct Message)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTI-001	Close modal.	-	1. Press the “X” icon.	-	The support message modal is closed.	Same as expected result.	Pass
UTI-002	Enable modification of pre-written counselling support message.	-	1. Press the “Modify” button.	-	The support message text box is enabled.	Same as expected result.	Pass
UTI-003	Disable modification of pre-written counselling support message.	- The support message text box is currently enabled.	1. Press the “Cancel” button.	-	The support message text box is disabled.	Same as expected result.	Pass
UTI-004	Modify pre-written counselling support message	-	1. Press the “Modify” button. 2. Enter invalid input.	**Message:** hi anonymous	The tooltip box for the support message text box is triggered.	Same as expected result.	Pass

	with invalid input.		3. Press the "Save" button.				
UTI-005	Modify pre-written counselling support message with valid input.	-	1. Press the "Modify" button. 2. Enter valid input. 3. Press the "Save" button.	**Message:** Hello, my name is Hoh Kok Young from Childline Foundation and I would like to help you.	A pop-up modal with the message "The message has been successfully saved." is displayed.	Same as expected result.	Pass
UTI-006	Revert back to original message when modifying pre-written counselling support message.	-	1. Press the "Modify" button. 2. Enter input. 3. Press the "Cancel" button.	**Message:** Just some random input in the box.	1. The support message text box is disabled. 2. The message within the text box is reverted back to original message.	Same as expected result.	Pass

UTI-007	Send counselling support message through direct messaging to existing Twitter account.	- The Twitter account is in activated status.	1. Press the "Send" button.	-	1. A pop-up modal with the message "The message has been successfully sent." is displayed. 2. The support message modal is closed.	Same as expected result.	Pass
UTI-008	Send counselling support message through direct messaging to existing Twitter account with the feature of receiving direct message from	- The Twitter account is in activated status. - The feature of receiving direct message from outsiders in the Twitter	1. Press the "Send" button.	-	1. A pop-up modal with the message "You cannot send messages to this user. The user did not allow Direct Message (DM) from	Same as expected result.	Pass

	outsiders deactivated.	account is deactivated.			outsiders.” is displayed. 2. The support message modal is closed.		
UTI-009	Send counselling support message through direct messaging to deactivated Twitter account.	- The Twitter account is in deactivated status.	1. Press the “Send” button.	-	1. A pop-up modal with the message “Cannot find specified user. The user's account has been deactivated. The profile will be removed from the system.” is displayed. 2. The support message modal is closed.	Same as expected result.	Pass

					3. The profile will be removed from the user interface.		
UTI-010	Send counselling support message through direct messaging wherein the organisation's internally stored Twitter tokens have expired or became invalid.	-	1. Press the "Send" button.	-	1. A pop-up modal with the message "Invalid or expired token. Please authorise the app again with your organisation's Twitter account." is displayed. 2.. The twitter login modal is prompted up.	Same as expected result.	Pass

10.1.10 Support Message History

Table 114: Unit Testing - Support Message History

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTJ-001	Close modal.	-	1. Press the "X" icon.	-	The support message history modal is closed.	Same as expected result.	Pass

10.1.11 Organisation

Table 115: Unit Testing - Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTK-001	Access change password functionality.	-	1. Press the "Change Password" button.	-	The change password modal is displayed.	Same as expected result.	Pass

UTK-002	Access edit organisation functionality.	-	1. Press the "Edit Organisation" button.	-	The edit organisation modal is displayed.	Same as expected result.	Pass

10.1.12 Change Password

Table 116: Unit Testing - Change Password

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTL-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The change password modal is closed.	Same as expected result.	Pass
UTL-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The change password modal is closed.	Same as expected result.	Pass
UTL-003	Change password with empty field(s).	-	1. Leave the current password field, new password field and/or	**Current Password:** *empty*	1. The tooltip box for the	Same as expected result.	Pass

			confirm password field empty. 2. Press the "Save" button.	**New Password:** *empty* **Confirm Password:** *empty*	password field is triggered. 2. The empty field(s) are coloured red.		
UTL-004	Change password with invalid password in either field.	-	1. Enter invalid password in either field. 2. Press the "Save" button.	**Current Password:** tp0460 **New Password:** 1234 **Confirm Password:** 1234	1. The tooltip box for the password field is triggered. 2. The invalid fields are coloured red.	Same as expected result.	Pass
UTL-005	Change password with wrong current password and unmatching new	-	1. Enter incorrect password in the current password field.	**Current Password:** wrongpass	1. All the fields are coloured green.	Same as expected result.	Pass

	password and confirm password.		2. Enter new password in the new password field. 3. Enter unmatching new password in the confirm password. 4. Press the "Save" button.	**New Password:** 1234abcd **Confirm Password:** 1234dcba	2. The message "The new password and confirm password do not match." is displayed in the error field.		
UTL-006	Change password with wrong current password and correct new password as well as confirm password.	-	1. Enter incorrect password in the current password field. 2. Enter new password in the new password field. 3. Enter matching new password in the confirm password. 4. Press the "Save" button.	**Current Password:** wrongpass **New Password:** 1234abcd **Confirm Password:** 1234abcd	1. All the fields are coloured green. 2. The current password and the new password are RSA encrypted. 3. The message "Wrong current password." is	Same as expected result.	Pass

					displayed in the error field.		
UTL-007	Change password with correct current password and unmatching new password and confirm password.	-	1. Enter correct password in the current password field. 2. Enter new password in the new password field. 3. Enter unmatching new password in the confirm password. 4. Press the "Save" button.	**Current Password:** tp046085 **New Password:** 1234abcd **Confirm Password:** 1234dcba	1. All the fields are coloured green. 2. The message "The new password and confirm password do not match." is displayed in the error field.	Same as expected result.	Pass
UTL-008	Change password with correct current password and matching new password and	-	1. Enter correct password in the current password field. 2. Enter new password in the new password field.	**Current Password:** tp046085 **New Password:** 1234abcd	1. All the fields are coloured green. 2. The current password and the new	Same as expected result.	Pass

	confirm password.		3. Enter matching new password in the confirm password. 4. Press the "Save" button.	**Confirm Password:** 1234abcd	password are RSA encrypted. 3. A pop-up modal with the message "The password has been successfully changed." is displayed. 4. The change password modal is closed.		

10.1.13 Edit Organisation

Table 117: Unit Testing - Edit Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTM-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The edit organisation modal is closed.	Same as expected result.	Pass
UTM-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The edit organisation modal is closed.	Same as expected result.	Pass
UTM-003	Edit organisation with empty name in the name field.	-	1. Leave the name field empty. 2. Press the "Save" button.	**Name:** *empty*	1. The tooltip box for the name field is triggered. 2. The name field is coloured red.	Same as expected result.	Pass
UTM-004	Preview image.	-	1. Press the "Camera" icon. 2. Select a file of png, jpg or jpeg exntensions.	**Image File:** image.png	1. The image selected is displayed. 2. The "X" icon is displayed.	Same as expected result.	Pass

UTM-005	Remove image selected.	An image is selected.	1. Press the "X" icon in the image field.	-	1. The original image is displayed. 2. The "Camera" icon is displayed.	Same as expected result.	Pass
UTM-006	Select an invalid image in the image field.	-	1. Press the "Camera" icon. 2. Select a file of not png, jpg or jpeg extensions.	**Image File:** file.pdf	The tooltip box for the image field is triggered.	Same as expected result.	Pass
UTM-007	Edit organisation with invalid name in the name field.	-	1. Enter an invalid name in the name field. 2. Press the "Save" button.	**Name:** Chi!@ld Fo!@ation	1. The tooltip box for the name field is triggered. 2. The name field is coloured red.	Same as expected result.	Pass

UTM-008	Edit organisation with invalid phone number in the phone number field.	-	1. Enter an invalid phone number in the phone number field. 2. Press the "Save" button.	**Phone Number:** 012-abcdefg	1. The tooltip box for the phone number field is triggered. 2. The phone number field is coloured red.	Same as expected result.	Pass
UTM-009	Edit organisation with invalid email in the email address field.	-	1. Enter an invalid email in the email address field. 2. Press the "Save" button.	**Email Address:** kelvin@com	1. The tooltip box for the email address field is triggered. 2. The email address field is coloured red.	Same as expected result.	Pass
UTM-010	Edit organisation with the same organisation name that has	- There must be an organisation with the same name	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field.	**Image:** image.png **Name:** BefriendersKL	1. All the fields are coloured green. 2. An error message "There	Same as expected result.	Pass

	already registered within the database.	registered in the database.	3. Leave the phone number field empty. 4. Leave the email address field empty. 5. Press the "Save" button.	**Phone Number:** *empty* **Email Address:** *empty*	is already an organisation registered under the same name" is displayed.		
UTM-011	Edit organisation with valid image, name and.	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Leave the phone number field empty. 4. Leave the email address field empty. 5. Press the "Save" button.	**Image:** image.png **Name:** Childline Foundation **Phone Number:** *empty* **Email Address:** *empty*	1. All the fields are coloured green. 2. A pop-up modal with the message "The account has been successfully edited." is displayed. 3. The edit account modal is closed.	Same as expected result.	Pass

UTM-012	Edit organisation with valid image, name, and phone number.	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Enter valid phone number in the phone number field. 4. Leave the email address field empty. 5. Press the "Save" button.	**Image:** image.png **Name:** Childline Foundation **Phone Number:** 03-21312221 **Email Address:** *empty*	1. All the fields are coloured green. 2. A pop-up modal with the message "The organisation has been successfully edited." is displayed. 3. The edit organisation modal is closed.	Same as expected result.	Pass
UTM-013	Edit organisation with valid image, name, phone number	-	1. Enter valid image file in the image field. 2. Enter valid name in the name field.	**Image:** image.png **Name:** Childline Foundation	1. All the fields are coloured green. 2. A pop-up modal with the message "The	Same as expected result.	Pass

	and email address.		3. Enter valid phone number in the phone number field. 4. Enter valid email in the email address field. 5. Press the "Save" button.	**Phone Number:** 03-21312221 **Email Address:** mc@mcmc.org	organisation has been successfully edited." is displayed. 3. The edit organisation modal is closed.		

10.1.14 Management – Organisations

Table 118: Unit Testing - Management (Organisations)

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTN-001	Filter and display organisations based on empty search keyword.	- The user must belong to a government organisation.	1. Enter an empty search keyword in the search field.	**Search Keyword:** *empty*	All the organisations exist within the database is displayed.	Same as expected result.	Pass

		- There must at least be one organisation in the database.					
UTN-002	Filter and display organisations based on inexistent organisation name search keyword.	- The user must belong to a government organisation. - There must at least be one organisation in the database.	1. Enter an inexistent organisation name search keyword in the search field.	**Search Keyword:** mcdonald	The message "No organisations were found." is displayed on the page.	Same as expected result.	Pass
UTN-003	Filter and display organisations based on existing organisation	- The user must belong to a government organisation.	1. Enter an existent organisation name search keyword in the search field.	**Search Keyword:** childline foundation	The organisation(s) with the entered organisation name is	Same as expected result.	Pass

	name search keyword.	- There must at least be one organisation in the database.			displayed on the page.		
UTN-004	Display organisations of the subsequent page.	- There are two or more pages of organisations within the pagination bar.	1. Press the “Next” button.	-	The organisations of subsequent page are displayed on the page.	Same as expected result.	Pass
UTN-005	Display organisations of the previous page.	- There are two or more pages of organisations within the pagination bar.	1. Press the “Previous” button.	-	The organisations of previous page are displayed on the page.	Same as expected result.	Pass

UTN-006	Display organisations based on selected page number.	- There are two or more pages of organisations within the pagination bar.	1. Select a page number on the pagination bar.	-	The organisations of selected page number are displayed on the page.	Same as expected result.	Pass
UTN-007	Display one organisation's phone number and email address when both the information is not set.	- The user must belong to a government organisation. - There must at least be one organisation in the database. - The targeteed organisation has no phone	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. No information of the organisation is displayed on its backside.	Same as expected result.	Pass

		number or email address set.					
UTN-008	Display one organisation's phone number and email address when only the phone number is set.	- The user must belong to a government organisation. - There must at least be one organisation in the database. - The targeted organisation has no email address set.	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. Only phone number of the organisation is displayed on its backside.	Same as expected result.	Pass
UTN-009	Display one organisation's phone number	- The user must belong to a	1. Hover on one organisation profile.	-	1. The organisation profile user	Same as expected result.	Pass

	and email address when only the email address is set.	government organisation. - There must at least be one organisation in the database. - The targeted organisation has no phone number set.			interface is flipped. 2. Only email address of the organisation is displayed on its backside.		
UTN-010	Display one organisation's phone number and email address when both information has been set.	- The user must belong to a government organisation. - There must at least be one organisation	1. Hover on one organisation profile.	-	1. The organisation profile user interface is flipped. 2. The phone number and the email address of the organisation	Same as expected result.	Pass

		in the database. - The targeted organisation both phone number or email address set.			is displayed on its backside.		
UTN-011	Access add organisation functionality.	- The user must belong to a government organisation.	1. Press the "Add Organisation" button.	-	The add organisation modal is displayed.	Same as expected result.	Pass

10.1.15 Add Organisation

Table 119: Unit Testing - Add Organisation

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail

UTO-001	Close modal through "X" icon.	-	1. Press the "X" icon.	-	The add organisation modal is closed.	Same as expected result.	Pass
UTO-002	Close modal through "Cancel" button.	-	1. Press the "Cancel" button.	-	The add organisation modal is closed.	Same as expected result.	Pass
UTO-003	Add organisation with empty name in the organisation name field.	-	1. Leave the organisation name field empty. 2. Press the "Save" button.	**Name:** *empty*	1. The tooltip box for the organisation name field is triggered. 2. The organisation name field is coloured red.	Same as expected result.	Pass
UTO-004	Add organisation with empty username in the	-	1. Leave the system username field empty.	**System Username:** *empty*	1. The tooltip box for the system	Same as expected result.	Pass

	system username field.		2. Press the "Save" button.		username field is triggered. 2. The system username field is coloured red.		
UTO-005	Add organisation with empty username in the twitter username field.	-	1. Leave the twitter username field empty. 2. Press the "Save" button.	**Twitter Username:** *empty*	1. The tooltip box for the twitter username field is triggered. 2. The twitter username field is coloured red.	Same as expected result.	Pass
UTO-006	Preview image.	-	1. Press the "Camera" icon. 2. Select a file of png, jpg or jpeg exntensions.	**Image File:** image.png	1. The image selected is displayed. 2. The "X" icon is displayed.	Same as expected result.	Pass

UTO-007	Remove image selected.	An image is selected.	1. Press the "X" icon in the image field.	-	1. The original image is displayed. 2. The "Camera" icon is displayed.	Same as expected result.	Pass
UTO-008	Select an invalid image in the image field.	-	1. Press the "Camera" icon. 2. Select a file of not png, jpg or jpeg extensions.	**Image File:** file.pdf	The tooltip box for the image field is triggered.	Same as expected result.	Pass
UTO-009	Add organisation with invalid name in the organisation name field.	-	1. Enter an invalid name in the organisation name field. 2. Press the "Save" button.	**Name:** Bar!@ Foundation	1. The tooltip box for the organisation name field is triggered. 2. The organisation field is coloured red.	Same as expected result.	Pass

UTO-010	Add organisation with invalid username in the system username field.	-	1. Enter an invalid username in the system username field. 2. Press the "Save" button.	**System Username:** as@!	1. The tooltip box for the system username field is triggered. 2. The system username field is coloured red.	Same as expected result.	Pass
UTO-011	Add organisation with invalid username in the Twitter username field.	-	1. Enter an invalid username in the Twitter username field. 2. Press the "Save" button.	**Twitter Username:** @!fdwq	1. The tooltip box for the Twitter username field is triggered. 2. The system username field is coloured red.	Same as expected result.	Pass
UTO-012	Switch organisation type.	-	1. Press the organisation type or the arrow icon.	-	The selected organisation is displayed in the	Same as expected result.	Pass

			2. Select an organisation type.		organisation type field.		
UTO-013	Add organisation with a non-existent Twitter username.	- The Twitter username must not exist on Twitter.	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field. 3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid but non-existent username in the Twitter username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** vgadmin **Twitter Username:** sdqwdxsz1qqre12	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "The username did not exist on Twitter" is displayed.	Same as expected result.	Pass
UTO-014	Add organisation with the same organisation name that has	- There must be an organisation with the same name	1. Enter valid image file in the image field. 2. Enter valid existing name in the name field.	**Image:** *empty* **Name:** Childline Foundation	1. The organisation name, system username and the Twitter	Same as expected result.	Pass

	already registered within the database.	registered in the database.	3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid username in the Twitter username field. 6. Press the "Save" button.	**Type:** Non-Government **System Username:** cfadmin **Twitter Username:** testcf5	username fields are coloured green. 2. An error message "There is already an organisation registered under the same name" is displayed.		
UTO-015	Add organisation with the same system username that has already registered within the database.	- There must be an organisation with the same system username registered in the database.	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Select an organisation type.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** mcmcadmin	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "There	Same as expected result.	Pass

			4. Enter valid existing username in the system username field. 5. Enter valid username in the Twitter username field. 6. Press the "Save" button.	**Twitter Username:** testcf5	is already an organisation registered under the same system username" is displayed.		
UTO-016	Add organisation with the same Twitter username that has already registered within the database.	- There must be an organisation with the same system username registered in the database.	1. Enter valid image file in the image field. 2. Enter valid name in the name field. 3. Select an organisation type. 4. Enter valid username in the system username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** cfadmin	1. The organisation name, system username and the Twitter username fields are coloured green. 2. An error message "There is already an organisation	Same as expected result.	Pass

			5. Enter valid existing username in the Twitter username field. 6. Press the "Save" button.	**Twitter Username:** testbefrienders	registered under the same Twitter username" is displayed.		
UTO-017	Add organisation with valid name, type, system username and twitter username.	-	1. Leave the image field empty. 2. Enter valid name in the organisation name field. 3. Select an organisation type. 4. Enter valid username in the system username field. 5. Enter valid username in the Twitter username field.	**Image:** *empty* **Name:** Vanguards **Type:** Non-Government **System Username:** cfadmin **Twitter Username:** testcf5	1. The organisation name, system username and the Twitter username fields are coloured green. 2. A pop-up modal with the message "The organisation has been successfully created. The password for the	Same as expected result.	Pass

			6. Press the "Save" button.		organisation account is: {}." is displayed. (The curly bracket represents a randomly generated six-characters password.) 3. The add organisation modal is closed.		
UTO-018	Add organisation with valid image, name, type, system username and twitter username.	-	1. Enter valid image file in the image field. 2. Enter valid name in the organisation name field. 3. Select an organisation type.	**Image:** image.png **Name:** Vanguards **Type:** Non-Government	1. The organisation name, system username and the twitter username fields are coloured green.	Same as expected result.	Pass

			4. Enter valid username in the system username field. 5. Enter valid username in the twitter username field. 6. Press the "Save" button.	**System Username:** cfadmin **Twitter Username:** testcf5	2. A pop-up modal with the message "The organisation has been successfully created. The password for the organisation account is: {}." is displayed. (The curly bracket represents a randomly generated six-characters password.) 3. The add organisation modal is closed.		

10.1.16 Pop-up Message

Table 120: Unit Testing - Pop-up Message

Test Case ID	Test Case	Pre-Condition	Test Step	Sample Data	Expected Result	Actual Result	Pass/Fail
UTP-001	Close modal.	-	1. Press the "Continue" button.	-	The pop-up message modal is closed.	Same as expected result.	Pass

10.2 User Acceptance Testing

Within the user acceptance testing phase, several individuals were invited to conduct the test. Although fortunately that two of the individuals participated are from Childline Foundation, a non-government organisation, therefore they could provide more constructive opinions regarding the developed system. However, due to the fact that the government agencies are difficult to approach during the pandemic, one of the acquaintances was invited instead to represent the government agency within this test. To ensure the participants including the acquaintance can embody the appropriate mindset when using the system, the main purpose and objectives of the entire project and system was thoroughly explained before the test.

10.2.1 Tester #1

Code-Switching Cyberbullying Detection and Communication System					
Name: Datin Wong		**Date:** 26 June 2021			
Role/Position: Non-Executive Director (Childline Foundation)		**Time:** 3:00 P.M. – 3:20 P.M.			
Name of category	**Score (1 = Very Poor, 5 = Very Well)**				
	1	**2**	**3**	**4**	**5**
Meet Objectives					■
User Interface (Design)					■
Security					■
Performance (Speed)				■	
Easy and Convenient to Use					■
Bug-free				■	
Input Validation					■
Tester's Comment: This would be useful in our work at Childline to battle cyberbullying and it is easy to use for our beneficiaries.					

Action taken by Developer: Based on the score given for each quality attributes by the current tester regarding the system, the system was regarded to be performing immensely satisfactory as all the scores were leaned towards the positive side. During the system demonstration, a defect was discovered when accessing the past support messages sent modal, thus explained the score given for the "Bug-free" attribute. Undoubtedly, the bug was fixed by the developer immediately after to ensure the system always execute as intended. Apart from that, the score given for the attribute "Performance" indicates the occasional delay presented during the system usage. Although the delay could be explained wherein the participant's device that was viewing the demonstration has poorer performance, the developer has carried out several techniques to further smoothen the system performance including cleaning the code as well as optimising the database queries, preventing any displeasing sensation when utilising the system. According to the tester's comment, the system was considered to be effective in combatting cyberbullying issues in their environment, hence no additional requirements was necessary to be implemented within the system.	
Signature (Tester): _____	Signature (Developer): _____

10.2.2 Tester #2

Code-Switching Cyberbullying Detection and Communication System					
Name: Richie Lee		**Date:** 26 June 2021			
Role/Position: Operation Manager (Childline Foundation)		**Time:** 3:00 P.M. – 3:20 P.M.			
Name of category	**Score (1 = Very Poor, 5 = Very Well)**				
	1	**2**	**3**	**4**	**5**
Meet Objectives					
User Interface (Design)					
Security					
Performance (Speed)					

Easy and Convenient to Use					
Bug-free					
Input Validation					

Tester's Comment: The system does meet the objectives, however, based on the explanation given on how the tweets were streamed, if possible, the system should be able to detect more tweets. There was a bug presented as well during the demonstration of viewing the past support messages.

Action taken by Developer: Based on the score given for each quality attributes by the current tester concerning the developed system, the system was regarded to be performing satisfactory as well due to the scores were all inclined towards the positive spectrum. Aligning the comment as well as the "Meet Objectives" attribute score, the incidents the system is capable to detect was thought to be improvable such as extracting device's location without the location tag. However, due to the limitations and restrictions the Twitter API imposes, the additional improvement was deemed to be not possible at the current moment. Therefore, the improvements that could elevate the system ability in detecting cyberbullying incidents will be implemented when the restrictions were lightened in the future. Apart from that, the user interface score did not reach its peak due to the reason that the design language was not entirely consistent as voiced out by the tester during the demonstration. Therefore, the developer has scrutinised every single page and ensure the respective pages adhere to the same design language, establishing optimal consistency and familiarity across the pages. Furthermore, the tester has also conveyed his slight concern during the system demonstration as the tooltip messages are not clearly expressed, therefore could cause inconvenience, which justify the score given to the attribute "Easy and Convenient to Use". Thus, the developer has modified the tooltip messages to be as detailed as possible in order to provide comprehensive context to the users when using the system. As evident by the tester's comment, the attribute "Bug-free" was not given the perfect score due to the system crash when viewing the past support messages, which was the exact same bug as previously mentioned because these two testers were demonstrated the system concurrently. And as explained earlier, the bug was resolved shortly after.

Signature (Tester): _____	Signature (Developer): _____

10.2.3 Tester #3

Code-Switching Cyberbullying Detection and Communication System	
Name: Elijah Woo Weng Kong	**Date:** 01 July 2021
Role/Position: Software Engineering Student	**Time:** 7:00 P.M. – 7:30 P.M.

Name of category	Score (1 = Very Poor, 5 = Very Well)				
	1	2	3	4	5
Meet Objectives					
User Interface (Design)					
Security					
Performance (Speed)					
Easy and Convenient to Use					
Bug-free					
Input Validation					

Tester's Comment:

The developed system shows incredible capability in meeting its objective of detecting cyberbullying cases. Not to mentioned that the pristine looking user interface coupled with well thought out functionalities provides a superb user experience in approaching cyber bullying cases from the standpoint of cyberbullying prevention organisations. The demo that showcased the usage of the system was certainly impressive particularly in the aspect of performance whereby a tested twitter message that have been containing profanities was almost immediately identified and thus provides ample opportunities to intervene and suppressed the situation.

Action taken by Developer: Based on the score given for each quality attributes by the current tester concerning the developed system, the system was regarded to be performing extremely

well as almost score leaned towards the end of the positive spectrum. The only attribute that was somewhat lacking is the “Input Validation”, which explained by the tester that during editing organisation information, the possibility of the organisation having the same name as other organisation exist. Thus, the developer has enforced further restriction within the codebase to prevent same organisation name to be saved within the database.	
Signature (Tester): _____	Signature (Developer): _____

10.3 Summary

As the developer scrutinise and execute each and every test case within the unit testing, the developer has concluded that everything went as expected and the components including the input fields as well as the validations imposed are working perfectly fine. Through conducting the unit testing, the system was validated to its core, certifying the system execute with no defects meanwhile ensuring the system demonstration in the user acceptance testing phase went steadily.

Meanwhile, from the results gathered from the user acceptance testing, the system in overall was considered to be built exceedingly well. Not only does the system has meet the main objectives as in becoming an important factor to reduce cyberbullying cases in Malaysia, but the major quality attributes the target users were highly concerned of gathered during the interview conducted previously including user experience, user interface, performance and security have all perceived to be achieved incredibly as well within the developed system. Apart from the minor fixes with regards to the irregularities unveiled during the system demonstration, there was one suggestion given by a tester wherein the messages detection range should be enlarged is impossible and unachievable as of current due to restrictions imposed, thus such consideration will be placed for future enhancement. All in all, the system has passed both the unit testing and the user acceptance testing with flying colours and is more than ready to be deployed within the real-life environment.

Chapter 11: Conclusion and Reflections

11.1 General Conclusion

Before the commencement of any system development, the project foundation must first be evidently built through extensive planning and thorough research in diverse areas. For starters, the project documentation introduces the background of the project to delineate the general focus of the project. With that said, without identifying the root of the problem, the project direction will be in shambles. Therefore, the problem context is described meticulously to complement the project background. The main problem that inspires the proposal of this project is the prevalence of cyberbullying in Malaysia despite the current approaches and strategies established. Apart from that, there are several other problems related to cyberbullying unveiled and discussed as well. The problems comprised of the ineffectiveness or unawareness of NGOs helpline services, the lack of reporting from both victims and bystanders regarding the cyberbullying incidents and the inefficacious of monolingual cyberbullying detection system in Malaysia context. From these problems identified, the rationale defined to resolve these issues is through the development of a code-switching cyberbullying detection and communication system using sentiment analysis specifically on Twitter, whereby the system users can monitor cyberbullying messages and thereafter warn the cyberbullies or offer counselling support to the cybervictims. Through the employment of the system developed, multiple tangible and intangible benefits were perceived, the important ones include reducing the number of cyberbullying cases in Malaysia as well as decreasing the likeliness of victims suffering from mental illness. As mentioned earlier, there will be system users utilising the system. Since the system involves monitoring public tweets, warning cyberbullies and offering emotional support to the victims, the most appropriate target users deemed were cyberbullying-prioritised government agencies and emotional support-focused NGOs.

Based on the information elucidated above, the shape of the project scope and objectives must be mould concretely so as to prevent the occurrences of scope creep as well as facilitate the planning process. First and foremost, the project aims to develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government agencies and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets (Text-based only) generated

on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia. In order to accomplish the project aim defined timely and successfully, a series of measurable objectives is clarified in detail such as, to perform a study on topics with regards to cyberbullying and sentiment analysis to acquire in-depth knowledge and insights towards them in addition to devise and design comprehensive UML diagrams to define the system architecture and ease system development. As the system plays a huge role in the project, a myriad of preconceived system deliverables including sending Direct Message on Twitter and generating graphical chart is clearly established as well, which will be updated accordingly based on the research conducted. Aside from the project scope and objectives, the challenges that will be faced during the project timeline were individually stated and explained. For example, the lack of knowledge concerning the technologies applied as well as the time required to learn poses a threat to the project timeline. For the purpose of paving the first stage of the project into the correct direction along with counteracting said challenge, the project plan that contains the schedule of each task is conceived and illustrated carefully.

Furthermore, an abundant of published scholar articles in the topics of cyberbullying, sentiment analysis together with the research on similar areas was thoroughly studied. Through these rigorous investigations, the researcher has understood the severity of cyberbullying, the categories of cyberbullying, the concepts, approach and application of the proposed technology in different fields as well as the techniques employed during the machine learning model implementation that tackles similar problem such as hate speech and cyberbullying. Based on these valuable insights acquired from the past research, it assists the researcher in better identifying potential cyberbullying messages when creating the dataset to train the machine learning model and recognising the suitable approaches for constructing a competent system in terms of functionalities and techniques. Apart from that, several similar systems that address similar subject matter were selected, compared and analysed as well. This process was necessary to determine not only the essential features but also to unearth any explored or unexplored enhancements that could be incorporated to further improve the system. According to the analysis carried out, existing features such as generating graphical representations of the statistics calculated and displaying the profiles alongside the messages detected as cyberbullying in addition to new features including assessing the toxicity level of the cyberbullies based on the cyberbullying tweets posted over the past month

were considered important to be implemented into the system. Additionally, as far as the researcher concerns, no papers have explored cyberbullying detection system in Malaysia, a multilingualism country with an exorbitant usage of code-switching amongst the citizens. Thus, the case was determined as research gap which will be fulfilled by this paper.

Understanding the specifics pertaining to the functionalities to be developed and the techniques to be applied does not imply that the system can be built immediately. Choosing the wrong technical instruments to construct the system could be detrimental because the tools impulsively selected could be costly, hard to learn, complex to use, or may not even capable to achieve what the system originally intended in the first place, eventually leads to project failure. Therefore, meticulous technical research has been executed while accounting the project circumstances in the aspects of available budget, allocated timeline and the knowledge developer currently possess in order to pinpoint the most appropriate technical instruments to be applied when implementing the proposed system in terms of machine learning model, front-end and back-end. First of all, the programming languages selected that primarily builds the foundation of the system are Python 3.9.0 and JavaScript, specifically React 17.0.1. For the purpose of increasing the developer's productivity during the machine learning model and system development, two corresponding IDEs, Google Colaboratory and Visual Studio Code 1.52.1 were chosen. Besides, several libraries including Flask 1.1.2, mysqlclient 2.0.3, Tweepy 3.10.0, pandas 1.2.0, Matplotlib 3.3.3, scikit-learn 0.24.0 and TensorFlow 2.4.0 were carefully selected to either accelerate system development, ensure maintainable and readable codebase or even establish connection to the database. Speaking of database, MySQL 8.0.24 was deemed to suit the system use case the closest due to the system architecture drafted. Apart from that, the selection of the operating system wherein the system will be developed and deployed requires just as much attention as well. Based on the project context, Microsoft Windows 10 64-bit was determined to be the wisest choice yet without sacrificing the quality produced. Since the web-based system needs to be deployed and used by different users from their respective computers, after much consideration from the project and system perspective, Apache 2.4.46 was chosen as the most practical web server to be applied. Although the proposed web-based system can be accessed in all browsers, specifying one browser to develop the system at will guarantee uniformity in terms of system functionalities and design when being utilised by the targeted users. Thence, through rigorous research, the selection concluded with Microsoft Edge 87.0.664.75.

Technical research aside, the selection of the system development methodology is just as important as well. System development methodology is defined as a standardised process in developing systems ranging from planning up until maintaining. Without the proper selection of a methodology, not only will the system not developed in maintainable and timely manner, but the system may very well not satisfy the stakeholders' requirements as well, which is the most problematic issues amongst anything else. This is because the dissatisfaction towards the system developed leads to lack of utilisation, therefore making the system obsolete in no time. Thus, after comparing the two most widely known methodologies, Waterfall and Rapid Application Development in the aspects of project size, degree of flexibility, documentation requirements, business involvement rate, risk level as well as developer knowledge and expertise, the methodology that is believed to be the most suitable ones for the current project is rapid application development. As the methodology choice has been defined, the actual implementation on how each stage of rapid application development including requirements planning, user design, construction along with cutover will be adopted into the project was roughly drafted as well.

Although punctilious research has been conducted on previous resources, different factors such as timeline could result in distinct survey outcome. Moreover, the public as well as the target users may have different opinion or preferences regarding the proposed system and its features. Therefore, a concrete research methodology was defined to streamline the process of collecting and analysing data. For this particular project, the data collection methods, survey and interview were chosen, each designed to gather data from different population for different objectives. First of all, the technique, survey was utilised for the purpose of understanding the Malaysian victims' emotion towards cyberbullying experiences, the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and language presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system or government and NGOs' strategies in better handle cyberbullying incidents in Malaysia. Based on the objectives defined for the survey, data from 40 samples that represent the population of anyone who is a Malaysian, 18 years old or above and have either experienced or witnessed cyberbullying has been collected in the form of questionnaire using the snowball sampling technique. As for the other method, interview was conducted with the targeted system

users (Cyberbullying-focused government agencies and emotional support-focused NGOs) to acquire greater insights on the prevalence of cyberbullying cases in Malaysia from their perspective, their domain itself in handling cyberbullying incidents and their opinion and requirements for the proposed system. According to the objectives determined for the interview, data from 4 samples, each from MyCERT, MCMC, Childline Foundation and Vanguards4Change were gathered using the judgmental sampling technique. After analysing the data collected from both methods, the proposed system and its features will be retained with additional features that are categorised as prioritised and considered. The considered feature will only be incorporated into the system if there is available time. The prioritised features include a reminder that informs the system users to craft the messages that will be sent carefully as well as allowing system users to offer counselling help to even the cyberbullies. Meanwhile, the considered features are system features that allows the system users to create tweets that prevents outsiders' intervention except the tagged users (Cyberbully or cybervictim) and generate a 24-hour report regarding the cyberbullying incidents occurred. Features aside, the main system quality attributes concerned by the targeted users interviewed are user experience, user interface, performance and security, which will be optimised. There are several future enhancements identified as well, wherein it includes enabling the system to monitor cyberbullying messages transmitted from another social media platform (Facebook, Instagram and YouTube) along with the ability to detect code-switching cyberbullying messages that exists in between English, Mandarin and Malay simultaneously for the overall purpose of pinpointing cyberbullying incidents comprehensively and accurately.

Based on the results retrieved from the research conducted, the system development phase approaches accordingly. However, before the system starts being development, its internal implementation shall be elucidated with several diagrams to streamline the implementation process. According to the system architecture as well as the developer's knowledge and expertise, the system design methodology, object-oriented analysis and design methodology was selected wherein diagrams including use case diagram, use case specification, activity diagram and sequence diagram except class diagram was depicted to represent the system and its flow of communication from different perspective. Additionally, the database structure implemented within the system was illustrated with entity relationship diagram and data dictionary to provide greater insights on how the data were structured within the system. Not the mention, the interface design or essentially wireframe was drafted as well to provide the developer a general idea as to

how the system should be developed from the target users' perspective in order to maximise user experience. Due to the system development methodology chosen, the diagrams are illustrated in conjunction with the system development revolving around the detailed explanation of the core features as well as the abstract architecture concocted within the same phase. During the design process, a project plan regarding versions released for each iteration of system development was formulated as well, wherein each version contains major feature or features the to be demonstrated to the target users.

As soon as the components developed for each iteration have been consolidated within the construction phase, the test plans particularly for unit testing and user acceptance testing was composed to ensure a complete and thorough testing across the system features from both the developer as well as the target users. Within the unit testing process, the developer has certified that the individual components developed in the system achieved their purpose after the step-by-step execution and observation of the respective test cases formulated. On the other hand, after demonstrating the system to various testers through video call for the user acceptance testing phase, two from Childline Foundation to represent non-governmental organisation users meanwhile one from acquaintance to represent governmental organisation users as the government agencies are difficult to approach due to the pandemic at present, the system received an overwhelming great responses and regarded as satisfactory and applicable as all the scores given for the quality attributes leaned towards the positive spectrum. Although there are minor defect and irregularities presented during the demonstration, which have been fixed immediately after, the main system quality attributes concerned by the interviewees during the interview carried out at earlier phase including user experience, user interface, performance as well as security have most importantly, all successfully achieved, signifying that the system can be transitioned into the real-life environment and start detecting cyberbullying incidents on Twitter.

As the testing process ended, the screenshots of the system supplemented with elaborate description in terms of its user interface as well as several code-based internal implementations were concocted to provide readers especially the system engineers after deployment a comprehensive context about the system as to how the system works and be maintained when faulty errors occurred.

11.2 Critical Evaluation

11.2.1 Limitations

Despite the proposed system has been developed successfully with careful considerations and excellent quality, there were several limitations exist within the system as well.

11.2.1.1 Restricted Detection Range of Cyberbullying Messages

As contemplated by the developer previously as well as expressed by the tester, the most noteworthy limitation within the system would be the necessity to include the location tag within the tweet, only then will it be captured by the system and perform the necessary validations and operations. With said limitation, cyberbullying tweets with no location tag will unfortunately be neglected. There are several techniques that have been pondered by the developer before. One of which involves collecting tweets based on the messages with code-switching language between English and Malay rather than bounded by location tag. However, this approach would mean that the tweets will be streamed from the entire world, which could take a huge toll on the system performance and cause the entire system unusable. On top of that, despite the project focuses on code-switching cyberbullying messages, the main problem the current project is tackling still remain the prevalence of cyberbullying incidents in Malaysia, meaning although exists, there are still cyberbullying messages that are purely English and Malay language alone, employing such approach would imply omitting these incidents as well, making this approach considerably ineffective. The ideal technique would be locating the tweet based on the device's location instead of monitoring the location tag, which also thought by the developer as well. Having said that, that approach would be impossible as of current due to the restrictions imposed by the Twitter API utilised. Thus, as long as restriction persists, the present technique implemented is still regarded as the most optimal approach.

11.2.1.2 Lack of Two-way Communication

Another limitation of the system involves the absence of the chatroom wherein the system users are able to communicate with the cyberbullies or cybervictims and vice-versa. With the chatroom feature, the communication process can be carried out through the system itself without the need

to contact via phone number, therefore streamline the communication process. However, due to limited period of system development time as well as its intense difficulty to construct said feature, the feature would be implemented in the future as enhancement towards the system. With that being said, the current one-way communication implementation still possesses its benefits as the system users will not be bombarded with spam chats and cluttered the other conversation meanwhile maintaining secrecy of the affected concerns as the conversation will not be recorded within the system.

11.2.1.3 Unavailable to Generate Incidents Report

The following limitation revolves around the inability for the system users to generate report regarding the cyberbullying incidents occurred. Through the feature implemented, the system users shall have a holistic view regarding the respective cyberbullying incidents detected and take suitable actions to the individuals. Since the system has already considered to segregate cyberbullies into different toxicity levels to highlight their cyberbullying behaviours as well as amount of time and effort required to implement this feature during such finite timeline, the feature was not implemented in the system. Nonetheless, the feature was still regarded as a limitation presented within the system because one of the interviewees in earlier project phase has proposed said feature. To ensure the system perform as efficacious as possible, the feature will be considered as future enhancement.

11.2.2 Future Enhancements

Apart from the enhancements proposed within the limitations section, there are several other interesting improvements that could be integrated within the developed system as well.

11.2.2.1 Greater Model Prediction Accuracy

Although perfect accuracy in predicting cyberbullying messages, or anything using machine learning is impossible, its accuracy can still be improved to approximate perfection. Based on the plethora of machine learning and deep learning techniques trained and tested against the filtered dataset, the logistic regression model has achieved the best recall score in identifying particularly the code-switching cyberbullying and was integrated within the system. However, its precision score is considerably low regardless, meaning it will be more likely in detecting non-cyberbullying messages as cyberbullying. Therefore, in the future, more code-switching data could be collected or even the technique itself could be tweaked in fine-grained manner to further augment the model accuracy. These two factors aside, the system could take the cyberbullying messages detected and fed into the machine learning model as well to simultaneously ease the process of data collection and also increase the model efficaciousness in predicting cyberbullying incidents.

11.2.2.2 Expand Language Detection

Another enhancement that could be integrated within the system in the future time is the ability to detect code-switching cyberbullying messages of other languages as well. As evident within the survey conducted in previous section, most participants wholeheartedly agree that the code-switching cyberbullying messages between English, Mandarin and Malay are just as prevalent as between English and Malay. Through the expanded capability, the system can be equipped to detect more cyberbullying messages in Malaysia and allow more affected individuals to be extended help by the system users as well, making the system significantly more effective than ever.

11.2.2.3 Expand Social Media Detection

The subsequent future enhancement would involve detecting cyberbullying messages across other social media platform. Albeit straightforward, such advancement would make the system a few times more robust in combatting cyberbullying incidents within Malaysia as without questions, more cyberbullying incidents will be identified. Based on the survey conducted long ago, most participants browse through the social media platform such as Facebook and YouTube compared to Twitter. However, due to the restrictions imposed by these platforms, the intended concept for the proposed system was not accomplishable. Thence, once these restrictions have been lifted, these platforms can then be integrated within the system to facilitate its comprehensiveness in detecting cyberbullying incidents.

11.3 Personal Reflections

Throughout the entire journey within this project, the developer has grown significantly not only in terms of knowledge and skills but also personality-wise as well. During the system development, the countless nights of studying, researching and experimenting with technologies including machine learning and natural language processing previously unbeknownst to the developer has without questions assist the developer in acquiring a comprehensive understanding on the concept as well as the implementation behind them, which leads to the success of machine learning model creation with decent accuracy as well as coincidentally increases the job opportunities in the future as well. Additionally, the simultaneous development between client-side and server-side of the system has taught the developer immensely in the matters to be cautious of, plus becoming a better full-stack developer in the meantime. Not to mention, the encryption and decryption concept and process has remarkably ingrained within the developer's mindset as the developer has to spend a considerable period of time purely in researching and implementing encryption and decryption algorithm across different libraries, which in the end made the system extremely secure as the sensitive information transmitted across the front-end to back-end or vice-versa are always encrypted and hidden from the public. Technical knowledge aside, during the research phase, the developer has comprehended on how to better approach the others especially when it involves official subjects and thankfully, several non-governmental organisation and government agencies have agreed to the interview.

As mentioned earlier, the project has contributed to the developer's personal growth as well, especially when the problems strike, and there are multitude issues the developer has encountered so far. The most memorable ones would undoubtedly when MyCERT has mentioned that their agency will be refrained from involving cyberbullying-related cases, thus cannot offer in-depth opinion for the proposed system. However, thanks to the leniency of the project supervisor, the opportunity to interview other government agency was given, and this situation has taught the developer to stay calm even in the direst circumstances. Apart from the research area, although the first stage of the project was able to be completed in time, the developer realises that indecisiveness and constantly getting distracted have been the main cause as to why an immense amount of time was wasted. The long-winded hesitation to make a decision and the addiction on social media have suspended the developer's progress for multiple occasions, such behaviour could raise a huge

complication during the system development. Thus, this experience has been helpful to the developer in pondering on the behaviour and attune against it, which was reflected in the second stage of the project as the system was able to be implemented within allocated timeline. Furthermore, although the initial database management system chosen was MongoDB, the developer has found out that the choice was not ideal even though the developer has already reached halfway through the system development. Therefore, the developer has to essentially waste days of important development time merely in modifying the codebase as well as the documentation significantly just to switch to a more appropriate database management system.

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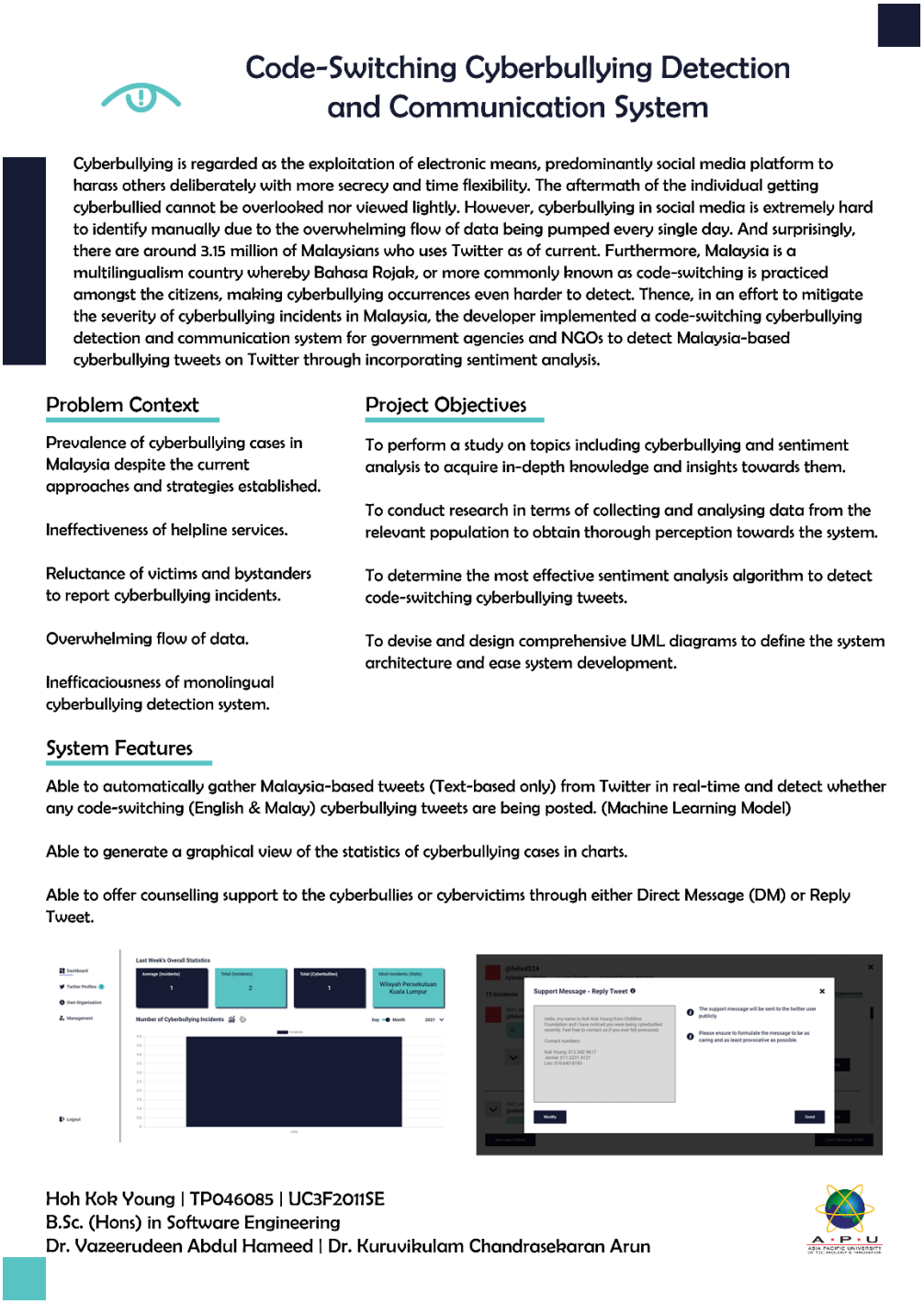
Appendices

Log Sheets

Final Year Project Poster



Code-Switching Cyberbullying Detection and Communication System

Cyberbullying is regarded as the exploitation of electronic means, predominantly social media platform to harass others deliberately with more secrecy and time flexibility. The aftermath of the individual getting cyberbullied cannot be overlooked nor viewed lightly. However, cyberbullying in social media is extremely hard to identify manually due to the overwhelming flow of data being pumped every single day. And surprisingly, there are around 3.15 million of Malaysians who uses Twitter as of current. Furthermore, Malaysia is a multilingualism country whereby Bahasa Rojak, or more commonly known as code-switching is practiced amongst the citizens, making cyberbullying occurrences even harder to detect. Thence, in an effort to mitigate the severity of cyberbullying incidents in Malaysia, the developer implemented a code-switching cyberbullying detection and communication system for government agencies and NGOs to detect Malaysia-based cyberbullying tweets on Twitter through incorporating sentiment analysis.

Problem Context

Prevalence of cyberbullying cases in Malaysia despite the current approaches and strategies established.

Ineffectiveness of helpline services.

Reluctance of victims and bystanders to report cyberbullying incidents.

Overwhelming flow of data.

Inefficaciousness of monolingual cyberbullying detection system.

Project Objectives

To perform a study on topics including cyberbullying and sentiment analysis to acquire in-depth knowledge and insights towards them.

To conduct research in terms of collecting and analysing data from the relevant population to obtain thorough perception towards the system.

To determine the most effective sentiment analysis algorithm to detect code-switching cyberbullying tweets.

To devise and design comprehensive UML diagrams to define the system architecture and ease system development.

System Features

Able to automatically gather Malaysia-based tweets (Text-based only) from Twitter in real-time and detect whether any code-switching (English & Malay) cyberbullying tweets are being posted. (Machine Learning Model)

Able to generate a graphical view of the statistics of cyberbullying cases in charts.

Able to offer counselling support to the cyberbullies or cybervictims through either Direct Message (DM) or Reply Tweet.

Hoh Kok Young | TP046085 | UC3F2011SE
B.Sc. (Hons) in Software Engineering
Dr. Vazeerudeen Abdul Hameed | Dr. Kuruvikulam Chandrasekaran Arun

Figure 303: Final Year Project Poster

Semester 1 - Meeting #1

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
3. A log sheet is to be brought by the STUDENT to each supervisory session.
4. The actions by the student (and, perhaps the supervisor), which should be carried out before the next session should be noted briefly in the relevant section of the form.
5. The student should leave a copy (after the session) of the Project Log Sheet with the supervisor and to the administrator at the academic counter. A copy is retained by the student to be filed in the project file.
6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 14/12/2020 **Meeting No:** 1

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Viability of the FYP title chosen.

2. Expectations regarding the system during the system demonstration.

3. Clarify what kind of systems are identified as similar.

4. Enquire the suitability of traditional methodology.

5. Enquire the suitability of using sources from 2015.

6. Enquire whether the investigation report (IR) can exceed word limit.

Record of discussion (noted by student during mandatory supervisory meeting):

1. The FYP title chosen is accepted.

2. The system during demonstration can be a prototype, whereby the system can focus on only English and the usage of Facebook API is unnecessary.

3. Understood that systems that have elements of text mining or machine learning can be identified as similar systems.

4. Comprehended that any methodologies are completely applicable as long as proper justifications are elaborated.

5. Recognized that sources from any year can be referred provided that the sources are one of the

Project Log Sheet

Figure 304: Log Sheet Meeting #1 - Part 1

latest. **6.** Understood to stay within the word limit for IR. **7.** Ensure to submit project proposal form (PPF), project specification form (PSF) and IR on time.
Action List (to be attempted or completed by student by the next mandatory supervisory meeting): **1.** Complete the PSF by next meeting including the software development methodology discussed. **2.** Decide on similar systems and discuss the appropriateness of these systems for comparison purpose.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 305: Log Sheet Meeting #1 - Part 2

Semester 1 - Meeting #2

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
3. A log sheet is to be brought by the STUDENT to each supervisory session.
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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 12/01/2021 **Meeting No:** 2

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Enquire the feasibility to proceed further on the current FYP idea after discovering Twitter API prohibits any usage of its data for monitoring purpose.

2. Enquire whether main problem statement can still be maintained and discussed despite literature review identifies different research gap.

3. Clarify the procedures required to contact government officials.

4. Identify whether certain benefits written can be considered as tangible benefits.

5. Enquire the necessity to compose full-track ethics form because victims of cyberbullying are involved in data collection.

6. Shed light on whether the systems from research articles can be selected and compared under investigation report (IR).

Record of discussion (noted by student during mandatory supervisory meeting):

1. The current FYP idea is still deemed feasible because FYP is a proof of concept.

2. The main problem statement can still be retained meanwhile the research gap can be listed as one of the problem statements as well.

3. E-mailing should be enough to contact government officials, no official letter from APU required.

Project Log Sheet

Figure 306: Log Sheet Meeting #2 - Part 1

4. Advised to leave those under intangible benefits. **5.** Understood that fast-track ethics form is sufficient as long as the victims of cyberbullying are given the choice of whether to answer the survey or not. **6.** Encouraged to compare systems selected from research articles in IR.
Action List (to be attempted or completed by student by the <u>next</u> mandatory supervisory meeting): **1.** Polish the project specification form (PSF) in accordance with the discussed resolution. **2.** Complete the fast-track ethics form by the next meeting.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 307: Log Sheet Meeting #2 - Part 2

Semester 1 - Meeting #3

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
3. A log sheet is to be brought by the STUDENT to each supervisory session.
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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 02/02/2021 **Meeting No:** 3

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Reaffirm the necessity of completing full-track ethics form.

2. Enquire the required number of respondents to be received for the questionnaire and the interview.

3. Enquire whether it is acceptable to surpass the word limit for investigation report (IR).

4. Shed light on whether it is possible to email Mr. Dhason to requests for an official reference letter from APU so that the governmental bodies contacted can recognise the legitimacy of the email sent.

Record of discussion (noted by student during mandatory supervisory meeting):

1. Reassured that fast-track ethics form will be adequate as long as the victims of cyberbullying have the choice to withdraw from the survey at any time for any reasons.

2. Advised that the minimum number of respondents for the questionnaire is 30, recommended is between 50 to 70, generally, the idea is the more the respondents, the better. Meanwhile for the interview, the total minimum number of respondents is 3, can be two from the NGOs and one from the government (MyCERT).

3. Advised to keep writing as usual, and the word limit for IR should not be a concern.

4. Encouraged to email Mr. Dhason to acquire an official reference letter from APU so as to streamline communication with governmental bodies.

Project Log Sheet

Figure 308: Log Sheet Meeting #3 - Part 1

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Complete the fast-track ethics form and have the supervisor to sign it before the deadline.

2. Send an email to Mr. Dhason to obtain an official reference letter from APU.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 309: Log Sheet Meeting #3 - Part 2

Semester 1 - Meeting #4

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
3. A log sheet is to be brought by the STUDENT to each supervisory session.
4. The actions by the student (and, perhaps the supervisor), which should be carried out before the next session should be noted briefly in the relevant section of the form.
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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 25/02/2021 **Meeting No:** 4

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Enquire on what to do about not having sufficient time to interview another government agency (MCMC) because MyCERT will shift its focus in the future to cyberthreats that are more technical, not cyberbullying.

2. Enquire on which format of log sheet to submit, either the ones submitted on FYPBaNK or document based.

3. Enquire on whether to update the previous chapters based on the findings obtained from the collected and analysed data.

Record of discussion (noted by student during mandatory supervisory meeting):

1. Advised to submit the IR with the obtained results. Proceed the interview with the government agency and update the results afterwards.

2. Recognised that submit either format of log sheet is fine.

3. Understood that update or not update the previous chapters is up to own decision. However, updating one chapter requires other chapters to be updated accordingly as well.

Project Log Sheet

Figure 310: Log Sheet Meeting #4 - Part 1

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Complete and submit the IR.

2. Complete the interview with the other government agency.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 311: Log Sheet Meeting #4 - Part 2

Semester 2 – Meeting #5

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 19/05/2021 **Meeting No:** 5

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Enquire improvements and modifications necessary regarding the investigation report.

2. Enquire required number of participants in user acceptance testing and raise concerns on difficulties in approaching government agencies during the pandemic.

3. Discuss on the lack of code-switching cyberbullying dataset and enquire on the possibility to employ pure English and Malay dataset if creating own dataset prove to be too implausible within the short period of time.

Record of discussion (noted by student during mandatory supervisory meeting):

1. The software development methodology chosen and documented in the investigation report was deemed not practical, therefore was suggested to change when there was sufficient time.

2. Informed that three participants are necessary in the user acceptance testing phase and suggested that friends or families can partake the testing on behalf of the government agencies, provided they were thoroughly educated with the project and system objectives.

3. Reassured that method suggested on constructing the dataset is applicable.

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Switch and document the new software development methodology to be incorporated into the project.

Project Log Sheet

Figure 312: Log Sheet Meeting #5 - Part 1

2. Explore methods and techniques on constructing the code-switching cyberbullying dataset.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 313: Log Sheet Meeting #5 - Part 2

Semester 2 – Meeting #6

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
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7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 01/07/2021 **Meeting No:** 6

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Enquire on the necessity to conduct integration or system testing.

2. Enquire on the format and standard when formulating the interface design.

3. Enquire on how to construct the class diagram to represent the database structure instead as no object-oriented programming concept was employed within the proposed system despite selecting the object-oriented analysis and design (OOAD) system design methodology.

4. Clarify the contents to be included in the video presentation and whether need to setup camera or not.

5. Clarify the contents to be included in the final year project poster.

6. Clarify the contents to be included in the conclusion section.

Record of discussion (noted by student during mandatory supervisory meeting):

1. Informed that only the unit testing and the user acceptance testing are compulsory, the others are optional.

2. Informed that the format and standard for the interface design is up to the developer.

3. Reassured that the class diagram was not necessary and can be removed, meanwhile construct the entity relationship diagram to represent the database instead.

4. Informed that the video presentation should include the project's problem context, the main

Project Log Sheet

Figure 314: Log Sheet Meeting #6 - Part 1

objectives and the system demonstration without the need to setup camera, all within ten minutes. **5.** Understood that the final year project should contain necessary information reflecting the project. **6.** Understood that the contents necessary within the conclusion section are limitations and future enhancements.
Action List (to be attempted or completed by student by the next mandatory supervisory meeting): **1.** Complete the testing process for unit testing and user acceptance testing. **2.** Complete the interface design as well as the system design based on the discussed requirements. **3.** Finish shooting the video presentation and illustrate the final year project poster. **4.** Complete the conclusion section within the report based on the discussed requirements.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 315: Log Sheet Meeting #6 - Part 2

Semester 2 – Meeting #7

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: Hoh Kok Young **Date:** 12/07/2021 **Meeting No:** 7

Project title: Code-Switching Cyberbullying Detection and Communication System in Malaysia **Intake:** UC3F2011SE

Supervisor's name: Dr. Vazeerudeen Abdul Hameed **Supervisor's signature:** Vazeer

Items for discussion (noted by student before mandatory supervisory meeting):

1. Enquire on the contents to be included within the presentation slides and maximum slides permitted.

2. Enquire on whether the scope of tweets streamed to the system can be lowered during presentation.

Record of discussion (noted by student during mandatory supervisory meeting):

1. Informed that presentation contents should contain summarised information of the final year project report and the maximum slides are restricted to 15 in total.

2. Informed that the scope of tweets streamed to the system can be lowered during presentation.

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Complete the presentation slides based on the requirements discussed.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Figure 316: Log Sheet Meeting #7

Project Proposal Form (PPF)

ASIA PACIFIC UNIVERSITY
OF TECHNOLOGY & INNOVATION

Project Proposal Form (PPF)

Code-Switching Cyberbullying Detection and Communication System in Malaysia

Name:	Hoh Kok Young
TP Number:	TP046085
Intake Code:	UC3F2011SE
Supervisor:	Dr. Vazeerudeen Abdul Hameed
Second Marker:	Dr. Kuruvikulam Chandrasekaran Arun

Figure 317: Project Proposal Form - Cover Page

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Aims....3
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Figure 318: Project Proposal Form - Table of Contents

Introduction

Since the birth of social media, people around the globe have been gifted the unimaginable opportunity to communicate amongst each other with total freedom without the hassle of travelling or mailing. Aside from communication purposes, the social media community may also freely express their personal interests and opinions with the choice of being anonymous to the public. Having said that, some people have taken the freedom and the anonymity for granted and went overboard with their actions. For instance, some of the individuals on the social media blatantly calling Muslims being pigs or declaring that everyone should decapitate Muslims (Imran Awan, 2020). These behaviours that reek of absolute disgust, believe it or not, is a ubiquitous phenomenon today and unfortunately is expected to rise substantially for years to come (Patchin, 2019).

Cyberbullying, unlike traditional bullying, is regarded as the exploitation of social media platform to harass others deliberately with more secrecy and time flexibility (Zhao, Zhou and Mao, 2016). The aftermath of the individual especially the young ones getting cyberbullied cannot be overlooked nor viewed lightly. These traumatic experiences may range from having low self-confidence to something much worse that could possibly last a lifetime (Foong and Oussalah, 2017). Despite that, cyberbullying in social media is extremely hard to combat due to one of the reasons being the overwhelming flow of data being pumped every single day. To illustrate, it is revealed that there are approximately 500 million of tweets being posted on Twitter every single day (Mention, 2018). The more devastating part about cyberbullying is the fact that no countries are insusceptible to the issue of cyberbullying, not even Malaysia, a country with variety of ethnicities. According to a large-scale survey with 20793 respondents conducted by Ipsos in 2018, it was revealed that Malaysia is ranked top 10 amongst the other 28 countries in terms of the most cyberbullying cases reported by the parents of the victims of cyberbullying (Cook, 2020). The cruel assumption would be that this just a mere fraction of cyberbullying cases that are reported while many more could have gone unnoticed. And surprisingly, around 3.15 million of Malaysians uses Twitter (Clement, 2020). Therefore, in an effort to mitigate cyberbullying cases in Malaysia, this paper will delve deeper towards the idea of implementing a web-based cyberbullying detection system that detects Malaysia-based cyberbullying tweets on Twitter through incorporating both machine learning (ML) and natural language processing (NLP), or in short, sentiment analysis.

1

Figure 319: Project Proposal Form - Page 1

Problem Statement

Prevalence of cyberbullying cases in Malaysia, is the main problem that inspires the proposal of this project. As mentioned earlier, Malaysia was ranked top 10 in a large-scale survey conducted in 2018 as the most cyberbullying cases reported by the victim's parents. To further solidifies the severity of this issue, another poll initiated by the United Nations Children's Fund (UNICEF) in 2019 have addressed that 3 in 10 youths have experienced getting cyberbullied (Athira Nortajuddin, 2020). It is fair to say that Malaysia as of current has not found the definite solution to mitigate cyberbullying cases. Speaking of solution, as of today, there are quite a few helpline services for victims of cyberbullying in Malaysia, such as Befrienders Malaysia and Protect and Save the Children (R.AGE, 2016). However, the ineffectiveness of these helpline services became obvious as it was reported that 63% out of the approximate 5000 Malaysian respondents were not acquainted with these services (Bernama, 2019). These data imply that there could be victims of cyberbullying out there being on the edge of the precipice, just one step away from leaving their loved ones yet was blind to the helping hand extended to them. Effectiveness aside, the perception of these victims towards the consequences of reporting their experiences from being cyberbullied can said to be the greatest factor in determining whether these cyberbullying cases will be unveiled and combated. Victims with low self-esteem are reluctant to report their incidents of getting cyberbullied as they perceive it will only worsen the situation or just flat out futile. Heartbreakingly to say, some may even think they deserve such treatment (Gordon, 2020), hence would rather not seek for help. As long as no parties have found the definite way to mitigate these occurrences, sooner or later the unexpected will arrive. Besides, as discussed previously, the amount of tweets generated on Twitter are enormous. Van Hee et al. (2018) claims that these overwhelming data are too many for the moderators to even remotely monitor manually and subsequently agreed that a system that automatically detects these negative sentiment messages is inevitable. Not to mention, cyberbullying detection system that prioritizes on one language at a time will not be as effective in Malaysia as there are Malaysians who uses code-switching in their communication with others. According to the study by Tan, Shahidatul Maslina Mat So'od and Bahiyah Abdul Hamid (2019), they unveiled that Malaysians uses code-switching which is switching from English to Malay and vice versa to insult other people on Twitter.

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Project Aims and Objectives

Aims

To investigate the characteristics of cyberbullying in Malaysia and develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for MyCERT and NGOs to monitor cyberbullying activities amongst myriad of Malaysia-based code-switching tweets generated on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia.

Objectives

The objectives of this project are:

1. To identify the categories of cyberbullying.
2. To determine the patterns of how Malaysians cyberbully others.
3. To determine the most effective sentiment analysis algorithm to detect code-switching cyberbullying tweets.
4. To design and develop a web-based code-switching cyberbullying detection and communication system.

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Literature Review

Various areas regarding cyberbullying has been gradually explored and scrutinized by researchers of diverse demographics as the severity of cyberbullying cases accelerates. Meanwhile, ML and NLP has become the new buzzword for recent generations due to the contributions it has made such as machine translation and speech recognition (Davydova, 2017). With the advancement of ML and NLP, the intertwinement of these two technologies pave a convincing path to achieve the development of cyberbullying detection system.

In prior to conferring about ML and NLP, recognizing whether a message has a notion or trace of cyberbullying is just as essential. Watts *et al.* (2017 cited in Peled, 2019) has unveiled that there is a total of seven categories of cyberbullying: flaming, harassment, cyberstalking, denigration, trickery and outing, masquerading, exclusion. Another study as well supports the categorization of cyberbullying above with two new additions; trolling and fraping (Haidar *et al*., 2016, Zainudin *et al*., 2016, Romsaiyud *et al*., 2017, Moncur *el al*., 2016 cited in Mahlangu, Tu and Owolawi, 2018). Although this type of compartmentalization of cyberbullying can assist the system in pinpointing cyberbullying precisely, some type of cyberbullying can be quite the challenge to detect accurately. For example, masquerading, where one snatches another identity and fool others by forging their profile. This kind of situation can be surprisingly tricky as it is near to impossible to identify which profiles are the real ones. However, the article by Van Hee *et al*. (2018) has categorized cyberbullying in an even more comprehensive and discernible manner wherein it comprises of threat/blackmail, insult, curse/exclusion, defamation, sexual talk, defense and encouragement to the harasser. Although these classifications are not as specific as the previous articles, it is certainly providing more coverage of cyberbullying as it does not restrict the perspective of looking at cyberbullying from the cyberbully itself but also the victim and even the defender as well. Ultimately, making the system much competent than ever before.

Several researches have been carried out to develop cyberbullying detection system. One of which is a mobile app called BullyBlocker that detects cyberbullying severity amongst the younglings on Facebook and reports it to the parents who installed it (Silva *et al*., 2016). Few years passed, a more effective system that uses ML and NLP has creeped up. Machine Learning (ML) is a branch of Artificial Intelligence (AI) that learns and ameliorates all by itself through the data that it was fed towards without explicitly programmed. One of the most employed methods of ML in detecting cyberbullying is supervised learning where it predicts the output

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based on the labelled data learned previously (Expert System, 2017). As proof, research conducted by Del Vigna *et al*. (2017), Foong and Oussalah (2017) have utilized the algorithm of classification in supervised learning, Support Vector Machine (SVM) to detect English-based cyberbullying messages on Facebook and ASKfm. Additionally, Amgad Muneer and Suliman Mohamed Fati (2020) have applied and compared various machine learning algorithms including SVM to detect cyberbullying on Twitter. The research concluded with Logistic Regression (LR) being the best algorithm with the highest accuracy and was observed that the algorithm become more accurate as the data being fed increases. On the contrary, SVM classifier has the lowest accuracy amongst the other classifiers. On the other hand, natural language processing (NLP), is a subset of AI where it aids the computers in comprehending, deciphering and manipulating the language we speak (SAS, 2020). NLP itself contains several algorithms, one of which is text classification algorithm, and SVM is one of the methods that can be utilized to devise text classification model. Another algorithm of NLP is text extraction algorithm. TF-IDF, also known as term frequency-inverse document frequency has also been applied by Foong and Oussalah (2017) in their research where it identifies the significant of a word within a sentence in a congregation of documents (MonkeyLearn, 2019). Alhamda Adisoka Bimantara *et al*. (2019) has attempted the TF-IDF approach as well to assist in detecting Indonesian-based cyberbullying comments on Instagram. These researches have proved more than enough that such system is a viable.

Although the studies above have achieved remarkable results, most researches are only focused on a specific language and have failed to consider the factors of countries with diverse ethnicities that practices multilingualism, which would influence the cyberbullying messages being conveyed. One of the prime examples is Malaysia, where the citizens of different ethnicities may or have mastered some degree of eloquence in the three main languages in Malaysia; Bahasa Malaysia, English and Mandarin, which most of the time influences the way they use these languages to speak with different ethnics. This statement can be supported by Albury (2017) where he discovered that Malaysians especially the youths uses Bahasa Rojak, a smooth exploitation of different languages in communicating with others based on the context and ethnicity. Tan, Shahidatul Maslina Mat So'od and Bahiyah Abdul Hamid (2019) also unveiled that Malaysians uses code switching which is switching from English to Malay and vice versa to insult other people on Twitter. It is evident that research on cyberbullying detection system in a multilingualism country is a crucial aspect to be considered.

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This comprehensive review has conferred about the segmentation of cyberbullying as well as the algorithm or technique of ML and NLP used in similar system. More importantly, it is identified that there are little to zero research papers that have explored the cyberbullying detection system in a multilingualism country of different ethnicities such as Malaysia. Therefore, this paper will be filling the research gap by proposing a cyberbullying detection system in Malaysia that can identify code-switching cyberbullying messages.

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Deliverables

The proposed system eases the Malaysian authorities' effort in identifying code-switching cyberbullying tweets on Twitter as well as allows the NGOs to offer counselling help to the victims of cyberbullying if needed. The list below shows the system features and functionalities that will be developed for each user:

System

- Able to automatically gather Malaysia-based tweets from Twitter and detect whether any cyberbully cases are occurring. (Machine Learning Model)
- Able to generate a graphical view of the statistics of cyberbullying cases.

All Users

- Able to login to the system.
- Able to monitor the statistics of the cyberbullying cases and filter based on time.
- Able to generate a report based on the statistics generated.
- Able to log out of the system.

Malaysia Authorities

- Able to register a new user as admin or NGO member in the system.
- Able to alert specific account on Twitter for cyberbullying behaviour.

NGOs

- Able to communicate with accounts on Twitter to offer counselling help.

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Project Specification Form (PSF)

ASIA PACIFIC UNIVERSITY
OF TECHNOLOGY & INNOVATION

Project Specification Form (PSF)

Code-Switching Cyberbullying Detection and Communication System in Malaysia

Name:	Hoh Kok Young
TP Number:	TP046085
Intake Code:	UC3F2011SE
Supervisor:	Dr. Vazeerudeen Abdul Hameed
Second Marker:	Dr. Kuruvikulam Chandrasekaran Arun

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A. Project Title

Code-Switching Cyberbullying Detection and Communication System in Malaysia

B. Brief description on project background. (i.e. problem context, rationale, description problem area, nature of challenge)

Problem Context

Prevalence of cyberbullying cases in Malaysia despite the establishment of MyCERT and CyberSAFE, is the main problem that inspires the proposal of this project. As mentioned earlier, Malaysia was ranked top 10 in a large-scale survey conducted in 2018 as the most cyberbullying cases reported by the victim's parents. To further solidifies the severity of this issue, another poll initiated by the United Nations Children's Fund (UNICEF) in 2019 have addressed that 3 in 10 youths have experienced getting cyberbullied (Athira Nortajuddin, 2020). MyCERT was already initiated since 1997 meanwhile CyberSAFE was introduced in 2010, yet the topic of cyberbullying is still relevant to the public's ears, it is fair to say that Malaysia as of current has not found the definite solution to mitigate cyberbullying cases in spite of the initiation of the reporting platform and the awareness programs. As of today, there are quite a few helpline services for victims of cyberbullying in Malaysia, such as Befrienders Malaysia along with Protect and Save the Children (R.AGE, 2016). However, the **ineffectiveness of these helpline services** became obvious as it was reported that 63% out of the approximate 5000 Malaysian respondents were not acquainted with these services (Bernama, 2019). These data imply that there could be victims of cyberbullying out there being on the edge of the precipice, just one step away from leaving their loved ones yet was unaware to the helping hand extended to them. Effectiveness aside, the perception of these victims towards the consequences of reporting their experiences from being cyberbullied can said to be the greatest factor in determining whether these cyberbullying cases will be unveiled and combated. Victims with low self-esteem are **reluctant to report their incidents of getting cyberbullied** as they perceive it will only worsen the situation or just flat out futile. Heartbreakingly to say, some may even think they deserve such treatment (Gordon, 2020), hence would rather not seek for help. As long as no parties have found the definite way to mitigate these occurrences, sooner or later the unexpected will arrive.

Based on the literature review conducted, almost every research focused on cyberbullying detection system in one language. However as established earlier, Malaysia citizens practices code-switching, which can significantly affect the accuracy of the prediction model, thence

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cyberbullying detection system that prioritizes in one language at a time will not be as effective in Malaysia.

Rationale

To resolve the issues stated above, a code-switching cyberbullying detection and communication system using sentiment analysis based in Malaysia is more than essential to be implemented, so as an endeavor to lessen cyberbullying incidents from occurring. From developing this system, MyCERT and NGOs are able to monitor Malaysia-based cyberbullying activities occurred throughout the platform Twitter. Everything is automatized, beautifully summarized and displayed in a graphical view for the users. Moreover, with the help of the system, MyCERT can warn any individuals for their cyberbullying behaviour before taking any severe measures to make them realize the consequences of cyberbullying others. Apart from that, some victims of cyberbullying are not aware of any available helpline services in Malaysia or are afraid from seeking any counselling help at all. Instead of waiting them to reach out for support, NGOs can be the ones to take the initiative and enquire them whether they need any form of assistances. Through such approach, victims of cyberbullying will be less likely to suffer from mental illness, or even worse, resulting to committing suicide. Additionally, the system will be built to detect code-switching cyberbullying tweets on Twitter particularly English and Bahasa Malaysia or Malay to mitigate cyberbullying cases from remain undetected.

Potential Benefits

Tangible Benefits

- Reduce human resources and workload required to monitor cyberbullying activities.
- Ensure comprehensive coverage and detection of cyberbullying tweets happening in Malaysia.
- Allow quick detection of cyberbullying cases in Malaysia.

Intangible Benefits

- Reduce the likeliness of victims of cyberbullying suffering from mental illness.
- Reduce the number of cyberbullying cases in Malaysia.
- Influence people to be more thoughtful when relaying opinionated messages towards the target reader in social media.

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- Create a healthier and a friendlier social media environment for the younglings.
- Relieve parents' worries on their children usage of social media.
- Improve public perception towards Malaysia through the reduction of cyberbullying cases.

Nature of Challenges

The proposed system implements machine learning and natural language processing, wherein these two technologies are foreign to the developer in terms of both concepts and tools to be applied, thus will prove to be a difficult challenge as the developer is essentially learning new technology from scratch with zero experience. Such challenge can be resolved through studying online from sentiment analysis experts as well as receiving insights and advices from FYP supervisor.

Apart from these two technologies, the system also needs constant flow of tweets from Twitter to not only for training the machine learning model but also for predicting cyberbullying tweets occurred in Malaysia. In order to achieve such feat, the understanding of the usage of Twitter API is important, which will be another challenge for the developer.

Since there are quite a few technologies the developer has to research on and learn, one of the biggest challenges the developer will face in this project is time management. Not to mention of the fact that the developer has to deal with assignments and exams from various modules in the meantime. To handle such immense challenge, proper planning must be conducted including the design of project plan as well as prioritizing tasks according to its urgency.

Another foreseeable challenge that will be confronted during this project is the process of gathering data from MyCERT and NGOs, which can be troublesome to get in contact with. To counteract said hassle, the developer will consult with the FYP supervisor to obtain insights on how to communicate with them.

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C. Brief description of project objectives. (i.e. scope of proposal and deliverables)

Aims

To investigate the characteristics of cyberbullying in Malaysia and develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for MyCERT and NGOs to monitor cyberbullying activities amongst myriad of Malaysia-based code-switching tweets generated on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia.

Objectives

1. To identify the categories of cyberbullying.
2. To determine the patterns of how Malaysians cyberbully others.
3. To determine the most effective sentiment analysis algorithm to detect code-switching cyberbullying tweets.
4. To design and develop a web-based code-switching cyberbullying detection and communication system.

Deliverables

The proposed system eases the MyCERT and the NGOs' effort in identifying code-switching cyberbullying tweets on Twitter as well as allows MyCERT to alert cyberbullies and NGOs to offer counselling help to the victims of cyberbullying if required. The list below shows the system features and functionalities that will be developed for each user:

System

- Able to automatically gather Malaysia-based tweets from Twitter and detect whether any code-switching cyberbully tweets are being posted. (Machine Learning Model)
- Able to generate a graphical view of the statistics of cyberbullying cases.

All Users

- Able to login to the system.
- Able to monitor the statistics of the cyberbullying cases and filter based on time.
- Able to generate a report based on the statistics generated.
- Able to view all the Twitter accounts that have send or received cyberbullying tweets.

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- Able to change the status of a specific Twitter account in the system.
- Able to log out of the system.

MyCERT

- Able to register a new user as MyCERT admin or NGO member into the system.
- Able to alert specific account on Twitter for cyberbullying behaviour.

NGOs

- Able to communicate with accounts on Twitter to offer counselling help.

D. Brief description of the resources needed by the proposal. (i.e. hardware, software, access to information / expertise, user involvement etc.)

Hardware

The recommended hardware specification to develop the proposed system in completion are as follows:

Computer

- Central Processing Unit (CPU): Intel(R) Core(TM) i5-8250U CPU @ 1.60GHz
- Random Access Memory (RAM): DDR4 RAM (16GB)
- Storage: 256GB SSD
- Graphics Processing Unit (GPU): NVIDIA GeForce 940MX

Peripheral Devices

- Monitor
- Keyboard
- Mouse
- Router
- Modem

Software

The recommended software specification to develop the proposed system in completion are as follows:

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Development

- Code Editor – Visual Studio Code (Version 1.52.1)
- Integrated Development Environment (IDE) – Google Colaboratory
- Operating System: Windows 10 Home (Version 1909) (64-bit)
- Web Browser – Microsoft Edge (Version 87.0.664.75)
- Database Management System – MongoDB (Version 4.4.3)
- Web Server – Apache (Version 2.4.46)
- Libraries:
  - Flask (Version 1.1.2)
  - PyMongo (Version 3.11.2)
  - Tweepy (Version 3.10.0)
  - TensorFlow (Version 2.4.0)
  - scikit-learn (Version 0.24.0)
  - pandas (Version 1.2.0)
  - Matplotlib (Version 3.3.3)

Documentation and Planning

- Microsoft Word 2019
- Microsoft Visio Professional 2016
- Microsoft Project Professional 2019

Access to Information/Expertise

In order to implement the proposed system effectively, consultations in regular basis from supervisor and lecturers are crucial. Opinions from sentiment analysis experts will be extremely helpful as well. The information gathered can be varied from the algorithms to be applied into the system to the documentation format and principles to be followed. Aside from that, interviews could be conducted amongst the MyCERT and NGOs' members to understand their expectations and requirements toward the system. The victims of cyberbullying will be surveyed to comprehend what can be improved upon the system as well.

User Involvement

The target users this system is specifically designed for include the MyCERT and the NGOs that prioritizes in providing counselling session for victims of cyberbullying. Both parties will

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have their own specialized functionalities built into the system to deal with the cyberbullies and the respective victims. These targeted users will be involved during the requirements gathering and analysis phase as well as the user acceptance testing phase.

E. Academic research being carried out and other information, techniques being learnt. (i.e. what are the names of books you are going to read / data sets you are going to use)

The following are the lists of books and online and web pages that will be studied by the developer in order to ensure project success.

Books

- Name: Learn TensorFlow 2.0: Implement Machine Learning And Deep Learning Models With Python
  Author: Pramod Singh, Avinash Manure
  Publisher: Apress
- Name: Sentiment Analysis in Social Networks
  Author: Federico Alberto Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu
  Publisher: Morgan Kaufmann Publishers
- Name: Flask Web Development: Developing Web Applications with Python
  Author: Miguel Grinberg
  Publisher: O'Reilly Media

Online Resources

Albury, N. J. (2017) Mother tongues and languaging in Malaysia: Critical linguistics under critical examination. *Language in Society*. [Online]. 46(4). pp. 567-589. Available from: https://www.researchgate.net/publication/317385146_Mother_tongues_and_languaging_in_Malaysia_Critical_linguistics_under_critical_examination [Accessed: 25th April 2020].

Alhamda Adisoka Bimantara, Afiatari Larasati, Ezar Mega Risondang, Muhammad Zidny Naf'an and Novanda Alim Setya Nugraha (2019) Sentiment Analysis of Cyberbullying on Instagram User Comments. *Journal of Data Science and Its Applications*. [Online]. 2(1). pp. 38-48. Available from:

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Amgad Muneer and Suliman Mohamed Fati (2020) A Comparative Analysis of Machine Learning Techniques for Cyberbullying Detection on Twitter. *Future Internet*. [Online]. 12(11). pp. 187-206. Available from: https://www.mdpi.com/1999-5903/12/11/187 [Accessed: 24th November 2020].

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Figure 340: Project Specification Form - Page 8

Me%2C-Hate-Me-Not%3A-Hate-Speech-Detection-on-Vigna-Cimino/2d21ebb96a5cd93bdfda391c70a3f77717b09833#references [Accessed: 5th April 2020].

Esen, S. (2019) *Code Switching: Definition, Types, and Examples*. [Online]. Available from: https://owlcation.com/humanities/Code-Switching-Definition-Types-and-Examples-of-Code-Switching#:~:text=Types%20of%20Code%20Switching,-1.&text=In%20inter%2Dsentential%20code%20switching,often%20in%20fluent%20bilingual%20speakers.&text=Different%20types%20of%20switches%20occur,and%20within%20the%20word%20level. [Accessed: 24th November 2020].

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Figure 342: Project Specification Form - Page 10

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Tan, K. H., Shahidatul Maslina Mat So'od and Bahiyah Abdul Hamid (2019) Communicating insults in cyberbullying. *SEARCH Journal of Media and Communication Research*. [Online]. 11(3). pp. 91-109. Available from:

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F. Brief description of the development plan for the proposed project. (i.e. which software methodology and why, the major areas of functions to be developed and the order in which developed)

System Development Methodology

System development methodology is a standardized approach in developing system, ranging from planning, designing, up until maintaining (Alliance Software, 2020). Selecting an appropriate software methodology can heavily affect the project success. Therefore, after thorough consideration towards the project timeline and research on different methodologies, the methodology that is deemed to be most suitable for this project is waterfall model.

Justification on Chosen Methodology

First and foremost, the project is considered small based on the project scope defined as well as the allocated timeframe of a few months, wherein waterfall model is suitable for. Although the waterfall model has low to zero degree of flexibility as well as high risk level, these two factors will not impact the project significantly or at all as long as the requirements are accurately and clearly defined in the initial phase. Furthermore, the waterfall model emphasizes

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Figure 344: Project Specification Form - Page 12

complete and comprehensive documentation, which is very appropriate to the context the current project is under whereby formulation of detailed documentation is necessary. Additionally, the waterfall model does not involve frequent clients' involvement during the implementation of the system, yet again totally aligns with the current project's circumstances whereby the target users, MyCERT and NGOs are difficult to keep in touch with, therefore they will only be approached during the requirements gathering and analysis phase as well as the UAT phase. In terms of developer knowledge and expertise, waterfall model requires the developers to be skilled and knowledgeable in the technology that the system will be based on. Even though the developer in this project has minor knowledge on the technologies the system will utilize, the developer will manage time efficiently to learn all these technologies in-depth in order to make this project a success through the waterfall model.

Waterfall Model

Waterfall model is a system development methodology that segregates the development procedures into individual phases, and each of these phases are executed linearly and sequentially, meaning that the next phase can be commenced only when the current phase has deemed accomplished, much like a waterfall (ProjectManager.com, 2020). Waterfall model falls under the category of traditional methodology, and unlike agile methodologies, it emphasizes fixed requirements, discourages contiguous user involvement as well as prioritizes comprehensive and complete documentation, which can be the perfect methodology for projects where the clients are inaccessible or uninterested throughout the project life cycle (O'Carroll, 2020). There are a total of six phases in waterfall model as shown in the diagram below.

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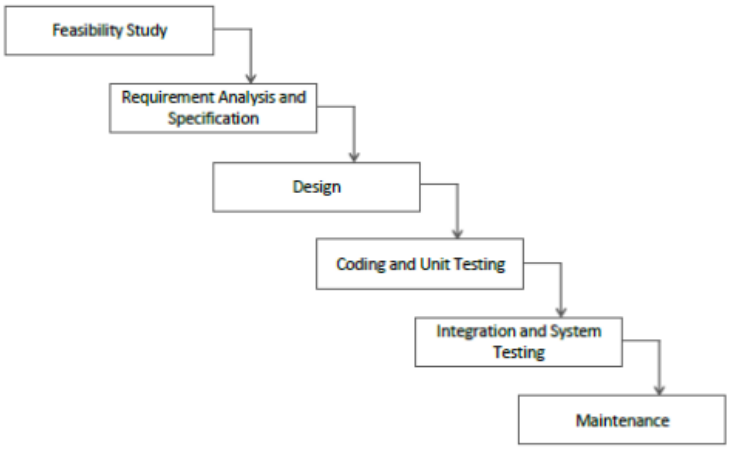

Figure 1: Waterfall Model – Phases (Geektonight, 2020)

Implementation of Chosen Methodology

Feasibility Study

During the feasibility study phase, the developer will investigate the cyberbullying issue in detail, understanding why cyberbullying in Malaysia is still prevalent as of today. Thereafter, the developer will formulate several solutions that are possible to mitigate said issues such as parental monitoring application. These solutions will then be assessed based on their benefits, limitations and feasibility in terms of different aspects. The code-switching cyberbullying detection and communication system has been determined to be the ideal solution; therefore, it is selected (Pal, 2019).

Requirements Analysis and Specification

This phase will involve the developer conducting interview with the MyCERT and NGOs' to determine the precise expectations and requirements they have regarding the system. The developer will also distribute questionnaires to the victims of cyberbullying to identify what can be improved in the system. Once these requirements are collected and analysed, the requirements will be documented into the SRS (Geektonight, 2020).

Design

In the system design phase, the developer will plan the necessary hardware and software required in addition to devise the designs necessary for building the cyberbullying detection

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and communication system including HLD and LLD (SoftwareTestingHelp.com, 2020), which everything will be then compiled and documented into the SDD (Javatpoint, 2018).

Coding and Unit Testing

This phase will be where the developer starts writing code for the cyberbullying detection and communication system based on the diagrams designed earlier. The developer will develop the system in independent units such as displaying dummy statistics. These unit will be tested individually afterwards to ensure each unit are working correctly (Geektonight, 2020).

Integration and System Testing

As soon as every system units have been developed and tested independently, these units will be continuously integrated partially and tested to ensure the units integrated are working together. For example, the authentication unit and the statistics unit are integrated and tested to certify that the logged-in users can view the statistics. After every system units have been fully integrated, the developer will conduct system testing to test the system as a whole, to verify that the system aligns with what was specified in the SRS in terms of functional and non-functional requirements such as the system will display the cyberbullying statistics in four seconds. Hereafter, the MyCERT and NGOs' members will be approached to conduct the UAT. If they are satisfied with the system, the system will then be deployed to their environment (Geektonight, 2020).

Maintenance

In the final phase, all different types of maintenance such as corrective maintenance and perfective maintenance will be performed to ensure the cyberbullying detection and communication system will always operate as expected as well as to increment new feature proposed (Geektonight, 2020).

G. Brief description of the evaluation and test plan for the proposed project. (i.e. what is the success criteria and how will be evaluated and implementation will be tested, indicate the estimated size of the demonstration / test database)

Success Criteria

In order to succeed in this project, the characteristics of cyberbullying in Malaysia must be understood so as to justify the solution proposed. In the meantime, the web-based code-

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switching cyberbullying detection and communication system will be tested by a few MyCERT and NGOs' members before deploying it to live environment to guarantee that the system is functional, applicable and satisfactory.

Testing

Unit Testing

Unit testing refers to the testing of individual software unit developed. For example, the developer will test whether the machine learning model can predict code-switching cyberbullying texts with decent accuracy.

Integration Testing

Integration testing refers to the testing of partially combined software units. For instance, the developer will test whether registering a user on the website will store the registration data entered into the database.

System Testing

System testing refers to the testing of the system as a whole. The cyberbullying detection and communication system will be tested based on the requirements documented on the software requirement specification (SRS).

User Acceptance Testing

User acceptance testing refers to the testing of the entire system by the clients themselves. This testing is conducted to ensure that the clients are satisfied with the system functionalities and features agreed upon the initial phase. As for this project, two members from MyCERT and two selected NGOs will be invited to conduct the testing on the system and provide their feedbacks afterwards.

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Figure 348: Project Specification Form - Page 16

Ethics Form

Office Record	Receipt – Fast-Track Ethical Approval
Date Received:	Student name: Student number: Received by:
Received by whom:	Date:

APU / APIIT FAST-TRACK ETHICAL APPROVAL FORM (STUDENTS)

Tick one box (level of study):
- ☐ POSTGRADUATE (PhD / MPhil / Masters)
- ☑ UNDERGRADUATE (Bachelors degree)
- ☐ FOUNDATION / DIPLOMA / Other categories

Tick one box (purpose of approval):
- ☑ Thesis / Dissertation / FYP project
- ☐ Module assignment
- ☐ Other: _____

Title of Programme on which enrolled **BSc (Hons) in Software Engineering**

Tick one box: ☑ Full-Time Study or ☐ Part-Time Study

Title of project / assignment **Code-Switching Cyberbullying Detection and Communication System in Malaysia**

Name of student researcher **Hoh Kok Young**

Name of supervisor / lecturer **Dr. Vazeerudeen Abdul Hameed (VAZ)**

Student Researchers- please note that certain professional organisations have ethical guidelines that you may need to consult when completing this form.

Supervisors/Module Lecturers - please seek guidance from the Chair of the APU Research Ethics Committee if you are uncertain about any ethical issue arising from this application.

		YES	NO	N/A
1	Will you describe the main procedures to participants in advance, so that they are informed about what to expect?	✓		
2	Will you tell participants that their participation is voluntary?	✓		
3	Will you obtain written consent for participation?	✓		
4	If the research is observational, will you ask participants for their consent to being observed?			✓
5	Will you tell participants that they may withdraw from the research at any time and for any reason?	✓		
6	With questionnaires and interviews will you give participants the option of omitting questions they do not want to answer?	✓		
7	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	✓		
8	Will you give participants the opportunity to be debriefed i.e. to find out more about the study and its results?	✓		

If you have ticked **No** to any of Q1-8 you should complete the full Ethics Approval Form.

		YES	NO	N/A
9	Will your project/assignment deliberately mislead participants in any way?		✓	
10	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		✓	
11	Is the nature of the research such that contentious or sensitive issues might be involved?		✓	

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Figure 349: Ethics Form – Page 1

If you have ticked **Yes** to 9, 10 or 11 you should complete the full Ethics Approval Form. In relation to question 10 this should include details of what you will tell participants to do if they should experience any problems (e.g. who they can contact for help). You may also need to consider risk assessment issues.

			YES	NO	N/A
12	Does your project/assignment involve work with animals?			✓	
13	Do participants fall into any of the following special groups? **Note that you may also need to obtain satisfactory clearance from the relevant authorities**	Children (under 18 years of age)		✓	
		People with communication or learning difficulties			
		Patients			
		People in custody			
		People who could be regarded as vulnerable			
		People engaged in illegal activities (eg drug taking)			
14	Does the project/assignment involve external funding or external collaboration where the funding body or external collaborative partner requires the University to provide evidence that the project/assignment had been subject to ethical scrutiny?			✓	

If you have ticked **Yes** to 12, 13 or 14 you should complete the full Ethics Approval Form. There is an obligation on student and supervisor to bring to the attention of the APU Research Ethics Committee any issues with ethical implications not clearly covered by the above checklist.

STUDENT RESEARCHER

Provide in the boxes below (plus any other appended details) information required in support of your application, THEN SIGN THE FORM.

Please Tick Boxes

I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee.	✓
Give a brief description of participants and procedure (methods, tests used etc) in up to 150 words. Survey and interview are chosen for this research. This survey aims to understand the Malaysian victims' emotion towards cyberbullying experiences and the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and languages presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system or the government and NGOs' strategies in better handle cyberbullying incidents in Malaysia. The target respondents for the survey are the Malaysian citizens, 18 years old or above and who have either experienced or witnessed cyberbullying in which a total of 30 of them will be gathered through the snowball sampling technique. The survey will be conducted online in the form of questionnaire using Google Forms. Moreover, the interview is designed for two parties, cyberbullying-focused government authorities and emotional support-focused NGOs in order to acquire greater insights on the prevalence of cyberbullying cases in Malaysia from their perspective, their domain itself in handling cyberbullying incidents and their opinion and requirements for the proposed system. The judgmental sampling technique will be utilised to interview one member from MyCERT, Childline Foundation and Vanguards4Change meanwhile the methods of interviewing will be totally up to the interviewees' preferences.	
I also confirm that: i) All key documents e.g. consent form, information sheet, questionnaire/interview are appended to this application.	✓

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Or ii) Any key documents e.g. consent form, information sheet, questionnaire/interview schedules which need to be finalised following initial investigations will be submitted for approval by the project/assignment supervisor/module lecturer before they are used in primary data collection.	

E-signature _____ _____ Print Name **Hoh Kok Young** Date **05/02/2021**
(Student Researcher)

Please note that any variation to that contained within this document that in any way affects ethical issues of the stated research requires the appending of new ethical details. New ethical consent may need to be sought.
The completed form (and any attachments) should be submitted for consideration by your Supervisor/Module Lecturer

SUPERVISOR/MODULE LECTURER
PLEASE CONFIRM THE FOLLOWING:

	Please Tick Box
I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee	✓
i) I have checked and approved the key documents required for this proposal (e.g. consent form, information sheet, questionnaire, interview schedule) Or	✓
ii) I have checked and approved draft documents required for this proposal which provide a basis for the preliminary investigations which will inform the main research study. I have informed the student researcher that finalised and additional documents (e.g. consent form, information sheet, questionnaire, interview schedule) must be submitted for approval by me before they are used for primary data collection.	

SUPERVISOR AND SECOND ACADEMIC SIGNATORY

STATEMENT OF ETHICAL APPROVAL (please delete as appropriate)

1) **THIS PROJECT/ASSIGNMENT HAS BEEN CONSIDERED USING AGREED APU/SU PROCEDURES AND IS NOW APPROVED**

2) **THIS PROJECT/ASSIGNMENT HAS BEEN APPROVED IN PRINCIPLE AS INVOLVING NO SIGNIFICANT ETHICAL IMPLICATIONS, BUT FINAL APPROVAL FOR DATA COLLECTION IS SUBJECT TO THE SUBMISSION OF KEY DOCUMENTS FOR APPROVAL BY SUPERVISOR (see Appendix A)**

E-signature… …Vazeer … … … Print Name… Dr. Vazeerudeen… … Date… 15th Feb 2021… … …
(Supervisor/Lecturer)

E-signature… … … … … … … … … … … … Print Name… … … … … … … … … … … … Date… … … …
(Second Academic Signatory)

Fast-Track Ethical Approval Form ver. 3.0 (Dec 2015) Page 3 of 4

Figure 351: Ethics Form – Page 3

Office Record	Receipt – Appendix A (Fast-Track Ethics Form)
Date Received: Received by whom:	Student name: Student number: Received by: Date:

APPENDIX A
AUTHORISATION FOR USE OF KEY DOCUMENTS

Completion of Appendix A is required when for good reasons key documents are not available when a fast track application is approved by the supervisor/module lecturer and second academic signatory.

I have now checked and approved all the key documents associated with this proposal e.g. consent form, information sheet, questionnaire, interview schedule

Title of project/assignment… …

… ……

Name of student researcher …. …

Student ID: …… Intake: … … … … … … … … … … … … … … … …

E-signature… … … … … … … … … … … … … Print Name… … … … … … … … … … … … Date… … …….. …
(Supervisor/Lecturer)

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Figure 352: Ethics Form – Page 4

Confidentiality Document

DECLARATION OF THESIS CONFIDENTIALITY

Author's full name: **HOH KOK YOUNG**

IC No./Passport No.: **991209145885**

Thesis/Project title: **CODE-SWITCHING CYBERBULLYING DETECTION AND COMMUNICATION SYSTEM IN MALAYSIA**

I declare that this thesis is classified as:

- ☐ CONFIDENTIAL
- ☐ RESTRICTED
- ☑ OPEN ACCESS

I acknowledged that Asia Pacific University of Technology & Innovation (APU) reserves the right as follows:

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3. The Library has the right to make copies of the thesis for academic exchange.

Author's Signature: .....

Date: 12 July 2021

Supervisor's Name: **DR. VAZEERUDEEN ABDUL HAMEED**

Date: 12 July 2021

Signature: .....

Figure 353: Confidentiality Document

Library Cataloguing Details

Table 121: Library Cataloguing Details

First Name: Kok Young
Middle Name (only if applicable):
Last Name: Hoh
Title of the Final Year Project / Dissertation / Thesis: Code-Switching Cyberbullying Detection and Communication System in Malaysia
Abstract: Social media for decades has always been a mechanism that brought the entire community together, yet for decades it has also always been a malevolent platform that has extinguish the existence of our loved ones where not a hint of sympathy is due. The main culprit for such vile actions is none other than, cyberbullying. The repercussions from cyberbullying are undeniably vomit-inducing and must be avoided at all costs. With that being said, the cyberbullying cases in Malaysia has become more prevalent than ever despite the current strategies established. Apart from that, domain research delved into has unveiled the severity of cyberbullying cases wherein many victims as well as the bystanders refrained from reporting the incidents. Having said that, the cyberbullying occurrences in social media are immensely difficult to identify manually due to the excessive data flow, prime example in which as much as 3.15 million Malaysians uses Twitter currently. Furthermore, Malaysia is a multilingualism country whereby Bahasa Rojak, or more commonly known as code-switching is practiced amongst the citizens wherein monolingual cyberbullying detection systems are much less effective. Not to mention, the research survey and interview conducted have solidified the presence of the aforementioned problems and the idea of code-switching cyberbullying detection and communication system are well-received by the respondents. Therefore, this project has aimed to develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government agencies and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets generated on Twitter, thus allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia. After an exhaustive process of system development, the system was successfully developed with fully functional features and satisfactory quality attributes that were highly concerned by the target users, validated and verified through unit testing and user acceptance testing, thus triumphantly achieved the aim of the project.
A few keywords associated with the work: Cyberbullying, Code-Switching, Sentiment Analysis, Twitter, Malaysia
General Subject: (e.g., Management information systems, Organizational behaviour, Risk management, Computer Software) Web-Based Application, Abnormality Detection System
Date of Submission: 14/07/2021

Gantt Chart

	Task Name	Duration	Start	Finish
1	**Project Proposal Form (PPF)**	**9.9 days**	**Wed 18/11/20**	**Fri 27/11/20**
2	**Project Specifications Form (PSF)**	**39.9 days**	**Sat 28/11/20**	**Wed 6/1/21**
3	Supervisory Meeting #1	30 mins	Mon 14/12/2(	Mon 14/12/2(
4	**Investigation Report (IR)**	**55 days**	**Thu 7/1/21**	**Wed 3/3/21**
5	Chapter 1: Introduction to the Study	3 days	Thu 7/1/21	Sat 9/1/21
6	Chapter 2: Literature Review	7 days	Sun 10/1/21	Sat 16/1/21
7	Supervisory Meeting #2	30 mins	Tue 12/1/21	Tue 12/1/21
8	Chapter 3: Technical Research	7 days	Sun 17/1/21	Sat 23/1/21
9	Chapter 4: System Development Methodology	2 days	Sun 24/1/21	Mon 25/1/21
10	Chapter 5: Research Methods	8 days	Tue 26/1/21	Tue 2/2/21
11	Supervisory Meeting #3	20 mins	Tue 2/2/21	Tue 2/2/21
12	Conduct Survey and Interview	18 days	Wed 3/2/21	Sat 20/2/21
13	Chapter 6: Requirement Validation	7 days	Sun 21/2/21	Sun 28/2/21
14	Supervisory Meeting #4	20 mins	Thu 25/2/21	Thu 25/2/21
15	Conclusion and Reflections	3 days	Mon 1/3/21	Wed 3/3/21

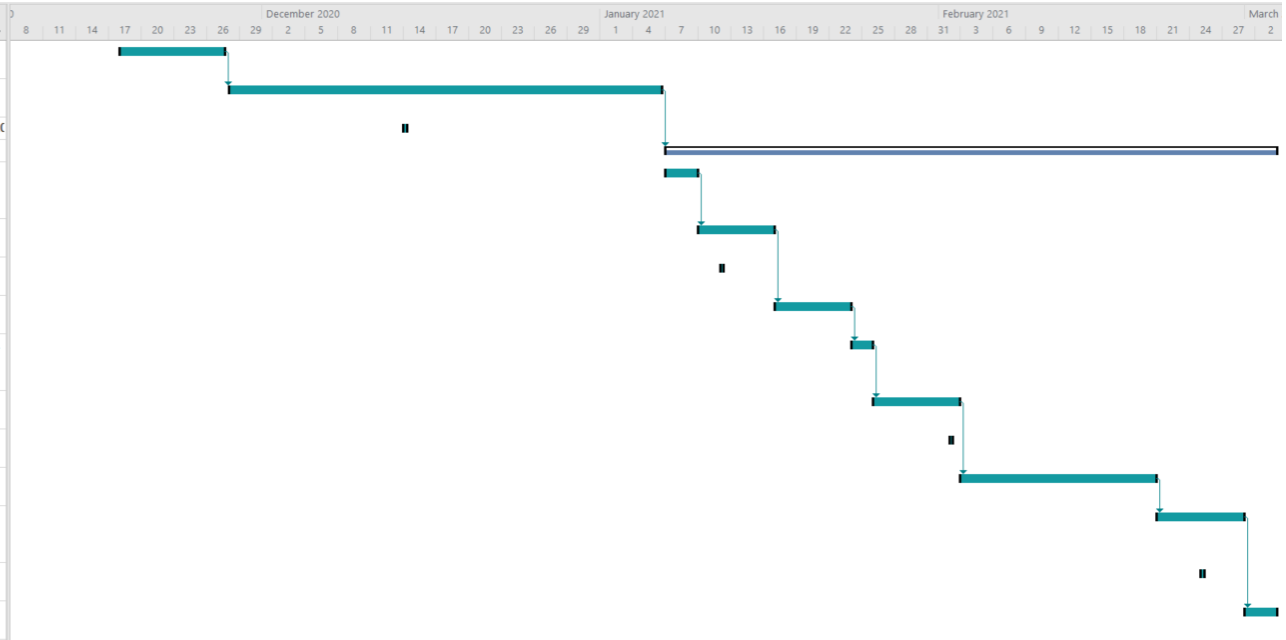

Figure 354: Gantt Chart – First Stage of Final Year Project

	Task Name	Duration	Start	Finish
16	**Final Year Project Report**	**133 days**	**Thu 4/3/21**	**Wed 14/7/21**
17	**First Iteration - Machine Learning Model**	**28 days**	**Thu 4/3/21**	**Wed 31/3/21**
18	System Architecture	4 days	Thu 4/3/21	Sun 7/3/21
19	Prototype Development	20 days	Mon 8/3/21	Sat 27/3/21
20	Demonstrate Prototype	30 mins	Sun 28/3/21	Sun 28/3/21
21	Refine Prototype	3 days	Sun 28/3/21	Wed 31/3/21
22	**Second Iteration - Stream Tweets**	**21 days**	**Thu 1/4/21**	**Wed 21/4/21**
23	System Architecture	4 days	Thu 1/4/21	Sun 4/4/21
24	Prototype Development	15 days	Mon 5/4/21	Mon 19/4/21
25	Demonstrate Prototype	30 mins	Tue 20/4/21	Tue 20/4/21
26	Refine Prototype	1.93 days	Tue 20/4/21	Wed 21/4/21
27	**Third Iteration - Dashbaord and Profile Page**	**21 days**	**Thu 22/4/21**	**Wed 12/5/21**
28	System Architecture	4 days	Thu 22/4/21	Sun 25/4/21
29	Prototype Development	15 days	Mon 26/4/21	Mon 10/5/21
30	Demonstrate Prototype	30 mins	Tue 11/5/21	Tue 11/5/21
31	Refine Prototype	1.93 days	Tue 11/5/21	Wed 12/5/21
32	**Fourth Iteration - Fundamental Features**	**21 days**	**Thu 13/5/21**	**Wed 2/6/21**
33	System Architecture	4 days	Thu 13/5/21	Sun 16/5/21
34	Prototype Development	15 days	Mon 17/5/21	Mon 31/5/21
35	Supervisory Meeting #5	20 mins	Wed 19/5/21	Wed 19/5/21
36	Demonstrate Prototype	30 mins	Tue 1/6/21	Tue 1/6/21
37	Refine Prototype	1.89 days	Tue 1/6/21	Wed 2/6/21

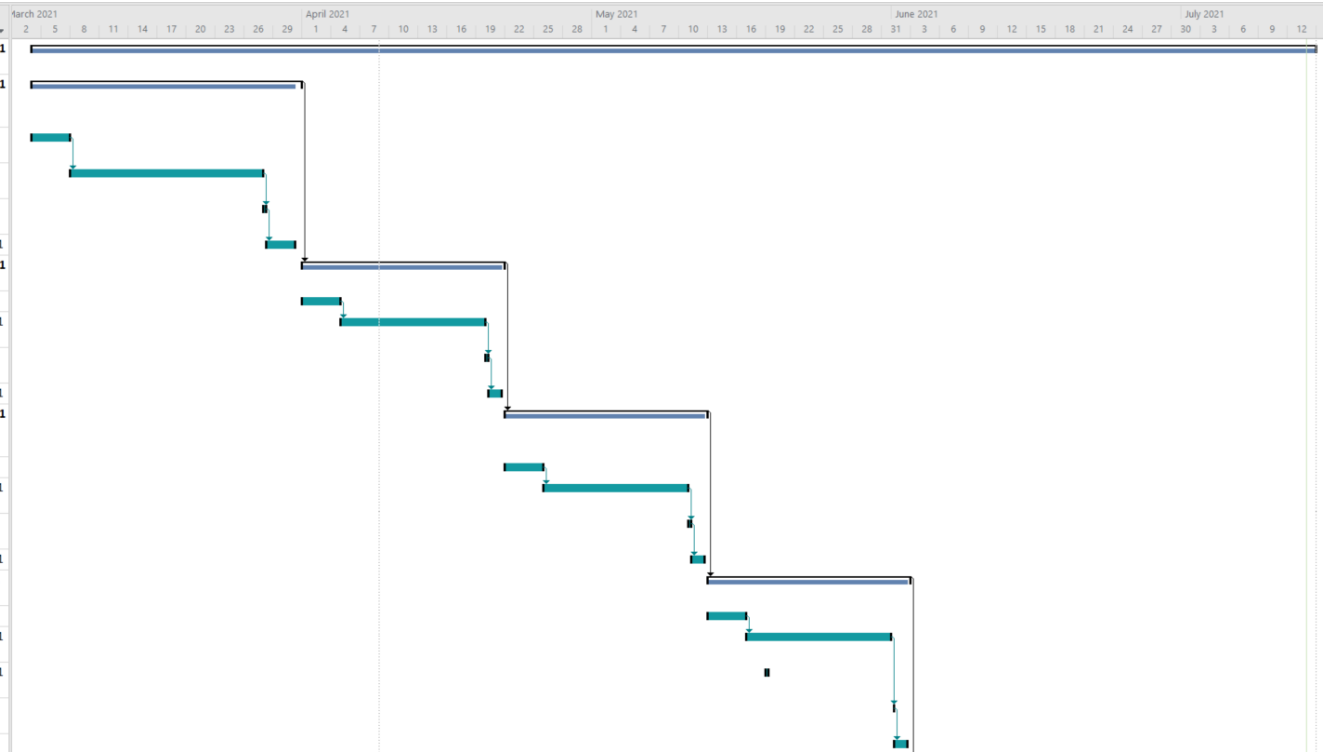

Figure 355: Gantt Chart – Second Stage of Final Year Project - Part 1

	Task Name	Duration	Start	Finish
38	**Fifth Iteration - Organisation Account and Management Page**	**14 days**	**Thu 3/6/21**	**Wed 16/6/21**
39	System Architecture	2 days	Thu 3/6/21	Fri 4/6/21
40	Prototype Development	10 days	Sat 5/6/21	Mon 14/6/21
41	Demonstrate Prototype	30 mins	Tue 15/6/21	Tue 15/6/21
42	Refine Prototype	1.93 days	Tue 15/6/21	Wed 16/6/21
43	**Sixth Iteration - Optimise**	**14 days**	**Thu 17/6/21**	**Wed 30/6/21**
44	System Architecture	2 days	Thu 17/6/21	Fri 18/6/21
45	Prototype Development	10 days	Sat 19/6/21	Mon 28/6/21
46	Demonstrate Prototype	30 mins	Tue 29/6/21	Tue 29/6/21
47	Refine Prototype	1.93 days	Tue 29/6/21	Wed 30/6/21
48	Supervisory Meeting #6	20 mins	Thu 1/7/21	Thu 1/7/21
49	Chapter 8: Project Plan	2.9 days	Thu 1/7/21	Sat 3/7/21
50	Chapter 10: System Validation	2.9 days	Sun 4/7/21	Tue 6/7/21
51	Chapter 9: Implementation	2.9 days	Wed 7/7/21	Fri 9/7/21
52	Chapter 11: Conclusion and Reflections	1.9 days	Sat 10/7/21	Sun 11/7/21
53	Supervisory Meeting #7	20 mins	Mon 12/7/21	Mon 12/7/21
54	FYP Poster	0.9 days	Mon 12/7/21	Mon 12/7/21
55	FYP Presentation Slides	2 days	Tue 13/7/21	Wed 14/7/21

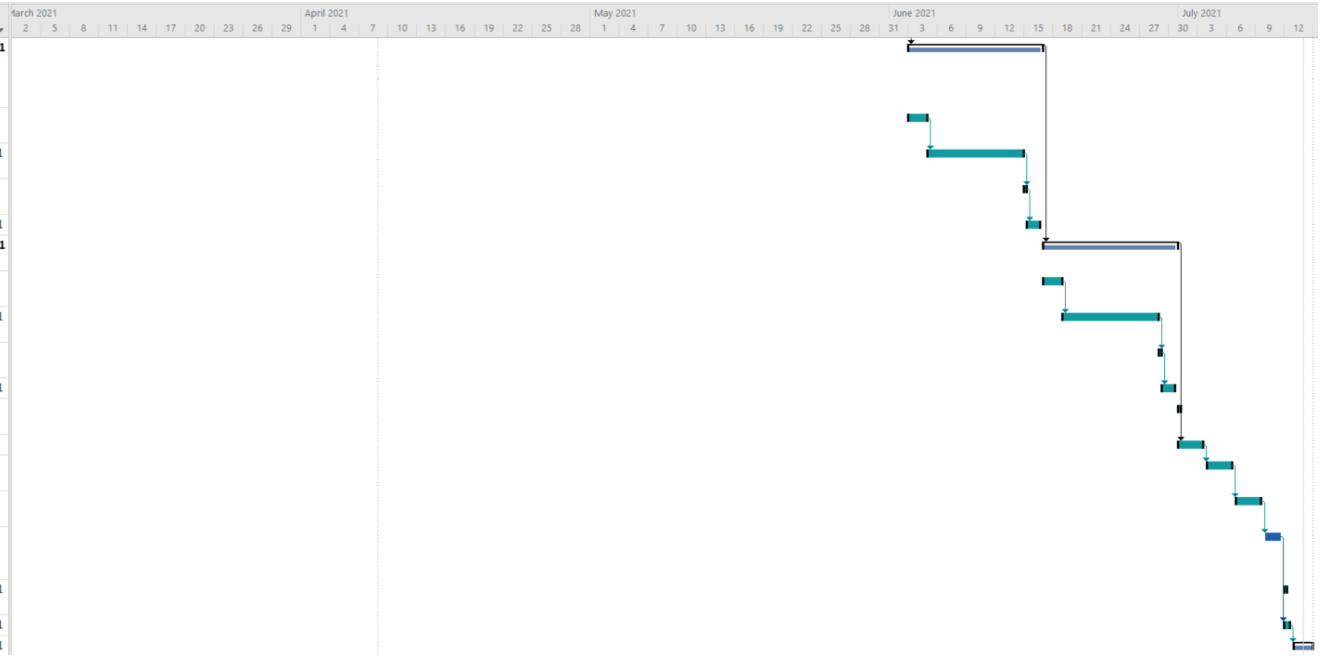

Figure 356: Gantt Chart – Second Stage of Final Year Project - Part 2

Survey Questions

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

Dear participant,

Thank you sincerely for partaking in the survey. My name is Hoh Kok Young and am currently pursuing a degree in software engineering at Asia Pacific University of Technology & Innovation (APU).

The current survey is conducted for my final year project "Code-Switching Cyberbullying Detection and Communication System in Malaysia". The aim of this project is to develop a web-based code-switching cyberbullying detection and communication system using sentiment analysis for cyberbullying-focused government authorities and emotional support-focused NGOs to monitor real-time cyberbullying activities amongst myriad of Malaysia-based code-switching tweets (Text-based only) generated on Twitter, therefore allowing them to take appropriate action toward the cyberbullies as well as the victims of cyberbullying and ultimately reducing the number of cyberbullying cases in Malaysia. The system revolves around two main components; Monitoring and communicating. The users will first be able to monitor detected public cyberbullying tweets on Twitter, the users can then provide warnings to cyberbullies and offer counselling session for victims if desired.

The outcome of this survey will contribute to the understanding of the Malaysian victims' emotion towards cyberbullying experiences and the willingness of victims and bystanders to report cyberbullying incidents, the common patterns and languages presented in cyberbullying messages in Malaysia, the awareness of Malaysians towards MyCERT, its service Cyber999 and emotional support-focused NGOs, the perceptions of Malaysians towards government and NGOs' involvement in assisting cyberbullying incidents as well as suggestions that may improve the proposed system or the government and NGOs' strategies in better handle cyberbullying incidents in Malaysia. Your participation in this survey will contribute to this project significantly in developing a well-rounded system for the greater good of Malaysian citizens. All the data gathered from this survey will be used as a reference to carry out project analysis and requirements gathering.

This survey is conducted solely for academic purposes. This survey takes roughly 10 to 15 minutes to complete. Your participation in this survey is absolutely voluntary and all the responses collected will be strictly confidential, which could and will solely be accessible by the researcher, the project supervisor and the project examiner (Second marker). Moreover, Your responses will also not be associated with any personal identifiable information. Furthermore, the survey does not impose any risks (either physical or psychological distress or discomfort) to the participant. Most importantly, you are given the opportunity and the right to withdraw from the survey at any time and for any reasons.

Your honest responses in this questionnaire are highly appreciated. If you have any inquiries or concerns regarding the survey, please do contact me via email; tp046085@mail.apu.edu.my or phone; +60123429617.

Figure 357: Survey Questions – Introduction Part 1

Thank you once again for committing your valuable time and effort.
Sincerely,
Hoh Kok Young
Third Year Degree Student of APU
tp046085@mail.apu.edu.my
+60123429617

*Required

Survey Participant Agreement

Before completing the survey, you understand that:
1. The survey only accepts participants who are Malaysian, aged 18 or above and have either experienced or witnessed cyberbullying.
2. The survey is conducted for academic purpose only.
3. The survey does not impose any risks to the participant (Either physical or psychological distress or discomfort).
4. You are completely voluntarily participating in the current survey which you are required to provide some basic personal information and your honest opinion towards the topic.
5. Your responses will be strictly confidential, which could and will solely be accessible to the researcher, the project supervisor and the project examiner (Second marker).
6. Your responses will not be associated with any personal identifiable information.
7. You have the right to withdraw from the survey at any time for any reason.
8. You have the right to decide whether you want to be debriefed about the study and survey results after completing the survey.

Please ensure that you have read, understood and well-informed about the information of the project and survey.

Survey Participant Agreement *

☐ I hereby acknowledge that I have read, understand and agree with the terms and conditions of the survey.

Please enter your email here if you would like to be debriefed about the study and survey results.

Your answer

Next

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Figure 358: Survey Questions – Introduction Part 2

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

*Required

Personal Details

The first section expects the participant's personal details and role in cyberbullying incidents.

1. Gender *

- Male
- Female

2. Age Group *

- 18 - 24
- 25 - 31
- 32 - 38
- 39 - 45
- 45 or above

Figure 359: Survey Questions – Section A Part 1

3. Race *

- Chinese
- Malay
- Indian
- Other:

4. Which state are you located at? *

- Selangor
- Sabah
- Sarawak
- Johor
- Perak
- Pahang
- Negeri Sembilan
- Kelantan
- Kedah
- Perlis
- Malacca
- Penang
- Terengganu
- Kuala Lumpur
- Labuan
- Putrajaya

Figure 360: Survey Questions – Section A Part 2

5. Which social media are you currently using? *

- [ ] Facebook
- [ ] Twitter
- [ ] Instagram
- [ ] Youtube

6. Please select the role in cyberbullying incidents you associate with the most. *

Bystanders are ones who witnessed cyberbullyings.

- ( ) Victim
- ( ) Bystander

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Figure 361: Survey Questions – Section A Part 3

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

*Required

Victim's Emotion and Willingness to Report Cyberbullying

This section comprises several questions on Malaysian victims' emotion towards cyberbullying experiences and the willingness of victims to report cyberbullying incidents.

1. Please select the emotion(s) you associate with when you were cyberbullied. *

- [ ] Sad
- [ ] Depressed
- [ ] Lonely
- [ ] Hopeless
- [ ] Angry
- [ ] Self-blame
- [ ] Suicidal Ideation
- [ ] Nothing
- [ ] Other:

2a. I report my cyberbullying experience(s) most of the time. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Figure 362: Survey Questions – Section B Victim Part 1

2b. Please explain your reason(s) for your answer in question 2a. *

Your answer

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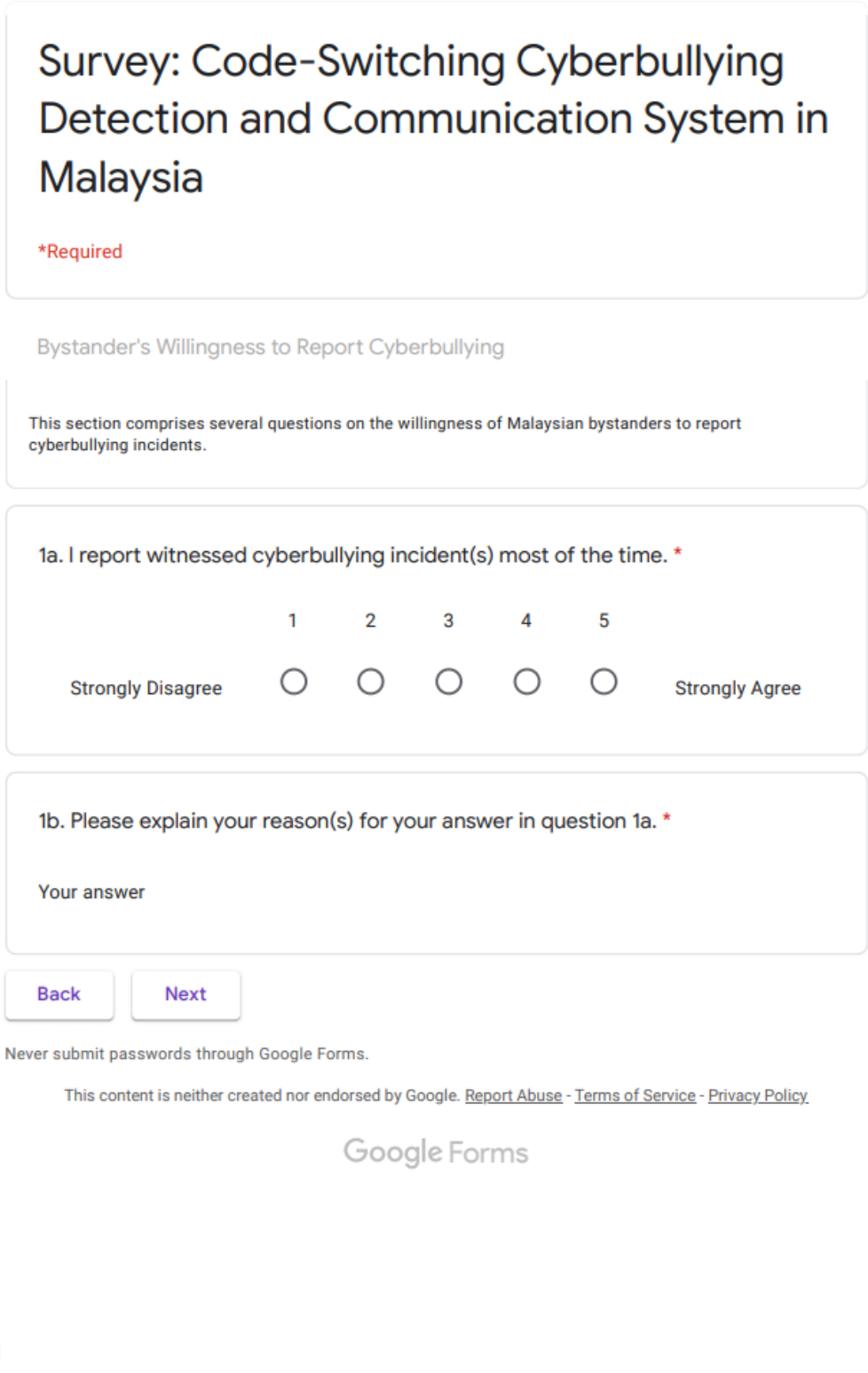
Figure 363: Survey Questions – Section B Victim Part 2



Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

*Required

Bystander's Willingness to Report Cyberbullying

This section comprises several questions on the willingness of Malaysian bystanders to report cyberbullying incidents.

1a. I report witnessed cyberbullying incident(s) most of the time. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

1b. Please explain your reason(s) for your answer in question 1a. *

Your answer

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Figure 364: Survey Questions – Section B Bystander

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

*Required

Common Cyberbullying Pattern and Language in Malaysia

This section is crucial in understanding how cyberbullying are usually conveyed and the common languages shown in cyberbullying messages in Malaysia.

1. Are cyberbullying messages usually conveyed publicly or privately? *

Examples of public cyberbullying messages: Public posts, comments. Examples of private cyberbullying messages: Direct message, group message.

- ◯ Public
- ◯ Private

2. Rank the following form of cyberbullying you have witnessed or experienced in the order of rate of occurrence, where 4 is the highest and 1 is the lowest. *

	1	2	3	4
Text	◯	◯	◯	◯
Image	◯	◯	◯	◯
Audio	◯	◯	◯	◯
Video	◯	◯	◯	◯

Figure 365: Survey Questions – Section C Part 1

3. Please select the language(s) that appeared the most in your witnessed or experienced cyberbullying. *

- [ ] English
- [ ] Mandarin
- [ ] Malay (Bahasa Malaysia)
- [ ] Tamil
- [ ] Other:

4a. Have you seen cyberbullying messages with a mix of languages? *

Examples of messages with mix of languages: English and Malay (nice to meet you, abang), English and Mandarin (long time no see, 朋友).

- ( ) Yes
- ( ) No

Figure 366: Survey Questions – Section C Part 2

4b. If you answered yes in the question 4a, out of the four main languages in Malaysia, please select the most common mix of languages appeared in most cyberbullying messages. If no, please skip this question.

Examples of messages with mix of languages: English, Malay and Chinese (long time tak jumpa ya, 朋友).

- English, Mandarin, Malay, Tamil
- English, Mandarin, Malay
- English, Mandarin, Tamil
- English, Malay, Tamil
- Mandarin, Malay, Tamil
- English and Malay
- English and Mandarin
- English and Tamil
- Mandarin and Malay
- Mandarin and Tamil
- Malay and Tamil

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Figure 367: Survey Questions – Section C Part 3

Survey: Code-Switching Cyberbullying Detection and Communication System in Malaysia

*Required

Awareness and Perception of Government and NGOs

The last section contains questions in understanding Malaysian participant's awareness of MyCERT, its service Cyber999 and emotional support-focused NGOs, perception and opinion of these two parties' involvement in cyberbullying cases, and the improvements that could be added upon the system.

1a. I am aware of the MyCERT (Malaysia Computer Emergency Response Team) and/or its service, Cyber999. *

MyCERT is a governmental department formed in Malaysia to combat cyberthreats.

- ◯ Yes
- ◯ No

1b. If you answered yes in question 1a, have you used MyCERT's service, Cyber999 to report a cyberbullying incident? If you answered no in question number 1a, please skip to question number 2a.

- ◯ Yes
- ◯ No

1c. Please explain your reason(s) for your answer in question 1b.

Your answer

Figure 368: Survey Questions – Section D Part 1

2a. I am aware of any NGOs (Non-Governmental Organisation) in Malaysia that offer emotional support. *

- Yes
- No

2b. If you are a victim and answered yes in the question 2a, have you ever contacted one of the NGOs to request a counselling session after being cyberbullied? If you are a bystander or answered no in question number 2a, please skip to question number 3.

- Yes
- No

2c. Please explain your reason(s) for your answer in question 2b.

Your answer

3. I agree or disagree that the government should focus on reducing cyberbullying cases in Malaysia. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Figure 369: Survey Questions – Section D Part 2

4a. I agree or disagree that the government and NGOs should have the authority to monitor public social media posts to prevent worsening of cyberbullying cases. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4b. Please explain your reason(s) for your answer in question 4a. *

Your answer

5a. I agree or disagree that the government and NGOs should publicly warn the cyberbullies monitored for their actions through methods such as replying to the cyberbullying comments on social media. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

5b. Please explain your reason(s) for your answer in question 5a. *

Your answer

6a. I agree or disagree that the government and NGOs should privately warn the cyberbullies monitored for their actions through either a phone call, SMS or personal messaging in social media. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Figure 370: Survey Questions – Section D Part 3

6b. Please explain your reason(s) for your answer in question 6a. *

Your answer

7a. I agree or disagree that the government and NGOs should publicly enquire whether the victim of cyberbullying monitored requires emotional support or not through methods such as replying to the cyberbullying threads in social media. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

7b. Please explain your reason(s) for your answer in question 7a. *

Your answer

8a. I agree or disagree that the government and NGOs should privately enquire whether the victim of cyberbullying monitored requires emotional support or not through either a phone call, SMS or personal messaging in social media. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

8b. Please explain your reason(s) for your answer in question 8a. *

Your answer

Figure 371: Survey Questions – Section D Part 4

9. Please state your suggestions to what else should the government and/or NGOs do to reduce cyberbullying cases in Malaysia.

Your answer

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Figure 372: Survey Questions – Section D Part 5

Interview Questions (Government Agencies)

Malaysia Computer Emergency Response Team (MyCERT)

Table 122: Interview Information - MyCERT

Interview Details		
Project Title: Code-Switching Cyberbullying Detection and Communication System in Malaysia		
Interview Type: Online		
Method: Zoom	**Date:** 19/02/2021	**Time:** 2:00 p.m. – 3:00 p.m.
Interviewer Name: Hoh Kok Young		
Interviewee Name: Ms. Norlinda Binti Jaafar		
Interviewee Organisation/Department: Malaysia Computer Emergency Response Team (MyCERT) – Cyber999 Unit		
Interviewee Position: Senior Analyst		
Interviewee Contact Information: norlinda@cybersecurity.my		
Interview Questions		
Question #1: Based on your opinion, what are the reasons behind the increase of cyberbullying incidents in Malaysia of more than two times the amount compared to last year?		
Question #2: Does MyCERT currently has methods to identify cyberbullying threats in Malaysia other than the ones reported to your platform?		
Question #3: How do MyCERT deal with cyberbullying incidents reported?		
Question #4: Does MyCERT provide any form of help to the victims of cyberbullying and how?		
Question #5: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?		
Question #6: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?		
Question #7: Do you think should the system users approach the cyberbullies publicly, privately or both?		

Question #8: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?
Question #9: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?
Question #10: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?
Question #11: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?
Question #12: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?
Question #13: What are the main quality attributes concerned do you have in the proposed system?
Question #14: Do you have any suggestions to improve the proposed system?

Malaysian Communications and Multimedia Commission (MCMC)

Table 123: Interview Information - MCMC

Interview Details		
Project Title: Code-Switching Cyberbullying Detection and Communication System in Malaysia		
Interview Type: Online		
Method: Email	**Date:** 28/04/2021	**Time:** 10:30 a.m.
Interviewer Name: Hoh Kok Young		
Interviewee Name: -		
Interviewee Organisation/Department: Malaysian Communication and Multimedia Commission (MCMC) – New Media Department		
Interviewee Position: -		
Interviewee Contact Information: newmedia.unit@mcmc.gov.my		
Interview Questions		
Question #1: Based on your opinion, what are the reasons behind the increase of cyberbullying incidents in Malaysia of more than two times the amount compared to last year?		
Question #2: Does MCMC currently has methods to identify cyberbullying threats in Malaysia other than the ones reported to your platform?		
Question #3: How do MCMC deal with cyberbullying incidents reported?		
Question #4: Does MCMC provide any form of help to the victims of cyberbullying and how?		
Question #5: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?		
Question #6: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?		
Question #7: Do you think should the system users approach the cyberbullies publicly, privately or both?		

Question #8: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?
Question #9: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?
Question #10: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?
Question #11: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?
Question #12: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?
Question #13: What are the main quality attributes concerned do you have in the proposed system?
Question #14: Do you have any suggestions to improve the proposed system?

Interview Questions (NGOs)

Childline Foundation

Table 124: Interview Information - Childline Foundation

Interview Details		
Project Title: Code-Switching Cyberbullying Detection and Communication System in Malaysia		
Interview Type: Online		
Method: Zoom	**Date:** 17/02/2021	**Time:** 4:00 p.m. – 5:00 p.m.
Interviewer Name: Hoh Kok Young		
Interviewee Name: Mr. Richie		
Interviewee Organisation/Department: Childline Foundation		
Interviewee Position: Operations Manager		
Interviewee Contact Information: 017-887 8814		
Interview Questions		
Question #1: Based on your experiences and perspective, has cyberbullying incidents in Malaysia increases or decreases over the years?		
Question #2: Based on your opinions and experiences, what are the possible reasons that lead to the increase or decrease of cyberbullying incidents?		
Question #3: Based on your experiences, have any victims of cyberbullying ever expressed reluctancy to report their experiences and why?		
Question #4: What are the standard procedures for Childline Foundation when approaching victims of cyberbullying who request counselling session?		
Question #5: Does Childline Foundation provide further check up on the individuals who requested counselling session previously and why?		
Question #6: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?		
Question #7: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?		

Question #8: Do you think should the system users approach the cyberbullies publicly, privately or both?
Question #9: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?
Question #10: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?
Question #11: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?
Question #12: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?
Question #13: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?
Question #14: What are the main quality attributes concerned do you have in the proposed system?
Question #15: Do you have any suggestions to improve the proposed system?

Vanguards4Change

Table 125: Interview Information - Vanguards4Change

Interview Details		
Project Title: Code-Switching Cyberbullying Detection and Communication System in Malaysia		
Interview Type: Telephone		
Method: Call	**Date:** 01/03/2021	**Time:** 2:00 p.m. – 3:00 p.m.
Interviewer Name: Hoh Kok Young		
Interviewee Name: Mr. Vidyasagar		
Interviewee Organisation/Department: Vanguards4Change		
Interviewee Position: Senior Child Advocate and Media Manager		
Interviewee Contact Information: 017-630 9925		
Interview Questions		
Question #1: Based on your experiences and perspective, has cyberbullying incidents in Malaysia increases or decreases over the years?		
Question #2: Based on your opinions and experiences, what are the possible reasons that lead to the increase or decrease of cyberbullying incidents?		
Question #3: Based on your experiences, have any victims of cyberbullying ever expressed reluctancy to report their experiences and why?		
Question #4: What are the standard procedures for Vanguards4Change when approaching victims of cyberbullying who request counselling session?		
Question #5: Does Vanguards4Change provide further check up on the individuals who requested counselling session previously and why?		
Question #6: Do you think it is highly beneficial or not to implement a cyberbullying detection system to monitor public messages to identify cyberbullying and why?		
Question #7: Do you think it is highly beneficial or not that the system should have a feature whereby system users can warn the cyberbullies that are detected online and why?		

Question #8: Do you think should the system users approach the cyberbullies publicly, privately or both?
Question #9: Do you think it is highly beneficial or not that the system should have a feature to identify the toxicity level of a cyberbully based on the number of tweets posted over the past month and why?
Question #10: Do you think it is highly beneficial or not that the system should have a feature whereby system users can offer counselling support to the victim of cyberbullying that are detected online and why?
Question #11: Do you think should the system users approach the victims of cyberbullying publicly, privately or both?
Question #12: Do you think it is highly beneficial or not that the system should have a graphical chart of the statistics regarding cyberbullying cases in Malaysia that can be filtered by time and why?
Question #13: Do you think it is highly beneficial or not that the system should have a feature to alert the system users whenever a cyberbullying message is detected and why?
Question #14: What are the main quality attributes concerned do you have in the proposed system?
Question #15: Do you have any suggestions to improve the proposed system?