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Music Recommendation System based on Emotions in User's Social Media behaviour

A dissertation by
Mr. Mahamarakkalage Ravidu Shehan Perera

Supervised by

Mrs. Sulochana Rupasinghe

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Declaration

I declare that the work presented in this dissertation is my work and to the best of my knowledge acknowledgement is made for all sources of information used in this dissertation. Further, this as a whole or as parts has not been submitted previously or concurrently for a degree or any other qualifications at any University or Institution of Higher Learning.

26/4/2021

Signature of the Student Date

Full Name of the Student: Mahamarakkalage Ravidu Shehan Perera

Student's Registration No: 2017486

UOW Id : w1699671

The above student carried out his research project under my supervision.

27/04/2021

Signature of the Supervisor Date

Name of the Supervisor: Mrs Sulochana Rupasinghe

Abstract

The modern lifestyle makes people more competitive. It can lead to more stressful situations in our lifestyle. With the changes in human emotional behaviour, they tend to share their feelings on social media platforms rather than communicating with relatives. Studies proved that people used to listen to music to avoid emotional situations in their life. But there is no proper way to get the most accurate music to listen to and avoid emotional conflicts.

Resolving these conflicts, the music recommendation system based on emotion introduced. It analyses the users' recent social media content and detects the various kind of emotions. To ensure that the suggested music is relevant to users emotions, the lyrics analysing was done using natural language processing techniques to identify the music emotions. Most people pay attention to the meaning of the songs, that was the major reason to consider the emotions of the lyrics.

The research was considered on a language-independent platform for both English and Sinhala. A labelled emotional dataset was chosen to evaluate the model. Using the English emotional detection model it was achieved a higher accuracy level than the Sinhala module. The researcher found that if music features can be added to consideration of the emotion detections for lyrics, It can be more accurate to recommend the songs. Furthermore, research revealed that there is no proper way to identify the exact emotion categories in lyrics due to different lines can give a different set of sentiment value. Therefore, the lyrics were categorised into positives and neutral to combined with the user’s emotions.

The researchers emphasize that the detection of complex emotion categories could be done using a more accurate dataset and by adding more music features. The outcome of the recommendation system proved that the recommended songs are relevant to identified emotion categories.

Keywords: Natural Language Processing, Text emotion detection, Music recommendations, Text analysing

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CHAPTER 1: INTRODUCTION

1.1 Chapter Overview

The introduction chapter of the research provides an overview of the project. In the first section, the problem domain and the background is briefly defined and discussed in detail. Research motivation and the existing works related to the problem domain is reviewed after that. The identification of the research gap and the scope is very important to complete the research successfully. The objectives are reviewed in the latter part of this chapter as well. Finally, the software, hardware, data and skill resource requirements will be discussed accordingly.

1.2 Problem Domain

1.2.1 Social Media Networks and User engagement

Social media networks in the 21st century, are playing a vital role in almost every person's lifestyle. Since the development of technology, social media trends can be seen in people's lives. When something is happening around, posting, and sharing about that incident has become a very common practice within people. (Hasan et al., 2017) Early days, people had television, radio and newspapers for entertainment, and they had time to relax. Also, people had good interpersonal relationships with society. But due to the competition of modern society, people have lost their interest to entertain themselves. Because of that reason, social media networks have become the most widely used communication method in human life. Using social networks people tend to make strong relationships with virtual friends, even some people find their soul mates through social networks. Complex life schedules force people to be stressed and make their lives complicated. They used social media networks to relieve the pressure they face and share their feelings. The influence of social media networks become a major technical aspect to control the human lifestyle (Bruning, Alge and Lin, 2020).

1.2.2 Music as a Therapy

Music is a universal language that can help people to relax their souls in a complicated life schedule. (Sablak, 2020) Quality music can heal someone's pain and keep them happy throughout the day with a happy mood. The taste of music can be different from person to person. Even Though music can be used as a treatment for issues like dementia. (Tsoi et al., 2018) With the development of technology, the current lifestyle has turned out to be more complex and busier. Children must pay attention to their studies until the end of their educational career. After that,

they have to engage in higher studies which brings much tension to their mind while the employers have to work with a stressful schedule in their workplaces. Human beings can be suffering from serious traumatic situations due to this busy life schedule. Though mental pressure cannot be considered as a serious illness it can be the root problems such as Depression. In this kind of situation, Music will be the best medicine (Arora, Kaul and Mittal, 2019)

1.2.3 Emotions based on Music

Music and emotions have a very close relationship since music can completely change the feelings and emotions of a person. (Abeyratne and Jayaratne, 2019) According to the survey conducted for the research, more than 80% of people who take part in the survey, believe music can heal their emotional changes in a complex lifestyle. But the issue they had to face was not having a proper method to select a suitable song to play according to their mood. Most of the users randomly select songs to listen to when they want to relax their minds. Sometimes this can exacerbate the current situation. The song they select randomly can make a drastic impact on their emotions. Since they want to select a song to listen to, it can be a time-wasting way to choose suitable music to play. (Schedl, 2019) Emotions can be a very sensitive aspect of different personalities. So, when suggesting a song, it should be very carefully selected.

1.2.4 Text mining and Music Recommendation

Text mining can be used to identify sentiments within people and the behaviour patterns after analyzing a text which they have posted or shared on social media platforms. Emotions can be detected using speech or facial expressions. But it is not accurate enough since people can fake their emotions and hide their feelings. By analyzing texts which user used to share their thoughts can be used to identify the emotional status. Identifying the emotions, researchers have experimented with a wide range of algorithms to extract the correct expression which is hidden inside the sentiment. Also, past researchers have identified the importance of music recommendation systems based on the user's sentiments, since the systems can identify the user's expectations of the recommendation system by analyzing their opinions and the way they build up the conversations. (Cheng and Tang, 2016a)

1.3 Problem Definition

With modern complex lifestyle, people always try to be relaxed. Listening to music is one of the popular methods to relieve stress and have a fresh start. They must search for quality music to listen to and heal themselves. Music recommendation systems have been helped in various stages of people and suggest them a various range of music. Some can be relevant for their current mood but it will not suggest the exact emotions from songs. (Bauer and Schedl, 2019) There should be a proper way to extract the user's emotions and the emotion which is generated from the song. This combination will help to solve the problem which the author identified.

1.3.1 Problem Statement

Modern days people use social media networks to share their feelings and thoughts. When they get stressed, posting on social networks become a daily habit. (Laeder, 2018) People love to listen to music since it is the best method to help them to relieve their stress and make them comfortable. Since there is no proper method to suggest a song according to their mood, people need to listen to quality but helpful music to relieve their stress and pain. This research on emotion-based music recommendation systems will be focusing to solve this issue.

1.4 Research Motivation

Even though there is past research regarding music recommendation systems, People are not aware of those existing systems. Besides, the emotion analyzing domain is lacking with proper algorithms to identify the emotions of people, especially the sentiments with the Sinhala language. Hence, a proper system to analyze the emotions from social media platforms and an accurate system for song recommendations from the playlist according to the users feeling for their satisfaction is difficult to find. As the goal of the research, the author's motivation is to build up a system for any person to listen to a suitable song according to their current emotion.

1.5. Existing Works

There are quite a lot of researchers who have been involved in the domain of music and emotion recognition. If a Music recommendation system can recommend a song by the emotional status, then that system can automatically simulate the listeners feeling lively or if it can feel them relax. Music recommendation systems based on emotions use various kinds of attributes to recommend the songs to the listeners. (de Assuncao and de Almeida Neris, 2018) Emotion identification can be based on text mining or image processing. This research paper is based on emotion detection

using text mining techniques such as NLP, Sentiment Analysis. (Calefato, Lanubile and Novielli, 2017)

1.5.1. Identification of the emotions of a user in social media networks through sentiment analysis

A state of feeling in people's mind can be defined as an Emotion. For better communication, People should be able to understand the emotions of others. (Wickramaarachchi and Kariapper, 2017) Usage of social networks has grown in the past few years and people tend to share their thoughts, feelings, daily routine, opinions and various kinds of information in social networks. (Roshanaei, Han and Mishra, 2015)

Research	**Techniques/Algorithms used**	**Advantages**	**Limitations**
(Nimeshika and Ahangama, 2019) Year - 2019	OCR -Python tesseract CNN Text Classifications	Identification of the current mood when using social networks with high accuracy. Identified the derived emotions when considering the gender, age and psychological aspects	Only 5 main emotions are detected. Read the posts of a particular time range and considering it to recognize the emotion. Identify the sentiments on the photos on Facebook and consider extracting emotions.
(Wickramaarachchiand Kariapper, 2017) Year - 2017	Latent Semantic Analysis Term Document Matrix - TDM	The accuracy of the model is significantly high. Text analyzing model can be expanded with platforms like Facebook to identify the sentiments.	Only Identify the complex emotions Dataset is not accurate. Language dependency. No proper studies to extract emotions from informal language. Usage of any other classifiers rather than SVD. Analyzing brain signal
(- and -, 2018) Year -2018	Naive Bayes Natural Language Processing k-Nearest Neighbor algorithm	Developed an ensemble approach, which further improves the sentiment classification performance in social networks	Accuracy should be improved. Expand for other languages

Table 1.1: Comparison of the Emotion recognition systems using texts

As the previous comparison mentioned, extracting emotions from the text is a complicated task. The main reason to consider the sentiment of the users' social network activities is, the text can express the feeling rather than the emotions in the face. Facial recognition can be faked sometimes. But the feeling which is shared through a text can be the honest opinion of someone's mind. So

the accuracy of identifying the true emotions from the text is high. (Radhika and Sankar, 2017) Past researchers have identified the methods to extract basic emotions such as happiness, sadness, anger through their research. Also, researchers have done their studies to extract the emotions in formal language aspects, but the lack of techniques to identify or analyse the informal language used in texts is a limitation to identify the complex emotions since most of the users are using informal language to share their thoughts.

1.5.2. Songs' Emotion identification and Recommendation

Song recommendation and identifying the emotion of the song are two different pathways that are considered in this research. The lyrics of a song can be stored in the users' mind for a long time. And it plays a major role to identify the emotion of the song. (Lakshitha and Jayaratne, 2016) Previous researchers have done some research to identify the emotions using various attributes of a song and they have developed systems to recommend songs to the users.

Research	**Techniques/Algorithms used**	**Advantages**	**Limitations**
(Rosa, Rodriguez and Bressan, 2015) Year - 2015	Sentimental Analysis Lexicon based sentiment intensity metric	Identify the user's sentiments and recommend the songs based on database	Only used sentiment intensity metric to determine the emotions in songs
(Abeyratne and Jayaratne, 2019) Year - 2019	Feature selection algorithm Random forest supervised ml algorithm	Suggest a song according to the emotion which user select	Limitation for the Sinhala contexts. Usage of hybrid variables such as music experts' ideas and the lyrics. Use of deep learning methods Apply for the English songs as well
(Kailash et al., 2017) Year - 2017	Image processing Support Vector machine Naive Bayes Extract the mp3 file and determine the emotion	Identify the current mood using image processing techniques	Should reduce the searching time for music thereby reducing the unnecessary computational time. Only consider the image results to provide the song

Table 1.2:Comparison of the Music recommendation systems

There are previous studies on Music recommendation systems by analyzing emotions using several methodologies. The most common way is to recognize emotions using image processing methods. Also, the recommended music will be chosen randomly. And as per previous studies mentioned above, the randomly generated songs give a low impact to help the users to relive their stressful situations. But this research aims to analyze the people's emotions based on their social media behaviours, such as posting, commenting on the posts and extracting the current mood of the user

using Natural language processing techniques and recommend the most suitable song according to their current emotions.

1.6. Research Gap

- **Identify the Complex emotions –** Apart from the basic emotions, the author has identified a gap between extracting complex emotions such as grief, regret, jealousy, disgust in the texts.
- **Identify the Emotions from informal language –** Emotional Features in the sentiments which are in the informal language needs to be identified as part of the research since it does not consider by the past research.
- **Language dependency gap – Sinhala –** Analysing and extracting the emotions in comments, posts in the Sinhala language.
- **Music categorizing based on emotions using lyrics –** Identify the emotions of the songs using their lyrics and categorize.
- **Improve the Accuracy and Use of Unsupervised techniques**

1.7 Contribution to the Body of Knowledge

1.7.1. Contribution to the Domain

Develop a system to help users to select suitable music according to the current mood - This can help people who have issues with depression and stress, and they can be relieved from their tension mindset. Even though there were existing systems, users are not aware of any of that. So, the author proposed to raise awareness about such techniques and develop it in a more user-friendly way to help the people who are struggling with so many stressful lives.

1.7.2. Contribution to the Technological Domain

Improve the accuracy of Sentimental analysis in textual contents in social networks – Research will analyze the sentiments without language dependency and will improve the accuracy of sentiment analysis for English, informal English, and Sinhala language. Consideration of the users' engagement with the social networks, their posts, comments, and ideas will be evaluated using text mining techniques to improve the accuracy in textual contents.

1.8 Research Challenges

Understand the lyrics of a song and Predict the emotion which will be generated in the user's mind.

Understanding the emotions of a song using lyrics is a difficult aspect. Past researchers have done the emotion recognition from the music by analyzing the song genre, melody and tempo. Although

there is previous research about mood identification from the songs, their main goal was to check the melody rather than the lyrics. (Automatic mood detection and tracking of music audio signals - IEEE Journals & Magazine, no date)

Identify the way of expressing emotions in a textual way.

Text Analyzing has its limitations to identify different types of emotions in people and the way they express through social networks. Researchers have tried to identify these emotions but ended up on the negative side. So, the usage of a more complex dataset will be used to analyze the different emotions.

Find a productive and more accurate way to analyze the sentiments in social networks for the Sinhala language.

Sinhala is one of the official languages in Srilanka. The majority of Sri Lankans use Sinhala as their first language, so they are using Sinhala to share their thoughts on social media. Identifying the emotional sentiments from the Sinhala language would be a challenge for the author because the Sinhala language-related dataset rare to find.

1.9 Research Questions

RQ1: What are the newer methods to identify the emotions in a text using formal and informal language sentiments?

RQ2: How natural language processing techniques identify the emotions of a song, using its lyrics analyzing?

RQ3: How Sentiment analysis techniques scrape the emotions in Sinhala text?

RQ4: What are the methods to recommend accurate songs for the users' current mood?

1.10 Research Aim

This research project aims to design, develop & evaluate a system that recommends the music, based on emotions in the songs extracted from the lyrics and matching them to the user's emotional states which analyzed from social media content with English and Sinhala languages.

1.11 Research Objectives

Objective	Description	Learning Outcomes

Literature Review	Analyze about the Previous works on the domain. Following areas are covered review, the domain and its existing works. • Analyse the basics of text mining and sentiment analysis • To analyse the emotion recognition from textual context using NLP techniques • To review the existing Music recommendation systems and identify the gaps. • Critically evaluate the proposed system with past research. • Determine the algorithms, techniques, tools. APIs used in previous works and analysed the advantages to use the proposed system	LO1 LO4
Requirements Gathering	• Carrying out the requirement gathering phase to determine the in-depth details of the problem domain. • Ideas and feedback from the domain experts, researchers will be taken through questionnaire and interviews to evaluate the requirement for the proposed system • Define and analyse the functional and non-functional requirements for working with the project	LO2
Submit the Ethical Clearance	• Analyse the SLEP issues and obtained ethical clearance to complete the research.	L07
Design the Prototype	Prototype development is one of the major parts of the research since the proof of concept would be the prototype. Before developing the prototype, it should be designed. By going through the designing phase, the author can prevent future failures, unwanted implementations and also can get a clear understanding of the high level and low-level architecture of the proposed system by designing class diagram, flow charts, Use case diagram and UML models	LO3
Development of Prototype	Develop the prototype to fulfil the proof of concept. The ultimate objective of the project is to develop a working prototype to prove the hypothesis	LO5
Testing and Evaluating	Testing and evaluating ensures the prototype is up to standard and working according to the requirements Analyze the performance of the prototype to validate the accuracy to ensure that the expected accuracy is achieved.	LO6

Table 1.3:Research Objectives

1.12 Project Scope

After considering the objectives and the review of existing research, the author has identified the following scope to continue the research.

1.12.1 In-Scope

The scope that will be covered in the research is as follows.

- Recognizing the emotions of the song using the lyrics analyzing – To get the high accuracy lyrics and the melody will be considered to analyze for the recognition of the emotion of the song.
- Identify the users' complex emotions in social media sentiments – Referring to the past researchers, complex emotions detecting using is untouched. It would be one of the main tasks of this research.
- Sinhala and English language sentiments analyzing – To detect the emotions of users, language would be one of the major facts. In Srilanka, most people used Sinhala to share their thoughts on social media. So, the language dependency gap will be considered, and the informal language will be considered to get emotions.

1.12.2 Out- Scope

The operations that will not be covered in the research as follows,

- **Analysing the Sinhala song's lyrics**
- Automatically playing the music after recommendations

1.12.3 Features of Prototype

The below figure shows the features of the prototype which will be developed as a part of this research

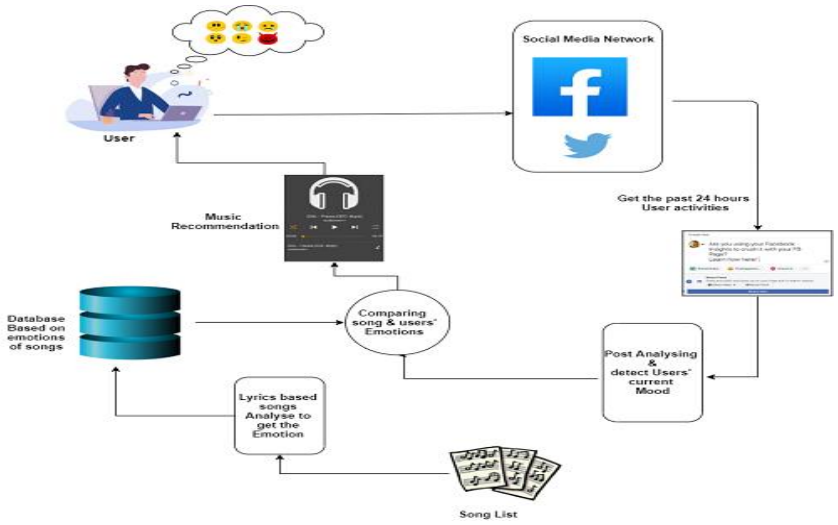

Figure 1.1: Features of Prototype

1.13 Resource Requirements

According to the project objectives, to accomplish the expected outcome, following software and hardware requirements are important to have.

1.13.1 Software Requirements

- **Natural Language Processing Libraries** – For Text analyzing and identifying, NLP techniques and the libraries are required.
- **Jupiter Notebook** – To run the NLP models Jupiter notebook is required
- **Python** –Base language for the development of the prototype. Python is consisting of so many libraries required for text analyzing and it can be beneficial for further development.
- **PyCharm and IntelliJ**-Basic Code editing IDEs will be required when developing the system.
- **Facebook SDK /Twitter API-**To get the data to feed the text analyzing models
- **Microsoft Word / Google Documents** –MS Word and google document tools are used for documentation purposes from the beginning of the research
- **Zotero** –A reference management tool used to manage and backup the research papers and the notes.

1.13.2 Hardware Requirements

- **Core i7 processor** –

  To process all related requirements and tasks as quickly as possible in an accurate way.
- **16GB Ram-**

  To run multiple programs simultaneously and smoothly and to manage the high-volume datasets which are used in text analyzing
- **50GB or above disk space –**To store all the project related documents and files

1.13.3 Skills Requirements

- **Communication Skills** – Communication skills are important for the research project since the author needs to validate the project idea, requirements from the domain experts. So good communication skills will be required to collect the requirements and feedback.
- **Time management** – One of the basic, but important skill research should have. To complete the research, the project deliverables and objectives need to be completed before

the due dates. Since the time management skill will be one of the key factors to finish the research.

- **Research & Analysing Skills** – Research & analysing skills will be useful to identify the project and its process. The author must read the previous systems and should be able to analyse the available research to prove the hypothesis.

1.13.4 Data Requirements

- **Natural Language Processing Algorithms** – Support Vector Machine, Naïve Bayes, Sentiment analysis, Semantic analysis
- **NLP data sets for Emotion Recognition** - Stanford dataset for NLP, ISER dataset,
- **NLP Model** - Open NLP, Natural language tool kit

1.14 Chapter Summary

This chapter discusses the decisions taken regarding the project initiation process. The problem, objectives, Aim and scope was defined in this chapter. The next chapters will be consisted of the relevant details to complete this research successfully.

CHAPTER 2: LITERATURE REVIEW

2.1 Chapter Overview

Music recommendation systems based on emotion recognition are a prevalent research topic. Recent research has been done to identify the main components which should be implemented in the future. This chapter will critically evaluate the existing researchers, technological approaches, and the evaluation methodology related to the music recommendation system based on emotions. The chapter starts with the concept map, which is a direct guide to the processes and techniques which will be used in this study.

2.2 Concept Map

The concept map consists of the entire literature related to the project idea. The map is attached in **Appendix 2.1**.

2.3 Literature review on Problem Domain

2.3.1 Issues Related to the stressful life cycle

The development of technology makes people's life cycle becomes more complicated. They had to face many challenges from the physical aspects as well as emotional breakdowns. Stress is the major issue people had to overcome with this competitive lifestyle, and it can lead to more dangerous situations like depression. (Acheampong, Wenyu, and Nunoo-Mensah, 2020). With the current education system and social behaviour, most students suffer from depression, which could be the worst problem soon (Lan et al., 2019). Also, many professions related jobs become much more stressful and can lead to depression situations. But identifying such situations is very difficult (Nisar, Rasheed, and Qiang, 2018). People used many methods to overcome their stressful situations and keep mental health positive, and they express their stressful emotions using many forms such as social media. (Aalbers et al., 2019)

2.3.2 Social media and Human behaviour to express the thoughts

Social media networks are the leading platform to share people's opinions. It isn't easy to maintain someone’s thoughts and actions in social networks since it is very personal and interconnected. According to (Bruning, Alge, and Lin, 2020), increased use of such social network platforms influences society to share their thoughts. People share their daily activities, opinions, and feelings using social network platforms, and they expect to be relaxed using social networks. As per the research done by (Nimeshika and Ahangama, 2019), they have identified the use of understanding

the emotions shared in social media networks. The posts and comments consist of people's opinions, so they have specified that the mood and behaviour pattern can analyze users' thoughts. The research of (Katchapakirin et al., 2018) has discussed the importance of validating the users' engagement with Facebook and how they have used Facebook to share their thoughts. They have also suggested that social media can detect people's stress at a specific time.

This research will use the above-mentioned social behaviours to identify the current mental state. And study will further be expanded to recognize the emotion using their post to suggest the most suitable music for their wellbeing.

2.3.3. Music therapy as a stress reliever

There are thousands of languages in the world. But among that, music is a very understandable universal language. The feel of music can change the entire mood in a few seconds. The recent research (Landis-Shack, Heinz, and Bonn-Miller, 2017) found out that music therapy can be used as a treatment method for posttraumatic stress disorder(PTSD).

Music therapy can be used as pain releasing techniques even for other diseases such as cancer, anxiety. Music can control our physiological functionalities in the body, such as pulse rate, heart rate, lower blood pressure, and decreased stress hormones level. (Krishnaswamy and Nair, 2016). Most people are not aware of these facts, but they love to listen to music in their free time.
In this competitive lifestyle, people’s engagement with music is very high. They always use music as a friend to erase their loneliness. The busy life schedule force people to limit their relationships. So as an alternative relationship method, people tend to choose music. (Särkämö, 2018) the article discusses the effect of quality music on people's relationships.

Music lyrics and melody have an excellent relationship to express the feelings in the users' minds. The right combination of melody and lyrics can control the listeners' emotions and actions. This study will use music therapy techniques and the lyrics' emotions to recommend the most suitable songs for the people who need to keep their minds fresh.

2.3.4. Text analysis for Emotion detection

Emotion can be recognized using several techniques. Facial expression is one of the popular ways to identify users’ emotions. Since people can fake their feelings, Text analysis methods are replaced to identify their feelings with high accuracy. In recent years text analysis plays a significant role in recommendation systems and classification systems. The sentiment intensity

metric can be used to identify a person's above-mentioned emotional state (Rosa, Rodriguez, and Bressan, 2015).

Emotions of a person described as an intense feeling which is expressed due to any kind of response. The behaviour pattern based on social media can be used as a resource set to identify emotions. The positivity and negativity of sentiment can be considered to determine the current emotion. The research of (Gaind, Syal, and Padgalwar, 2019, p1) suggests a two-way sentiment analysis method to identify the exact emotional behaviour.

A lot of work has been done regarding sentiment analysis to identify emotions. In the study of (Hulliyah, Bakar, and Ismail, 2017), they categorize the feelings into two parts, positive and negative, and it is further divided for their analyzing purposes. The author uses this technology for social media content and the music lyrics analyzing purpose in this research. Since the text analyzing method has consisted of a wide range of algorithms, results can be more accurate.

2.3.5 Music recommendation system based on emotions.

Recommendation systems can recommend music according to user preferences. The use of a recommendation system is to get the most accurate results. Music recommendation systems attract users and service providers if they can recommend the most precise music they prefer. The study (Cheng and Tang, 2016) shows that the acoustic features related to music recommendation are reliable for users to choose a song.

(de Assuncao and de Almeida Neris, 2018) was able to implement a system that can recommend songs according to user preferences. But users had to input their choices to get a relevant music recommendation. They have highlighted that the emotion-based recommendation system can be more accurate than the traditional recommendation methods. The proposed system will consider the music database created according to songs emotions and recommend the most suitable and accurate music according to the users' current emotional behaviour. The hybrid approach will recommend the music to the user and consider all other aspects to give the quality output.

2.4 Literature review on existing systems

There have been many systems that recommend songs according to user preferences in the recent past. This research is based on emotional recognition from text and suggesting the most suitable

music for the user. The author has identified the two main parts of the study, and the explored related works are categorized under that.

1. Identify the emotion using social media networks' contents.
2. Songs' emotion recognition and recommendation

2.4.1. Identify the emotion using social media networks' contents.

Gain and Bharat (Gaind, Syal and Padgalwar, 2019) designed a system to identify the emotions from English texts collected from the social media platforms. The problem they addressed was detecting, classifying, and quantifying text emotions in any form and considering English as the language. They have used a two-way approach to identify users' feelings. The first one was using NLP and Emotion Word set algorithm, and another method was using machine learning classifiers. When considering the text contents, they have used Twitter data to train their model. They have identified six raw emotions, Happiness, Sadness, Anger, Surprise, and Disgust. The limitation was to enhance emotion recognition methods to analyze real-time twitters, and they have not identified real-time mood identification. Comparing to other related works, they have achieved considerable accuracy in detecting the above mood groups from twitters. They also have devised a method to automate the model's self-training and have created a sizeable emotional dataset for future algorithms.

(Nimeshika and Ahangama, 2019) Nimeshika and Ahangama have developed a system to identify the emotions using frequently used social media networks. They try to analyze the daily mood changes using the content posted in the user's social media profiles. They have considered different attributes, such as gender and psychological measures. They have allocated the points to the sentiments extracted from the posts and images shared by the user, analyzing Facebook posts. They have combined the score and temporarily weighted them according to the emotion. For their research, they have used supervised learning methods to analyze emotions. For that, they have labelled the data set with four basic emotions. To detecting the feelings, they have used CNN and OCR- Optical character recognition and python tesseract. They also have considered the emojis in the texts and used emoticon classification; they have ranked the emoji's sentiments. As mentioned above, they have used two classifiers for model implementation. And after the evaluation, they have chosen the CNN methods rather than NN. They have limited their research to identify the basics emotions. And they have not considered the sentiments analyze from the shared images with textual contexts. The previous study done by Gaind and Bharat has used a different approach

than this. But Nimeshika and Ahangama have added more features to analyze the emotion of the user in their research.

(Udochukwu and He, 2015) Udochukwu and Yulan He has implemented a rule-based approach to detect emotions from texts. They have addressed the problem of identifying the implicit emotion which is hidden inside a text. They have used the OCC model for emotion detection. And text pre-processing done by using POS, Part-Of-Speech techniques. When identifying the implicit emotions, they consider the sentences' tense, polarity to determine the feelings. They have outperformed the lexicon matching method and F-measure algorithm by a 17%-30% margin for three datasets. Even though they achieved considerable accuracy in identifying the implicit emotions, there were few limitations. The authors suggest enhancing the OCC model to identify the influence of adverbs and adjectives on emotions. Also, poor performance results from the "fear" emotion category, and the study is related only to the primary emotion identification is another limitation. This research has used a different approach than other existing systems, and authors try to analyze the implicit emotions, which the other researchers did not attempt.

(Roshanaei, Han and Mishra, 2015) Features of mood prediction research by Roshanei and Richard Han addressed analyzing the users' current mood using their recent posts on Twitter. They try to consider the different features exhibited by the users through their social media activities. When determining the emotions, they weigh the psychological characteristics, Personal activities, and gender. Also, the essential details such as occupation, interest in sports, sleeping styles are considered to validate the emotions. For that, they have used crowdsourcing methods to get the relevant data. Support vector machine (SVM), MIR, and LIWC algorithms are used to analyze the above mood features. This research's main advantage was exploring the users' background and comparing it with social media sentiments. But this research has the lowest accuracy level among the mood prediction researches we are discussing here.

(Prabhakar and Sugashini,2018) This research has explored effective methods to understand people's opinions when using e-commerce sites. They designed a system to extract emotions while searching on the web site or blog. They have used Twitter data from the users and analyze it using several NLP algorithms. When classifying the feelings, they filtered out the twitters which are related to e-commerce platforms. They have suggested the New Ensemble classifier, which can be more useful for creating a learning model. They have compared the accuracy with popular

algorithms such as naïve Bayes, random forest, k-NN. The ensemble method uses several models to increase the accuracy of text classification, and it is based on the weighting of the schemes, which will later be assigned to the dataset. According to the evaluation result, their suggested approach has gained a significant accuracy level. This new ensemble approaches very efficiently since it consists of a combination of NLP models. But the authors failed to enhance the approach for identifying the advanced emotions.

2.4.1.1 Comparison of emotion detection from social media contents

Research	Improvements	Limitations
(Gaind, Syal and Padgalwar, 2019, p1)	Usage of both NLP and ML approaches to classify the emotions	• Only consider the English language • Real-time mood-changing can not be detected
(Nimeshika and Ahangama, 2019)	Identify the current emotions Consider the psychological features	• Only five emotion categories identified • Low accuracy
(Udochukwu and He, 2015)	Identify the emotions from the texts without emotion bearing words	• Classifying the informal texts • The influence of verbs and adverbs did not consider • Low-performance rate for specific emotion categories
(Roshanaei, Han and Mishra, 2015)	Classify the temporal nature of a person	• Accuracy is not enough • Language dependency
(Prabhakar and Sugashini,2018)	An ensemble approach to analyze the sentiments	• Identify the advanced emotion categories

Table 2.1: Comparison of emotion detection systems from social media

2.4.2. Songs emotion recognition and recommendation

The emotion of the song is based on several key aspects. Lyrical meaning, music, beat, and rhythm of the song can significantly impact the feeling generated after listening to it. Past research has been conducted to identify the emotion from a song and recommend a suitable song matching with the user's current mood.

(Chen and Tang, 2018) Chen and Tang research the Chinese song recommendation system based on its lyrical emotions. They have worked to develop a content-based recommendation platform for music. Their approach adopted several sentiment lexicon algorithms into the Chinese language, and for the sentiment analysis, they used corpus-based and lexicon-based textual sentiment methods. They have limited the use of the corpus-based analyzing process to ensure to reduce the

computational overhead. Also, that method needs a broad set of training data sets to get the predicted accuracy. Using lexicon ontology and *TF*IDF* analysis, they have generated a new music emotion matrix. The lyric's classifications have mapped the importance of word combination with a specific mood against all moods. And they have created an emotion point matrix and calculate the emotion points. Considering the emotion points and the collaborative filtering model, they have calculated the similarity to predict the song for most related emotion. The experimental results found out that the collaborative filtering method is very accurate in recommending the music. But the limitation was they only predict songs considering four emotions, and they need to focus on the song features such as speed, tone to calculate the content value.

EMOSIC (Nathan, Arun, and Kannan, 2017) EMOSIC is an emotion-based music recommendation platform developed to suggest an accurate music playlist to the user according to their current mood. In EMOSIC, they have used face recognition technology to identify the users' moods. They have used users' real-time pictures and analyzed using image processing techniques to determine facial expressions. But people can fake their emotional expression in many ways. So, identify the emotion using facial expression is not an accurate method. Authors used Audio Emotion Recognition (AER) and Music Information Retrieval (MIR) methods to analyze a song's emotion. They have considered the song's tempo and the music to extract the feeling of the song. Compared to other past works, EMOSIC lacks accurate prediction results since they used only a few characteristics to analyze the song's emotion. As mentioned above, facial recognition is not the best method to identify users' current mood. Even the authors suggest considering the lyrics to analyze the emotion for their future studies.

(Radhika and Sankar, 2017) The study is based on the song recommendation platform to a personalized emotional state. The authors extract the sentiments from social media and record the users' behavioural patterns to analyze the current mood. They have compared the three methods of emotion classifying techniques. Corpus-based, lexicon-based, and the hybrid method were their selected classifiers. They have attempted to design and develop a language-independent music recommendation system. So, extracting emotion from the text should be language independent. Lexicon-based classifiers are based on the dictionary word values, and they need to apply several algorithms to classify the sentiments in other languages. But machine learning-based approaches such as Corpus-based classifiers following supervised learning methods. The authors decided to

choose the corpus-based classification and improved the accuracy; they have suggested using correction factors. They have used a language-independent sentiment classifier. But it should be focused on enhancing it further. The main weakness was music recommendation is based on a manual method. Such as after getting the current mood, users need to select songs on their own. Even though this product could detect the current mood from language independently, the recommendation is not up to the expected level.

(Kashyap et al., 2016) This research was focused on analyzing mood using music features such as genre, melody, and lyrics. Their main target was to explore the audio features and compare the moods detected by lyrics analysis. The audio element analysis focused on the tone of the music and detected the song singer's age and gender. Naïve Baye's theorem is used to extract the emotion from lyrics, and with the support of an SVM classifier, they have identified the feelings from the song's audio feature. Audio features were able to outperform the lyrical features, and the hybrid system was able to achieve a reasonable accuracy rate to identify the feelings of the song. They have given eighteen mood arrangements as inputs for the identification. This study only suggests the song's emotion but with high accuracy level compared to other related works.

(Cheng and Tang, 2016b) Cheng and Tang conducted their study to identify the emotions in music using acoustic features. They have used a primarily hybrid approach in their research. For the content-based approach, they consider the songs' metadata and audio elements. They have grouped the music elements into three categorize, timber texture, rhythmic and pitch content. And then, they have considered the context information of the song. They have used user personality behaviours such as rating and commenting patterns for the songs, searching patterns, and then created the feature vector. They have used the SVR -Support vector regression model to predict user preferences for a specific song, and it outperformed the standard feature selecting based models. They have used the Radius Basis Function with SVM for their kernel function. After evaluating The suggested hybrid method, Their solution had the least Mean Absolute Error (MAE) to improve decision accuracy and achieved the high accuracy for the recommendation compared to the Collaborative filtering approach. As mentioned above in the related works, they have not considered the users' current mood to suggest the most suitable song for the user considering their emotional states.

2.4.2.1 Comparison for songs emotion recognition and recommendation systems

Research	Improvements	Limitations
(Chen and Tang, 2018)	Collaborative filtering recommendation to reduce the computational issues	• Did not consider the song features. • Need large datasets.
EMOSIC (Nathan, Arun, and Kannan, 2017)	Use of face recognition techniques to identify the mood of the user	• Identify hidden emotions. • Did not consider the features of music. • Always songs database should update
(Radhika and Sankar, 2017)	Language independent recommendation methods. Lexicon based approach has been used	• Not consider informal language features • Did not consider the lyrics. • Low-performance rate
(Kashyap et al., 2016)	Analyzed the audio features. Identify the eighteen emotional features in audio	• Lyrics are not considered. • Limitations in the training model
(Cheng and Tang, 2016b)	The hybrid approach outperforms the other methods. Consider the users' personality features	• Limited dataset and accuracy are not enough because of that.

Table 2.2: Comparison of Songs emotion detection systems

2.4.3 Benchmarking the Literature of the existing systems.

2.4.3.1 Benchmarking for identification the emotion using social media networks contents.

Udochukwu (Udochukwu and He, 2015), in his research, have achieved a 17% to 30% margin of accuracy level for the OCC model compared to lexicon-based approaches. They have used the ISEAR, SemEval, and Alm's emotional data sets for three methods, Lexicon, Naïve Bayes, and rule-based. They used 5-fold cross-validation and F-measure to evaluate the scores.

Prabhakar and Sugashini (- and -, 2018) achieved a high accuracy rate and identified the derived emotional categories. The new ensemble approach proves the proposed model efficiency is comparatively successful in identifying the emotions.

2.4.3.2 Benchmarking for songs emotion recognition and recommendation

Cheng and Tang's music recommendation uses a hybrid approach **(Cheng and Tang, 2016)** compared to collaborative filtering approaches. Online downloaded data sets have been used in the study. The data set consists of 120 different music and 1050 ratings from the users. MIR toolbox used to extract the audio features from the song and calculated the MAE value. Calculating the MAE, the skipped common tags from the text to get the productive result.

Radhika and Sankar's language-independent recommendation system (Radhika and Sankar, 2017) recommended suitable songs according to their feelings after listening to music. The datasets have

used real-time user input data and more than an 800million tweets with several languages to feed as the correction factor. The tweets' intensity value is calculated by the corpus-based method with the correction factor, which helped recommend more accurate personalized songs for the user.

2.5 Literature review on Technologies

2.5.1 Data Pre-processing technologies

Data pre-processing is one of the critical steps to consider in Data science-related researchers. In sentiment analysis, to extract the emotions, the data sets should be pre-processed accordingly. Punctuations, symbols are not useful to identify the sentiments. So, the relevant feeding data should be prepared before running in the algorithms.

As mentioned above, relevant texts should be pre-processed to extract emotions. After loading the datasets, there are few steps to do. Removing tags, whitespace, stopwords, and converting all the letters into lowercase or uppercase is the pre-process that needs to be done. Natural Language Processing uses many tools and technologies to pre-process the data(Amrullah, Hartanto and Mustika, 2017).

2.5.1.1. Word tokenizing

When detecting the emotions from the texts, the author needs to consider the emotion class's categorization. So, with the use of supervised learning approaches, it needs to be tokenized accordingly. Tokenizing would be used in this study since it's a common practice in the supervised learning approach. In Rahaman's research (Rahman, Islam, and Ahmed), they have used the Word tokenizing to tokenize the proverbs and emotion class in their text pre-processing stage keyword class.

2.5.1.2 Word Embedding

Word embedding helps to extract the semantic and syntactic content, which is used to understand the given text's similarity. Many word embedding techniques have been used to extract the features. Word2Vec is one of the famous word embedding techniques that converts the words into vectors. In unsupervised learning approaches, word vectors are more critical in labelling the meta tags. In word2Vec, there are two main models used to embed the words. A continuous bag of words and skip-gram is the neural network architecture that helps the neural network learn the Word representing way. The bag-of-words method was used in situations that do not have valid

data sets. CBOW considers the words as an independent entity, and it gives Boolean values to the terms.

When using the Word embedding techniques, handling the unknown Word is a limitation since your model has not trained with unfamiliar words. So then, the model is forced to use a random vector. Also, when the author deals with Sinhala language sentiments, there should be new embedding matrices since it does not allow parameter sharing.

2.5.1.3 Summary of the Tools and Libraries which can be used in data pre-processing.

Tool	Features	Advantages	Limitations
NLTK	Stemming, Lemmatization,POS, Word Embedding,Tokenization,Regex	The most comprehensive and famous library provides more corpus for model training. Can be access to the largest number of languages	It was challenging to learn from scratch. It does not consist of neural network models
TextBlob	POS, Stemming, Lemmatization, Word Embedding, Tokenization	Child library of NLTK Can be used to language translations with Google translate	Not consisted of neural network models or vectors. The process is comparatively slow
Spacy	Tokenization, POS, classification, sentiment analysis, dependency parsing, word vectors	Easy to learn and use in the models In the training model, spacy used the NN	Spacy is less flexible compared to the NLTK library.
Gensim	Word2Vec, LSA,LDA, TF-IDF,POS,Lemmatization, Stemming	Efficient implementation for the algorithms Scalability Can be used in text-similarity methods	They were designed for unsupervised approaches. Not independent, Should be used with NLTK or Spacy.

Table 2.3: Summary of Tools and Libraries

2.5.2 Emotion detection and classification

In this research, the author tries to detect the emotion for social media content and music to recommend a suitable song for the user to their current emotion. So, the emotion detection part is a very critical factor. After Data pre-processing, emotion detection and classification need to be done to prove the hypothesis. This research consists of three main models. Emotion detection

forms social media content, Emotion detection from music using lyrics and recommends the most suitable music according to users' current mood status.

2.5.2.1. Sentiment Analysis and Emotion detection

Sentiment analysis is a method to classify people's opinions, behaviour, and emotions. There are many algorithms and approaches to sentiment analysis. Sentiment analysis can be divided into two main approaches, Lexicon based approach and the machine learning approach. Also, a hybrid approach can be used for emotion detection using sentiment analysis. This section will be discussing both approaches and the technologies which can be used to identify emotions.

2.5.2.1.1 Lexicon- Based Approach to detect and classify the emotions

Lexicon based approach consists of a pre-defined word dictionary. As the author discussed above, after the Word tokenizing, extracted social media content will be categorized into lexicons. The lexicon approach is also divided into other major parts, the Dictionary-based approach, and the Corpus-based approach. In the Dictionary based approach, it used sentiment intensity metrics. A manually updated dictionary consists of a classified word set mapped with a positive and negative scale. Once all the words are defined in the dictionary, the sentiment intensity metric can be trained into a model. (Rosa, Rodriguez, and Bressan, 2015).

The corpus-based approach has enabled the researchers to use the actual form of sentiments. Corpus-based methods have been divided further into semantic and statistical.

- The semantic approach depending on the different aspects used to recognize the similarity between words in which sentiment values are given.
- The statistical approach gets an extensive collection of textual content and calculates the statistics based on that collection

Unlike the previously discussed approach, corpus-based approaches can get actual feelings from the textual contents. It can access the context of the given text content as well as the labelled sentiments. Also, statistical, or semantic methods can be used to identify the sentiments' polarity and can be expanded until identifying the emotions. In addition to Bag of words, N-grams, feature extraction can be identified as the corpus-based approach, which will be used in the emotion recognition system

Approaches	**Advantages**	**Limitations**
Bag of Words	Can implement with minimum resources	Can lead to the high dimensional feature vector

	Simplified the representation of texts	Assume all words are independent There are nonzero values in the corresponding words that occur in the sentences
N-grams	Convert raw text into features that can access in ML classifiers Usage of unbiased models and depends on real data Learning accuracy is high	Long-range dependencies unable to captures Spare the data for low frequency affected tags
Feature Extraction	Feasibility of the large-scale dataset Obtained with stable features Reduced the random selections	Higher computational power and dataset required

Table 2.4: Summary of Algorithms

2.5.2.1.2 Machine learning- Based Approach to detect and classify the emotions

Machine learning-based approaches are the most common method researchers have used in previous emotion detection works. Machine learning-based approaches have been further divided into several categories. (Medhat, Hassan, and Korashy, 2014). Machine learning-based methods play an essential role in sentiment analysis. Typically, textual content level sentiment analysis can be expressed as classification problems that determine the sentences' polarity. In this approach, the Support vector machine and the Naïve Bayes classifier are the most used algorithms. Also, random forest, Logistic regression can be used as a machine learning approach for sentiment classifications. Unlike supervised learning methods, unsupervised learning does not require a labelled dataset. So, the clustering should be done with the available datasets. When extracting emotions from the texts, we can identify some feelings since it is already labelled with emotional sentiments. But most of the hidden emotions extracting is difficult. So, both supervised learning and unsupervised learning approaches are selected in this research. Further research on the hybrid approach is done below.

Algorithm	**Advantages**	**Limitations**
Naïve Bayes	Implementation is very basic Computational efficiency and the classification rate are very high	Precision is dependent on the size of datasets The low accuracy rate for the small datasets.
SVM	Accuracy is high Distributional requirements are not needed Significant results can be obtained when working on high-dimensional spaces.	Complexity is high Memory is not in enough

K-NN	Classes can be not linearly separable	Training time is very high with the large dataset Memory and storage usage is high
Decision Trees	Fast training time Distribution is not required	Can occurs the overfitting issues when the tree is complex Extensive data set is required to get good accuracy
Logistic Regression	Easy to interpret Can perform with good results even the categorical variables are limited	Incrementation is very tough

Table 2.5: Summary of hybrid approach algorithms

Considering the given approaches, the author has decided to use a hybrid system in emotion recognition in social media content and music lyrics. Both sections need a similar approach to identify emotions. The best method is using the hybrid approach that can balance the sentiment analysis from the textual content and determine the real emotion.

2.5.3 Music recommendation methods

The recommendation is more important after the classification of the emotion. Recommendation systems are decision making strategy for users after analyzing given parameters. Music recommendation systems can connect both music emotions and the users' emotions extracted from social media content. Recommendation systems can be divided into three methods. (Radhika and Sankar, 2017)

2.5.3.1 Collaborative filtering

Collaborative filtering methods consider user inputs, ratings. The similarity of the user input will be accounted for to recommend the relevant detail. Prior domain knowledge is not needed since the embeddings and the learning can be done automatically. It only needs the feedback matrix to train the model. But collaborative filtering cannot handle the new items. So, every input should be trained to predict. And external features cannot be added while predicting. In this research, the author will decide the elements to consider in the prediction phase. The value of the emotions will be the main feature of the recommendation.

2.5.3.2 Content-Based Filtering

Content-based filtering used the features of the items to recommend. The similarity metric will consist of the recognized emotional database from the sentiment analysis results and the music database, which was categorized according to the feeling. In this approach, the model does not

need to have any data about others. This recommendation is specific to users. So, it can quickly scale to a large number of people. But to improve that, there should be considerable domain knowledge. So, the model can only be as good as the manually engineered features. Also, the ability to expand the users' existing interests is minimal.

2.5.3.3. Hybrid filtering method

The hybrid filtering method combines the techniques mentioned above and provides the combined output. The accuracy of the recommendation is usually high in hybrid filtering methods. In this music recommendation system, the pre-defined databases will recommend the most accurate songs to the user. The identified emotions from the texts and music will be compared, and they will be categorized according to the relevant users' emotional behaviour. And the similarity between the music genre and the emotion will be validated, and then recommend the most accurate song to the users with their present mind situation. The purpose of recommending the music is to overcome the sad situations with the users. So, the most suitable songs are considered for the categorization according to the emotions.

2.6 Literature Review on Evaluation Methods

Model Evaluation methods play a vital role in verifying the proposed algorithms' performance's validity and accuracy. Evaluation methods are discussed below.

2.6.1 Training metrics

Training metrics are used to validate the performance of the dataset. Using training metrics, the author can define three main processes: training, validating, and testing the data sets. There are two principal metrics used in training.

<table>
<tr><th colspan="2">Cross-Validation</th></tr>
<tr><td colspan="2">The most commonly used method is to select a model that does not depend on the initial training set. The most frequently used process is called k-fold cross-validation. In this method, the dataset will be divided into k number of folds to validate the model. Each fold will be considered into the validation, and the performance is validated using the average performance of all k-folds.
Cross-validation can be used when there is a smaller dataset and use high computational power</td></tr>
<tr><th>Advantages</th><th>Limitations</th></tr>
<tr><td>Estimates the broad performance range
Efficiency in data usage in testing and training</td><td>Can occur overlapping</td></tr>
</table>

Hold-Out Validation	
Hold-out depends on one train-test split, and it will impact the score of the metric. Hold-out uses less computational power than the cross-validation method and can get accurate results with a large dataset.	
Advantages	**Limitations**
Data splitting is easy and uses the less computational power	The reliability of the results is limited since the subset is based on one layer.

Table 2.6: Summary of training metrics

2.6.2 Regression metrics

Regression metrics are mainly used in the supervised learning approaches to the prediction process. In this research, the author chose a hybrid method as a development approach. So for the evaluation, the regression matrices can be used. The regression task is the prediction of the state of an output variable at a particular time. It can depend on some other related variables. Comparing to classification tasks, regression output consists of continuous values within a specific range. (Calefato, Lanubile and Novielli, 2017) For the research, the author did not use any regression matrix since it is a classification-based approach.

2.6.3 Classification Metrics

Classification metrics sort the model into categories comparing the predicted value and the actual value. Classification matrices are essential tools for analyzing the results of the model. This section discusses four main classification methods used in the research to classify the results.

Accuracy	
Accuracy can be used to calculate the overall performance of the model. It is easy to understand	
Advantages	**Limitations**
Very easy to use. Can use in binary and multi classes	Data distribution is not considered. So it can lead to miscalculations.
Confusion Matrix	
Shows a more detailed breakdown for classification classes. The confusion matrix is used to have a complete result when assessing model performance and giving direct comparisons.	
Advantages	**Limitations**
Dataset issues can be diagnosed. More accurate than the accuracy matrix	Only use with output models Sensitivity is limited with the response rate

Receiver Operating Curve (ROC) and Area Under Curve (AUC)	
ROC graph showing the performance of the model at all the classification thresholds. This consists of two parameters, True positive rate, and False positive rate. AUC measures the two-dimensional area under the ROC curve.	
Advantages	**Limitations**
Binary classification can be computed ROC curve can compare two or more diagnostic tests in an efficient way	ROC is a probability curve, while AUC shows the measure of separability. ROC-AUC score will depend on the context of the datasets.
Log Loss (Logarithmic Loss)	
If the output is in the form of numeric probability, the log loss can be used instead of a class name. It contains the details of the product, such as how it was incorrect or how correct. In the sentiment analysis methods, the result will be a numeric value. So the log loss can be more useful.	
Advantages	**Limitations**
Better Probability estimation	Accuracy is low

Table 2.7: Summary of classification metrics

2.7 Chapter Summary

This chapter mainly focused on selecting the best approaches and the technologies to solve the problem identified. The chapter started with a concept map, which showed the methods and techniques used in the existing systems. The review was divided into problem domain, existing works, algorithms, technologies, and evaluation methods. The problem domain presented the importance of solving the issue. Then the existing works section reviews the previous works and the technologies used in the recent research. The section was divided into two parts, social media emotion detection, and music emotion detection. The algorithm and technology review section reviews the algorithms, tools, and technological approaches that suit the identification of emotions and the music recommendation system. A comparison of the technologies has been made to identify the advantages and limitations of specific techniques. The final section discusses the evaluation methods that can be used to evaluate the testing results and accuracy. The chapter's findings are analyzed thoroughly to use for the proposed solution, and the author assesses the uses and limitations to get the best accuracy for the project.

CHAPTER 3: METHODOLOGY

3.1 Chapter Overview

The previous chapter discussed the literature related to the problem domain and the technologies. A methodology can be defined as a process, which can gather the available resources to develop research and follow a procedure to achieve the solution of the research. There is a different kind of methodology used in this research. This chapter contains the information related to the project management methodology used in this research. Then this chapter will discuss the risk management phase and finally discuss the suitable software development methodology for this research.

3.2 Research Methodology

The quality of any project is based on the management of resources and effectiveness. To achieve that, researchers use different kind of methodologies in their research. For research methodology, Saunder's research Onion model can be considered (Thesismind, 2019) The following table discussed the research methodologies selected and justifications for the selection.

Research Methodology	**Description**
Research Philosophy	Research philosophy can be defined as the type of knowledge which has been tested in the research. Among pragmatism, positivism, realism and interpretivism, Pragmatism is chosen for the research since the research is based on the **Pragmatism** method because of the research outcome based on both quantitative and the qualitative measures
Research Approach	Researchers can have one or more hypotheses to prove in their research. To prove that there could be deductive or inductive approaches they have chosen. In this research, the aim is to develop quantitative and qualitative software. So, the author chose the **hybrid method** as the research approach
Research Strategy	The Research Strategy is the way to respond to the research questions. It can be mainly surveying, Questioners, experiments, or interviews. For this research, the author chose both **surveys** and **interviews** to get evaluated input for the users. For the final stage of the research, the author can use interviews to get feedback on quality and quantity.

Research Choice	From the three types of research choices, Mono, mixed and multiple, Mixed methods are chosen to be used in the research since the research is backed by the quantitative and qualitative aspects.
Time Horizon	For the implementation of the prototype, the requirements can be changed with the research aspects. So, the time horizon should be cross-sectional. So, the author decided to use a **cross-sectional** method rather than the longitudinal one.

Table 3.1: Selection of Research Methodologies

3.3 Development Methodology

Software development is a different stage process that is related to each other. Each of those stages has a responsibility and the weightage for the final output. (Saeed et al., 2019). Selecting a suitable software development methodology can help to give a quality outcome to the research and the final prototype. Research is based on iterative steps. The author decided to use the Rapid application development method for the Software development methodology. This method known as prototyping is an iterative agile methodology that prioritizes rapid prototype release and iterations. Unlike the waterfall method, RAD does not need strict planning or requirements for development. (Sagala, 2018) The requirements can be changed with users' feedback and preferences. The advantages like low risk, better quality, fast delivery, low cost motivate the author to select the rapid application development method since the project must go on a fast track to develop the prototype.

3.4 Project Management Methodology

The author has decided to choose the Agile PRINCE2 methodology as the project management methodology. The advantage of using the Agile PRINCE2 method is it can manage the risk and issues, control the resource used in the research, as well as capturing and analyzing the lessons learned in the development process. So, it leads the author to select the Agile PRINCE2 methodology.

3.4.1. Project Plan and Deliverables

Gant chart and the project deliverables can be found under **Appendix 2.2**

3.4.2. Risk and mitigation

The following table analyses the predictable risks and mitigations that can be occurred throughout the project

Risk	Description	Probability	Impact
Time management	Time plays a major role in the research process since the deadlines are announced from the beginning, time management would be a major risk.	High	High
Mitigation	The author will utilize the works always before the deadlines and avoid the risk of getting delay for the submissions		
Detecting Incorrect emotions	Detecting wrong emotion can be a serious mistake, and it will give negative results	Medium	High
Mitigation	Usage of more accurate data to train the model will prevent accuracy issues		
Unfamiliar Technologies	The author had to work with new technologies since it can lead to more trouble situations. It can cause delays in prototype development.	Medium	High
Mitigation	learn from domain experts can ensure to gain the relevant knowledge base and can use the trial-and-error methods to prevent delays.		
Lack of datasets	Data is one of the major aspects of the project. To train the model, and availability of the dataset is important.	High	High
Mitigation	The author is advised to use a different kind of datasets and make a dataset manually if the data is not available for the research		
System Hardware, software failure	While the development process, software, hardware failures can happen. The author must face that issue	High	High
Mitigation	The source code and all other data should be back up and keep it safe in the cloud or local backups		

Table 3.3: Risk mitigations

3.5 Chapter summary

This chapter highlighted the selection of research methodology in the first section. All the selections were done according to Saunders' Onion model. Then the author discussed the software development methodology. Apart from the traditional methods, the author selected the RAD-Rapid application development method for the development phase. And for Project management, the author has selected the Agile PRINCE2 method. After discussing the methodologies, the author discussed the Project plan and the deliverables. Also, this chapter used to discuss the risk and mitigations.

CHAPTER 4: SOFTWARE REQUIREMENT SPECIFICATION

4.1 Chapter Overview

This Chapter will mainly focus on the requirements gathering and the methodology which is used to keep those recorded requirements in a meaningful manner. Requirement gathering is one of the main factors in the software development process. Also, when researching purpose, the correct set of requirements can give accurate results for the solution domain. In this chapter author discussing the rich picture for the problem domain, stakeholders' viewpoints, the use cases and the functional and non-functional requirements which will help to execute the expected outcome.

4.2. Rich Picture

The rich picture consists of the background stakeholder relationship for the system. This proposed system consists of many stakeholders. The core of this system will perform the main important functionality which is to identify the emotions from music and sentiments. Also, this system evolves from time to time.

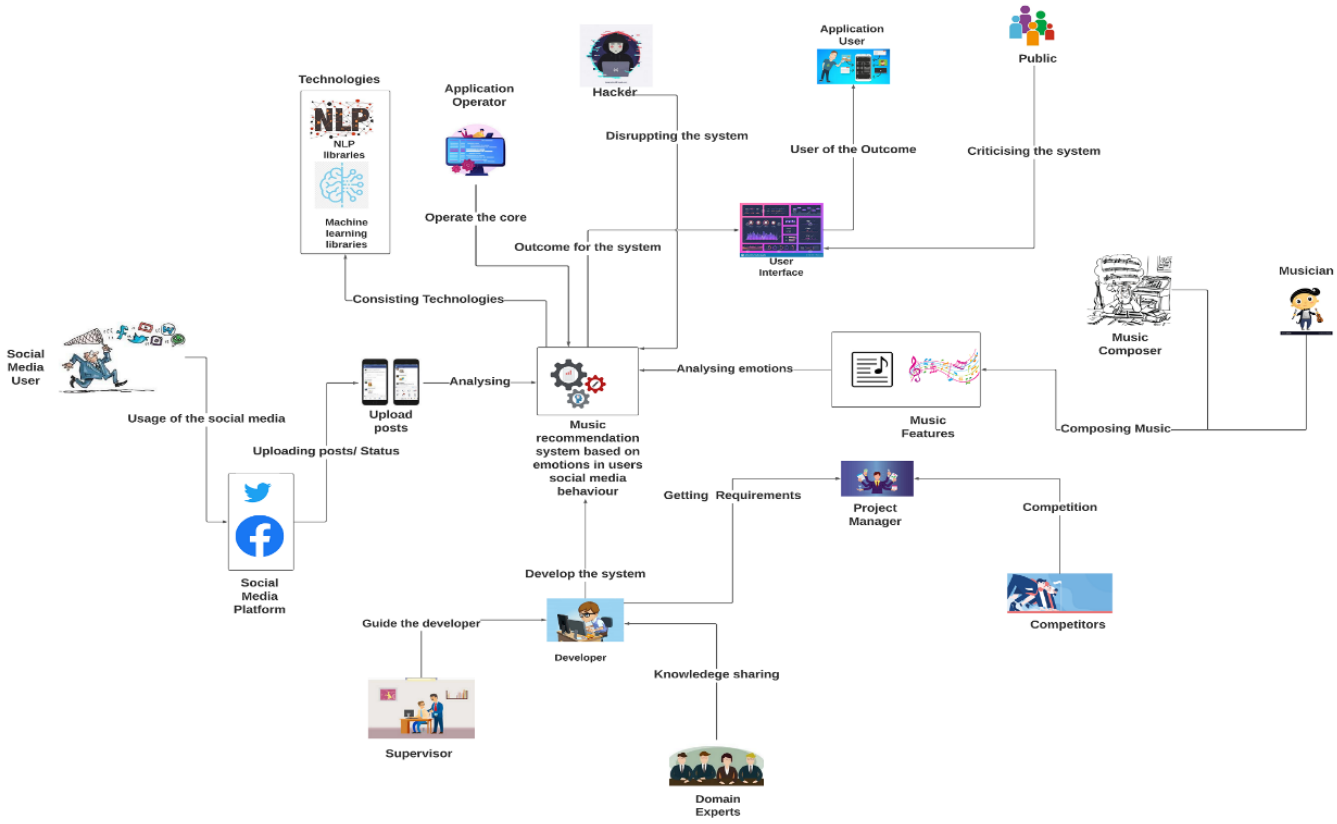

Figure 4.1: Rich picture

4.3. Stakeholder Analysis

4.3.1. Onion Model

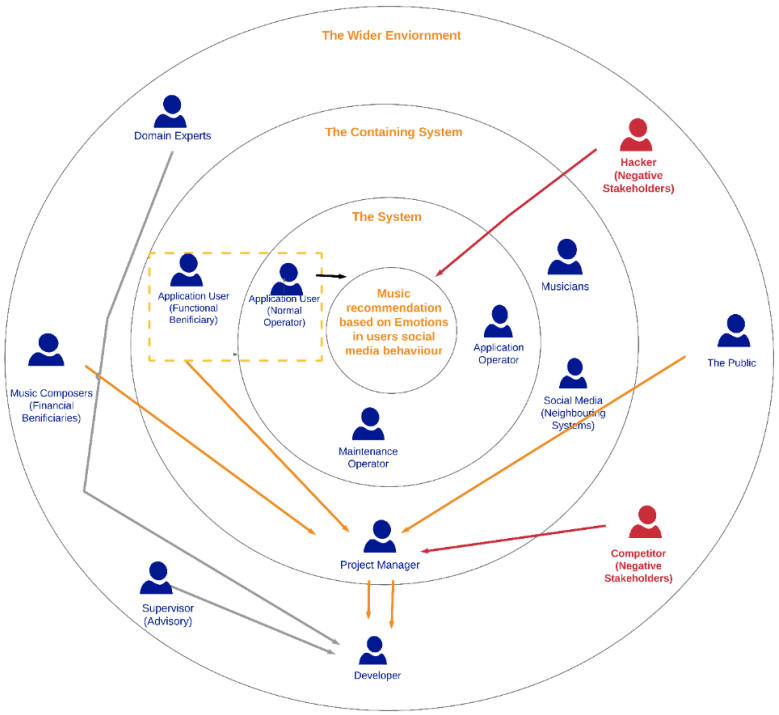

Figure 4.2:Stakeholder onion model

Following pressure points can be seen in the diagram.

1. Project manager should make sure that the system is developed according to the relevant quality
2. Project manager should make sure that the system is user friendly
3. Project manager should make sure that the music composers will be financially beneficial for the proposed solution.
4. Developer should make sure that the process should complete according to the given time frame.

4.3.2. Stakeholder Viewpoints

Stakeholder	Role	Viewpoint
Application Operator	Operational role - Support	Wants to recommendation platform
Maintenance Operator	Operational role- Maintenance	Maintain the system Recovers if bugs or error occurred
Application User	Operational / Functional beneficiary	Expects to receive music recommendations according to mood Add feedbacks
Social media	Functional support	Get the users posts and feed them to the system

Musicians	Functional support	Provide the music data to validate the emotions
Project manager	Financial beneficiary/Managerial	Assure the smooth flow of the developing process Check the requirements and report the bugs and issues
Supervisor	Advisory	Guide to complete the system
Domain experts	Expert	To provide expert opinions on the domain, technologies and methodologies which are used to develop the system
Public	Negative	Always point out the weakness and negativities in the system and post bad reviews
Music composers	Financial beneficiary	Promote their composed music and get publicity using the system
Competitor	Negative	Try to implement a better version of our system Always waiting for the failures
Hacker	Negative	Hack the system and break the servers
Developer	Financial beneficiary	Creates the system according to the requirements

Table 4.1: Stakeholder Viewpoints

4.4. Requirement Elicitation Methods

Requirement elicitation is the different methods of gathering requirements for the research project. The following table provides an overview of the requirement elicitation methods used by the author to identify the requirements.

Method 01	Literature Review
The literature review was carried out on the domain, technologies and existing systems related to music recommendation and sentiment analysis to identify the requirements and the gaps which did not address by other researchers.	
Justification	
Can identify the well-structured and critically evaluated features and gaps for the proposed system Can identify the areas which should get more attention in the requirement elicitation process.	
Disadvantages	Time-consuming With the delays of Literature review, new updates on the domain can be available
Method 2	Questionnaire
Two questionnaires conducted to identify the user requirements and the feedbacks related to the proposed solution. Music and social media are one of the most common features used by the current generation to	

get relaxed in their stressful life. The questionnaire was mainly targeted at the young generation to get their idea about social media behaviour and the music therapy	
Justification	
Can identify the various requirements from the different groups in the society. Time-saving method comparing to literature review to identify the requirements. Data analysing is comparatively easy with the tabulation Ability to reach a wide range of audience who are familiar with music therapy	
Disadvantages	Question answering accuracy can be various. Can get the open answers which lead to confusion when identifying the requirements. The success of the answering rate depends on the honesty of the audience.
Method 3	Brainstorming
Brainstorming was conducted in several phases of the research. This was done as a self-evaluation method as well. To identify the scope of the project, brainstorming was useful.	
Justification	
Identify the new requirements which may have not been notified in previous methods Can choose the most suitable and feasible requirements Get an understanding of direct insight details about the practical situations faced by the users	
Disadvantages	Certain requirements may be ignored with self-experience. Confusions may occur in each brainstorming session

Table 4.2: Requirement Elicitation Methods

4.5. Findings from the Requirement Elicitation process

4.5.1 Literature Review

The finding of the literature review was divided into main three parts, Domain, Technology and the Existing systems. It was discussed in the previous Literature review chapter. The literature review was one of the major contributors to identify the requirements in this research project.

4.5.2. Findings from the Questionnaire

The questionnaire was done in two phases, the first one is to identify the relevancy of the music therapy for the users and the second phase for identify the social media engagements. The questionnaire was distributed mainly to undergraduates and the young generations since they are the main victims of stress and depression. The findings of the questionnaire are given in **Appendix 2.3**

4.5.3. Brainstorming

Brainstorming sessions were used to identify the documentation issues, requirement issues and the problem statement of the project. The self-evaluation was the main key to identify the above-mentioned actions to complete the project and identify its main deliverable requirements

Selecting the dataset:

- Twitter data were chosen after reviewing the literature review since it is the most reliable source of data available to test the model.

Observing the Existing systems:

- A review of the existing systems was mentioned in the Literature review chapter. The outcome of the review used to identify the project scope and the requirement features which are the core functions in the proposed solution.

Identify the Documentation Issues:

- Documentation of the findings was done according to the given template. But the author reviewed the requirements of the relevant report and necessary changes done according to the proposed solution to analyse the correct document

4.6 Summary of the Findings

ID	Finding	Literature Review	Questionnai-re	Brainstormi ng
01	Should use both Facebook and Twitter data to analyses	√		√
02	Should ask the prior permission to access the social media data	√	√	√
03	Should provide quality recommendations for everyone using the system	√	√	√
04	Should consider the informal language aspects when validating the sentiments	√		
05	Should use both supervised and unsupervised learning aspects	√		
06	Should support for the Sinhala language sentiment analysis as well	√		
07.	Should identify all the proposed emotion categories	√		√
08	Should have an option to get the songs recommendations based on music emotions as well	√	√	
09	Should have a graphical interface	√		√
10	Should provide more than 70% accuracy level	√		

Table 4.3: Summary of the findings

4.7 Context Diagram

This context diagram consists of three main aspects, Social media user, System, and application operator.

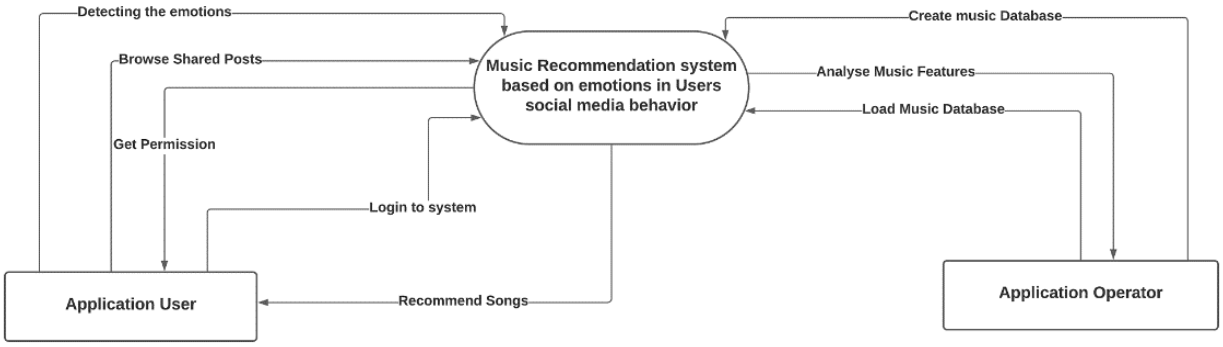

Figure 4.3:Context Diagram

4.8 Use Case Diagram

Figure 4.4: Use case Diagram

In this scenario, the author has used two actors for the use case diagram. Application user and Application operator have taken as two parts of the system. Initially, the user must get access to the system to process. After that user will be asked to permit to access their social media accounts and then the system will validate the recent posts and detect the current mood of the user. The application operator will feed the song details into the system and will collect both inputs and identify the emotions on it.

4.9 Use Case Description

The following table consists of the use case description for the core functionalities.

Use case Name	**Accessing the system**
Description	This use case shows the initial process in the system
Participating actors	Application user
Pre-condition	1. Users must have a social media account. 2.user should be logged in
Extended use cases	None
Included use cases	Retrieving social media account
Main flow	1. User enters username and password. 2. Press login Button
Alternative flow	At 02. Show error messages stating wrong credentials. 03. Go to option 1
Exceptional flows	None
Postconditions	The system will allow proceeding

Table 4.4:Use case description for accessing the system

Use case Name	**Retrieving the Posts**
Description	Retrieving the posts from the users' social media accounts
Participating actors	Application user
Pre-condition	1. Users must log into the system.
Extended use cases	None
Included use cases	None
Main flow	1. Select the date range.

	2. Grant permission to access social media accounts 3. Read the posts
Alternative flow	None
Exceptional flows	E1: During the execution of the use case Internet connection interrupts or fails. 1. Use case ends in failure.
Postconditions	The system will show the relevant post in the particular date range

Table 4.5:Use case description for upload a post.

Use case Name	**Detect Emotions**
Description	The emotion detection process will consist in this use case
Participating actors	Application user, Application Operator
Pre-condition	1. Users must have a social media account. 2.User must have shared a post into their account
Extended use cases	None
Included use cases	Apply NLP techniques, Text preprocessing
Main flow	1. The user grant access to their social media 2. Retrieve the recent posts consist of textual phrases. 3. Retrieve music lyrics 4. Identify the language. 5. Pre-process the text. 6. Run through the pre-trained model. 7. Identified the emotion in the text content
Alternative flow	None
Exceptional flows	E1: In step 5 errors can be occurred. 1. An error message is thrown, and the system will fail
Postconditions	The system will check the music emotions

Table 4.6:Use case description to detect emotions

4.10 Functional Requirements

Following functional requirements have identified by the author and the most important requirements will implement in the initial phase.

Priority	Description
Critical (C)	Most important category. Core functionalities and the mandatory functions which must implement have belonged to this category.
Important (I)	This category is not essential to implement but is necessary to implement.
Desirable (D)	Functions that are not important or out of scope belongs to this category

Table 4.7:Priority table for the requirements

FR No	Description	Priority Level	Use case mapping
FR1	Application User must be validated with the social media account	C	Login to the social media
FR2	Recent posts of the Application User must be validated	C	Retrieving the posts
FR3	Application Users' current emotions must be detected from given inputs	C	Detect Emotion
FR4	The recommended song must be accessible by the Application User	C	Load music and its link
FR5	The system must identify the Music emotions using given features	C	Detect Music Emotions
FR6	The emotions identified by the Application operator must be validated with songs emotions	C	Detect Emotion, Detect Music Emotions
FR7	The system must detect emotions without considering the language	C	Apply NLP techniques
FR8	The system must detect emotions without considering the formality of the language	C	Apply NLP techniques
FR9	The application operator must develop a UI interface for the solution	I	Music recommendation
FR10	The system must be able to store the recommended music list	D	Music recommendation
FR11	Application User must be able to ignore their emotions and select songs according to the music emotion	D	Music recommendation
FR12	Application User must be able to rate the songs	D	Music recommendation

Table 4.8:Summary of functional requirements

4.11 Non-Functional Requirements

The following are identified as non-functional requirements for the Music recommendation system. Implementation of the following non-functional requirements will help to satisfy the end-user and improve the performance of the proposed solution

NFR1	**Compatibility**
The proposed music recommendation system must maintain good compatibility with every browser such as Firefox, Microsoft Edge. Since the end-users are using a different kind of browsers, Compatibility is important.	
NFR2	**Accuracy**
Recommendation systems must have a higher accuracy level. This music recommendation system is expected to achieve an accuracy of more than 70% in the final stages of the research. High accuracy can strengthen the reputation of the solution	
NFR3	**Usability**
The user interface should be very simple and easy to understand. Also, the system should ensure a higher level of usability and the system should be able to reduce the time to get familiar with functionalities in the system for new users.	
NFR4	**Performance**
The system should get more accurate results when it open to a lot of real-time users. Also, it should keep loading without considering the number of users. Most social media users will use this app. So Performance is important.	

Table 4.9:Non- Functional Requirements

4.12. Chapter summary

This chapter mainly focused on gathering relevant requirements for the research. The chapter started with identifying the stakeholders for the proposed solution. The viewpoints of the stakeholders are taken into consideration. The requirement elicitation methods were analyzed and compared to choose the most relevant method for this research. Literature reviews, Questionnaire and Brainstorming methods have been used to gather the requirements. As for the final section, use cases, functional and non-functional requirements of the system were discussed.

CHAPTER 5: SOCIAL, LEAGAL, ETHICAL AND PROFESSIONAL ISSUES

5.1 Chapter Overview

The previous chapter discussed the requirement elicitation process of the research. The rich picture, stakeholder analysis was discussed in the previous chapter. This chapter will be focused on the social, legal, ethical and professional issues which can be a major concern for the research. Successful research needs ethical clearance to complete it without any issues. This chapter will be discussed about the issues and the mitigation circumstances to overcome them.

5.2 SLEP Issues and Mitigation

During the research, there weren't any legal or ethical issues faced. The only concern was to access the users' social media. But as long as they public that information, it is not violating any ethical issues to get those data. This project follows the ethical guidelines of the University of Westminster. The discussion about the SLEP policies are summarized in the following table

Social Issues
• During the requirement gathering, users' data did not collect. • Responses from the questionnaires not added to the documentation but discussed the results quantitatively • This research is focused on multilanguage support so the language won't be a social issue as well
Legal Issues
• When accessing the dataset, the author selected the platforms like Kaggle, IMDB to get the datasets and the terms and conditions are carefully reviewed. • All the dataset collection was done according to the data protection law. • All the used software tools, languages are legally accessed platforms and with open-source licenses. Any pirated software did not use for the research and development phase to ensure the legal status. • GDPR is followed and make sure not to violate by the system. • The details of the users in the questionnaire were kept anonymous. • The module guidelines are strictly followed as it is.

Ethical Issues
• All the justifications, diagrams are newly designed. The documentation and the literature review is not plagiarized. All the related details are cited and the restated using authors word to ensure the ethical issues are not affecting. • All the users were informed about the research survey and It was done before answering the questions. So, they had the option to accept or decline the answer. • When accessing the social media data, users will be informed and get their access to assure ethical clearance with social media accessing.
Professional Issues
• Datasets were professionally gathered according to the owner's rules and regulations. • The questionnaire was distributed using a professional way and the allocated enough time to respond • The system development and the documentation are done by using Asus VivoBook and Windows 10 Professional environment and the virus protection was done to the machine to ensure security. • When the research is ongoing, the backups of the project saved in the local storages as well as the google drive. • No data manipulation was done to the project to get the expected output.

Table 5.1: SLEP issues and mitigations

5.3. Chapter Summary

This chapter was used to discuss the SLEP issues in the research. Social, legal, ethical and professional issues must be addressed when conducting the research. The author ensures the all the aspects of the research is not violating SLEP issues. This chapter proposed the methods used to avoid those issues and get complete and ethical research

CHAPTER 6: SYSTEM ARCHITECTURE AND DESIGN

6.1 Chapter overview

This chapter will discuss the decisions related to the design and the diagrams which are used to implement the system. The system architecture, System design, Data flow diagram, sequence diagram, Activity diagram and UI wireframes are presented in this chapter. The relevant discussions about the proposed design are documented accordingly.

6.2 Design Goals

The following table summarized the design goals which will consider in this research.

Design Goal	Description
Accuracy	Accuracy is depending on the system functions. To achieve high accuracy user data should be extracted from the most suitable text phrases in social media content. Bugs free output will be the major factor to get a more accurate result.
Performance	Since this is a recommendation system, the recommendation list should be available without any delay to the user. The use of pre-trained models can be helpful to increase the performance of the system
Reliability	Users should be able to get the most accurate music recommendation list for their emotions. So the output should be reliable. Hence the reliability of the system needs to be concerned
Extensibility	The music recommendation should be implemented with expanding features and it should be designed and implemented with extensible features in case of adding new components to the system.

Table 6.1: Design Goals

6.3 System Architecture Design

The System Architecture diagram represents the high-level architecture of the proposed system. It separates the system functionality into layers and describes the basic structure of the proposed software. Among the two types of high-level architecture design, the author chose the Tired architecture model for the design. Considering the Tiered architecture with a layered architecture, it has a better fault-tolerant ability and ability to do changes independently without affecting other tiers. So it was the main reason to chose this tiered architecture design for the proposed system.

Also, it can be useful to develop the solution efficiently and can add new features very easily. The following diagram shows the 3-tier architecture for the proposed system.

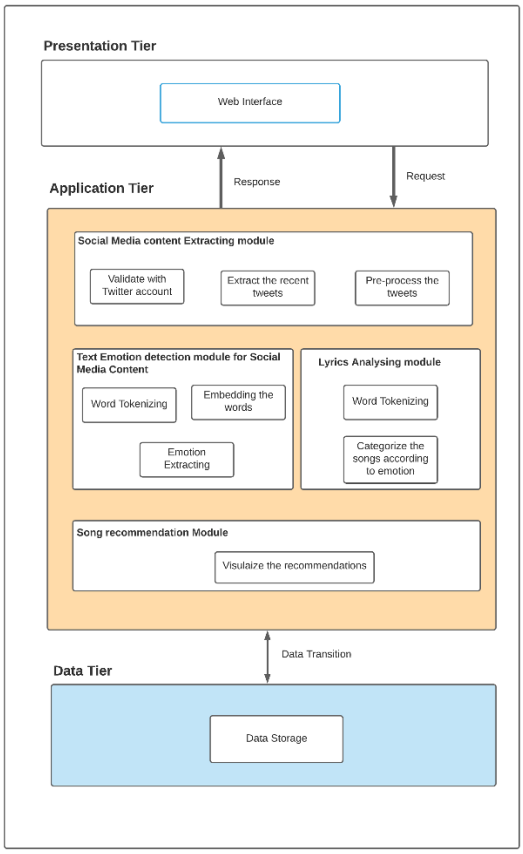

Figure 6.1: High-level architecture design

According to the above diagram, all the core functionalities are inside the application tier and the UI elements are in the presentation tier since it is the layer which deals with users.

- **Data Tier**: The bottom layer in the architecture. Data Tier consists of the data storage component with the saved lyrical data for the lyrics analysing component. Also, user details will be stored in the data tier as well
- **Application Tier**: The core of the proposed solution is included in the application tier. It has four main components in the system. All the logical operations are controlled by these four layers in the tier. The social media content extracting module is the topmost component and it also consists of three sub-tiers to represent the data extracting from the social media content. Text emotion detection and lyrics analysing module represent as the most important logical functionalities in the system. Text emotion module consists of the

submodule to represent the text preprocessing, word tokenizing and emotion detection. The final module in the application tier is the song recommendation module. It consists of the logic to recommend music to the user.

- **Presentation Tier**: The presentation tier consists of the UI component of the proposed solution which is a web application according to this system. Users will be interacting with the system using this presentation tier and all the inputs and outputs are included in this tier.

6.4 System Design

6.4.1 Choice of Design paradigm

System design is one of the most important aspects of software development. To provide the implementation for the solution, the author needs to design the architecture for the system and identify the designing aspect which is most relevant to the proposed solution. For that Structured System Analysis and Design Architecture (SSADA) method has been chosen. The proposed solution is based on structural programming concepts such as it is more focused on the functionalities rather than the classes and objects. Since this recommendation system is relay on a very basics method, SSADA identified as the most relevant design method.

6.4.2 Components Diagram

The components which are identified from the High-level architecture are developed as a module and the component of the system. The following diagram describes the relationships between the proposed system components and the module.

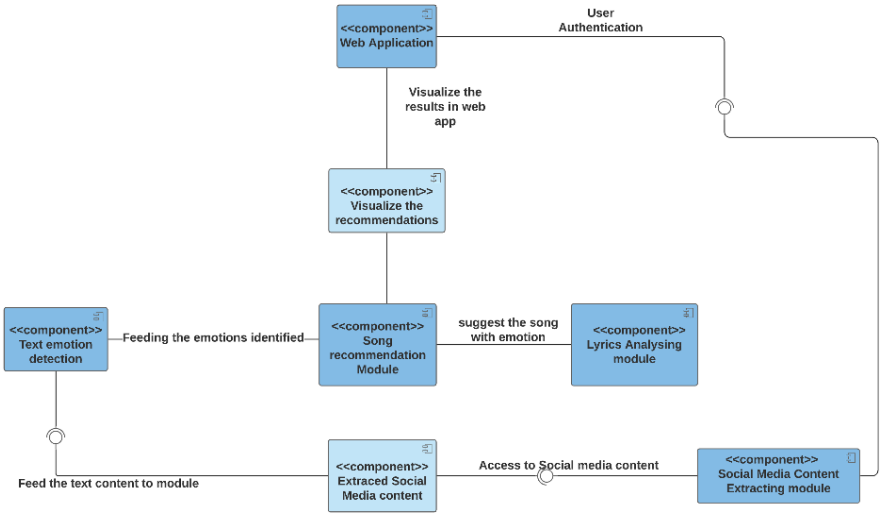

Figure 6.2: Components diagram

All the main components are related to each other according to high-level architecture. Data visualizing component controls the input and output for the core functions in the middle layer as describes in the high-level architecture.

6.4.3 Data Flow Diagram

The data flow diagram describes the system data flow from the input layer to output results.

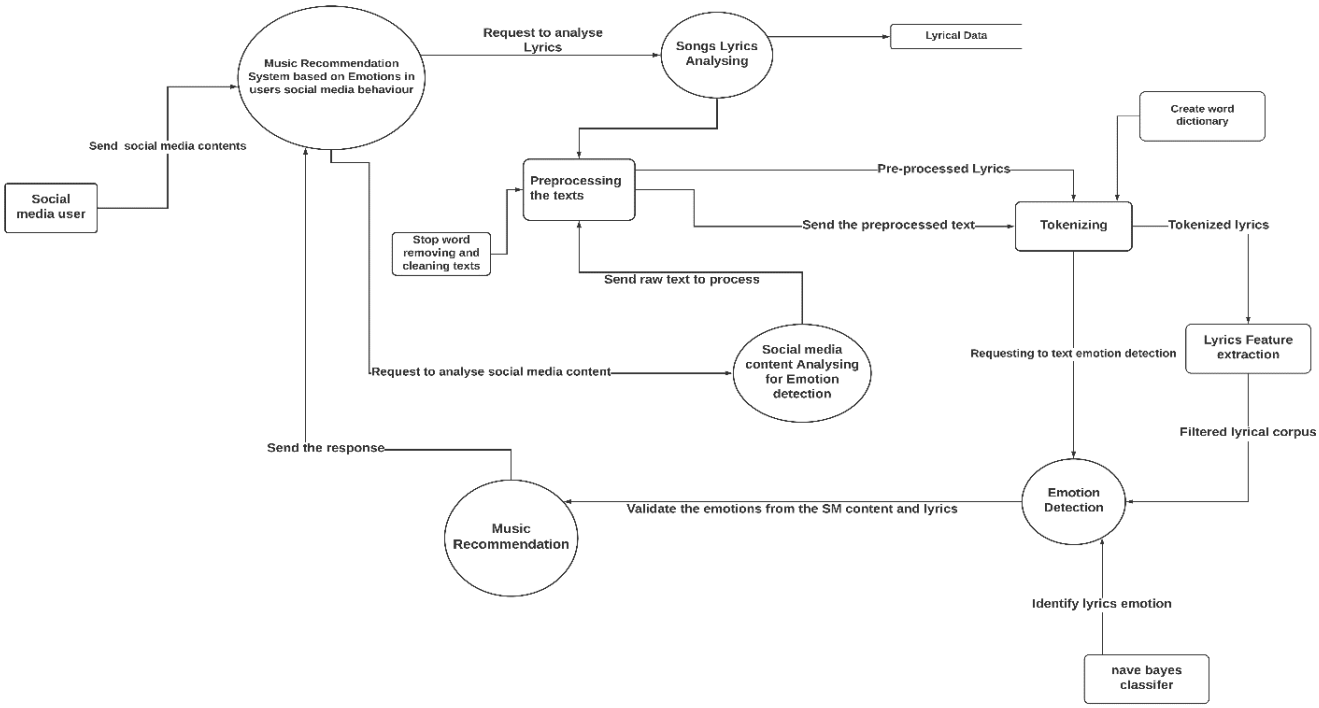

Figure 6.3: Data Flow diagram

In the application entity, the request will be progressing into the social media emotion detection process. The text processing steps will be included in the flow. Also, the lyrics analysing model consists of the same flow. After the detection of emotion in the song, it will be stored in the model itself. The recommendation entity is responsible for the suggest the songs for the user. In that process, it will evaluate with emotion detected from the social media content and send the response to the application operator with recommended songs.

Entity and Process	**Importance**
Social Media user	The user of the system who interacts with the social media platforms
Songs lyrics analysing	Store the lyrical data and process to analyse the songs and emotion from the emotion analyzer
Social media emotion analysing for emotion detection	Process the data to emotion detection model

Emotion detection	The main process of the system will be to validate and detect the emotions from social media content and songs lyrics
Lyrics feature extraction	Extract the lyrical features to emotion detection
Music recommendation	The core function of the system, evaluate the emotions with songs emotion and display the recommended songs list to the user

Table 6.2: Importance of entities in Data flow diagram

6.4.4. Sequence diagram

The sequence diagram is used to show the sequence of the proposed solution visually. The diagram consists of inter-communication between components in the data flow diagram. The following two diagrams describe the main sequence flows of the proposed solution.

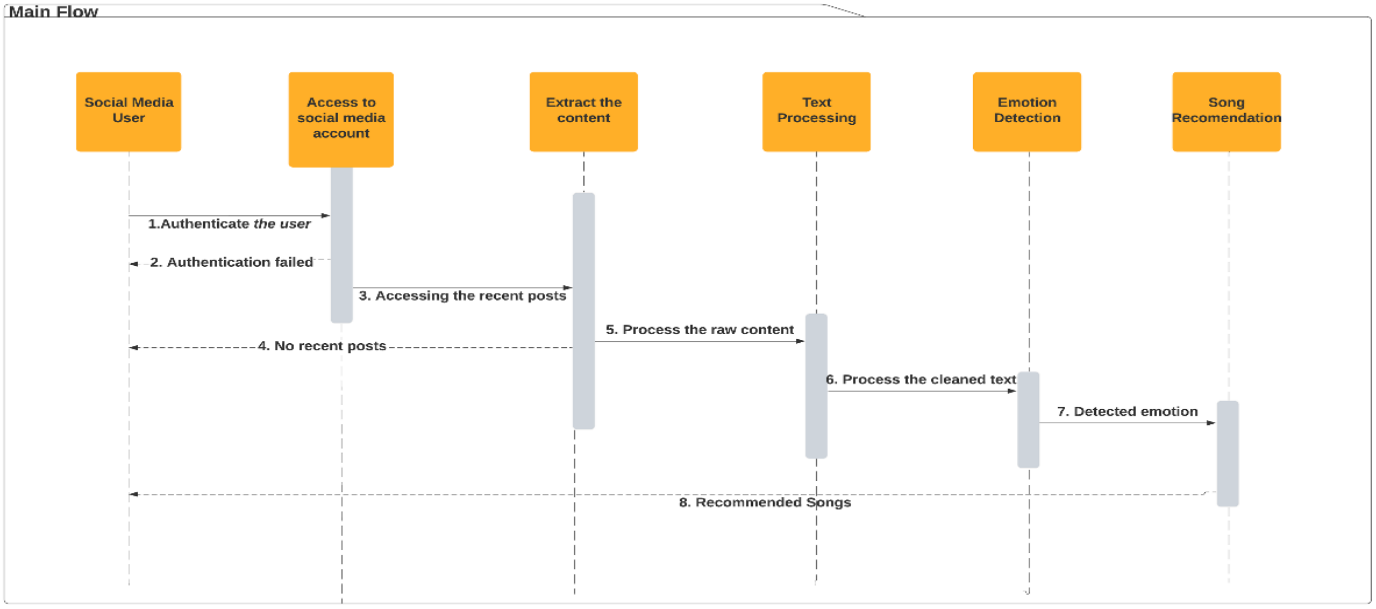

Figure 6.4: Sequence diagram -Main flow

Sequence diagram -Main flow: Figure 6.4 shows the sequence of the main system flow. It consists the interconnected relationships with the main functionalities. The sequence flow from the beginning (Authentication) is given in the above diagram. After extracting the social media content, the raw text will be processed to identify the emotion. The sequence of emotion detection is described below. After identifying the emotion, the songs recommendation component will be

triggered and display the relevant recommendations to the user. The song recommendation component is consists of the songs which are categorized according to the emotions

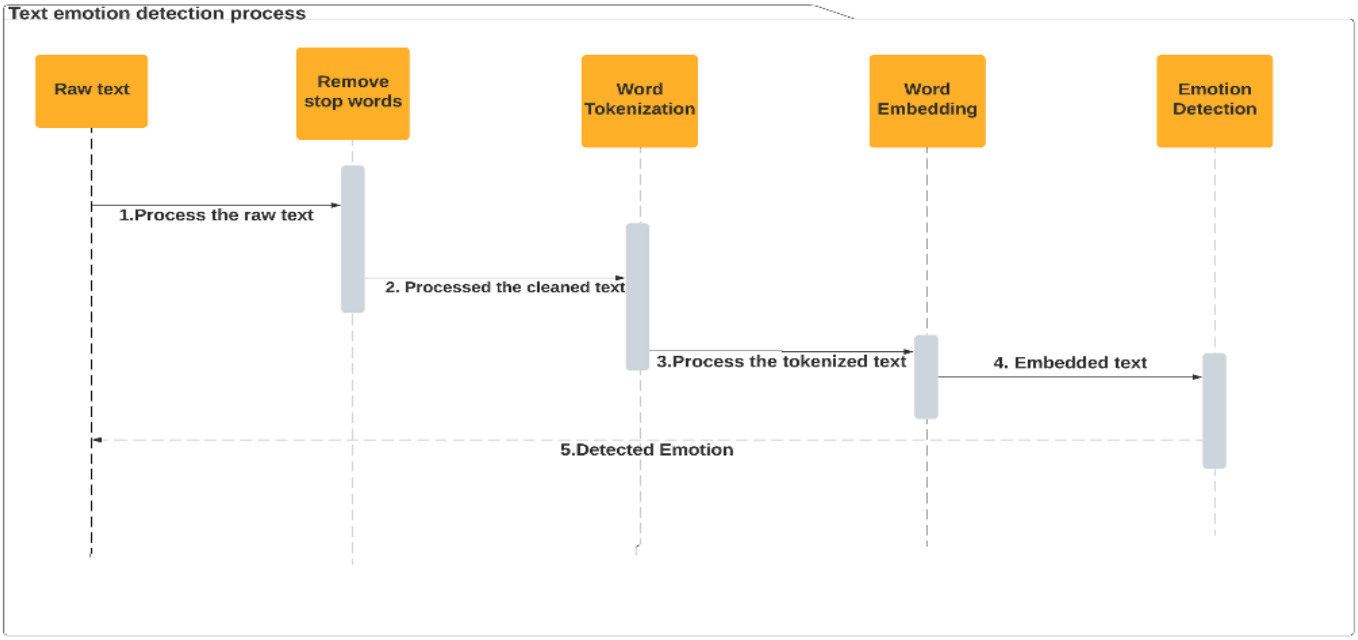

Figure 6.5. : Emotion detection sequence

Emotion detection process: Above diagram shows the sequence of emotion detection in the textual content. Initially, the system asked to process the raw data which is extracted from the social media content and will be cleaned using word tokenizing and the cleaned data will be used to embed to identify the key emotions.

6.4.5 Activity Diagram

The activity diagram was drawn to describe the dynamic aspects of the proposed solution. It is a type of flow chart which represent the system flow from one process to another. All the activities in the system are shown in the following activity diagram. The main advantage of the diagram is author was able to categorize the workflow of the system.

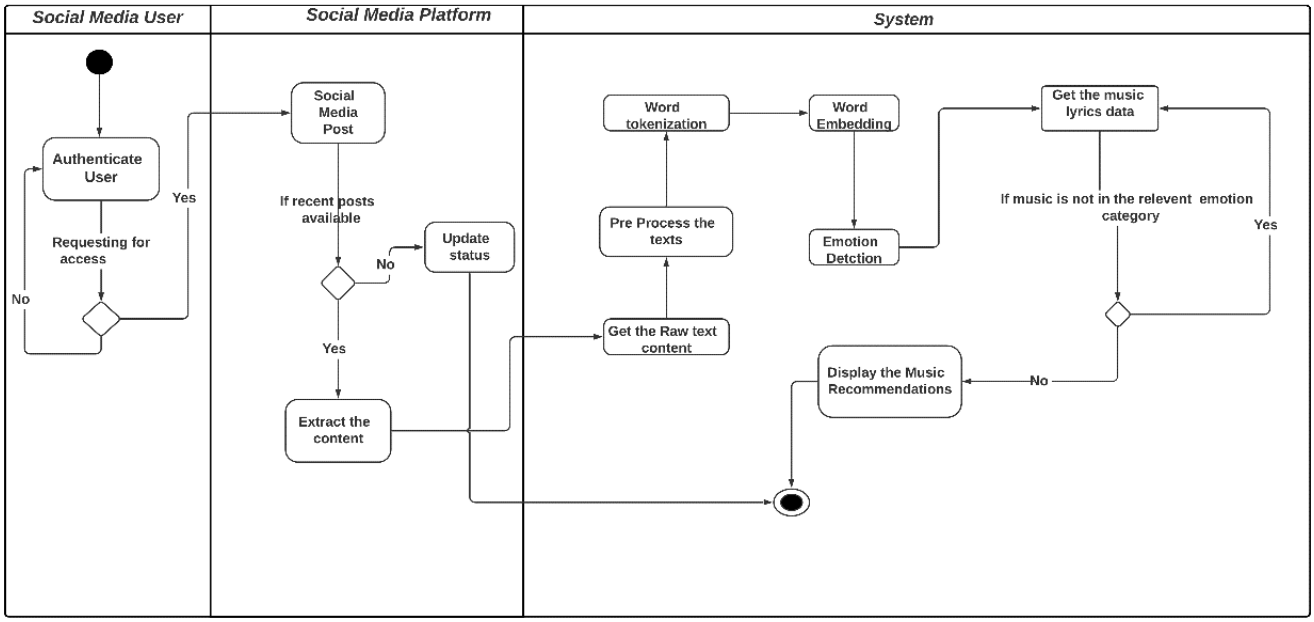

Figure 6.6: Activity Diagram

6.4.6 UI Design

The user interface wireframe was designed to show the sketch of the proposed solution. There are two mainframes in the solution sketch.

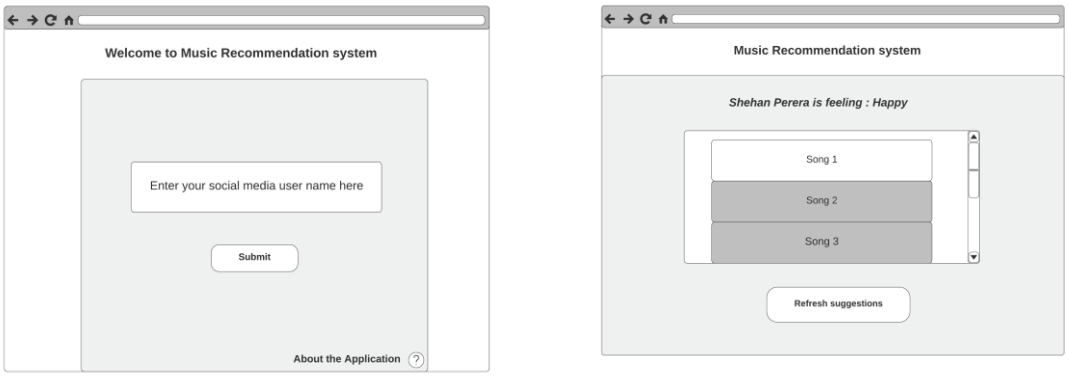

Figure 6.7 UI design

1. **Landing page**: The landing page is designed to get the user inputs such as the user name of the social media account. Also, there will be a link for users to get to know about the web application. Using that, users could get an idea about the application.
2. **Main Dashboard**: The main dashboard consists of the recommended songs list and the current emotion of the user. If the user does not agree with recommended songs list, they can get another recommendation list using the refresh button at the bottom of the panel

6.4.7 User experience flow

User experience flow describes the complete path for the users to identify the path they have to follow when they using the proposed solution. Initially, they need to validate their social media account to the system. If the validation is failed they need to re-enter the user name. After the authentication step is a success, the system will retrieve the recent social media content unless users have published posts on social media account. If they do not have recent content, users are asked to post a status. After validating with recent posts, the user will be able to access the recommended song list.

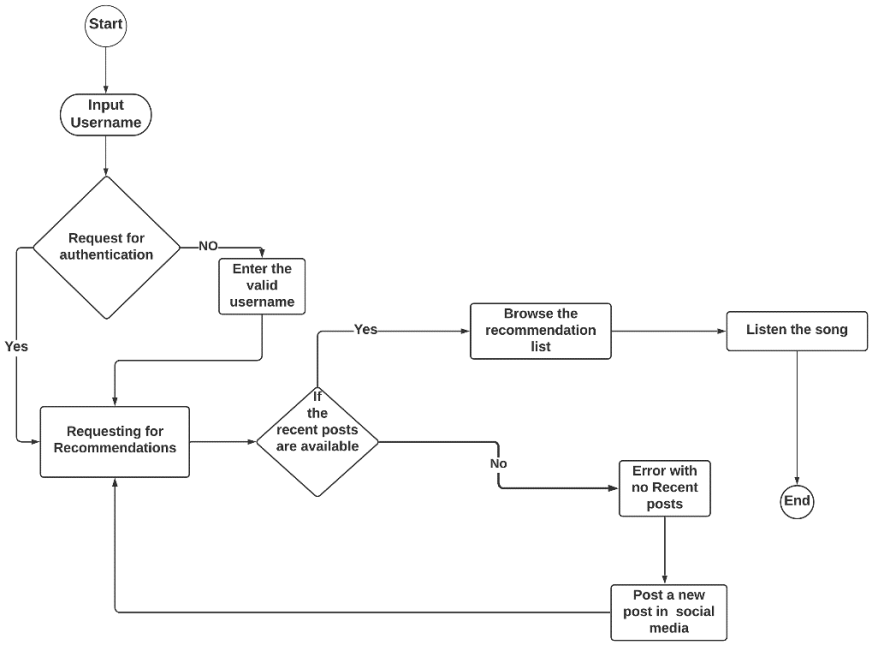

Figure 6.8: User experience flow

6.5 Chapter summary

This design chapter discussed the system design and architecture of the proposed system. After defining the design goals for the system, the high-level architecture was discussed. The author selected the three-tier architecture for the proposed solution. For the design methodology, Structured system analysis and design architecture were selected by the author. Also, the component diagram and the data flow diagram was included and discuss the components included in the above-mentioned diagrams. Sequence and activity diagrams display the flow of the system and thoroughly discussed their flows and the uses for the solution. After that, the UI wireframes were added to this chapter to get the proper understanding before the system implementation and the user experience flow was added to justify the user experience about the proposed solution

CHAPTER 7: IMPLEMENTATION

7.1 Chapter Overview

After the designing process, implementation is the main component of the research. This chapter briefly describes the prototype implementation details with in-depth analysis about the selected technology stack, tools, language, frameworks used to keep the coding standards in the prototype. Also, this chapter will critically evaluate the libraries and technologies used to implement the prototype. Important functionalities of the prototype and their explanations are also covered in this chapter and core code snippets are also evaluated.

7.2 Selection of Technologies

7.2.1 Technology stack

The following diagram describes the technologies which are decided to be used in the different tiers in the prototype implementation.

Figure 7.1: Technology stack

7.2.2 Data Selection

Data is the most important aspects when it comes to the implementation process. The author needs to select the most accurate and reliable data to achieve the expected outcome from the prototype. When implementing the system, the author had to find several data requirements.

- **Text analysing data set for both supervised and unsupervised aspects**- the author chose the Kaggle website after do some web scraping to get the relevant data. Kaggle website consists of a variety of datasets for many domains. So author considers the Kaggle as a dataset provider for the first requirement. And as planned the data set was available with the Kaggle which annotated with emotion labels.
- **Sinhala labelled data set for emotion detection**- For this author decided to follow the past research done in the Sinhala emotion detection domain and was able to get the dataset from the ACTSEA (Jenarthanan, Senarath and Thayasivam, 2019). There was further annotation to complete before using it in the model.
- **Music lyrics analysing dataset to identify the music emotions**- lyrical dataset was extracted from the Kaggle website as well. The lyrical dataset consists of the lyrics of old songs with the name and their sentiment. The author had to manually scrape the relevant tags before feeding them to the model.

7.2.3 Programming Language

The success of the whole process depends on the programming language which is used in the development process. Selecting the most suitable programming language was one of the main challenge authors had to face. After analysing several key aspects, the author considers about following criteria to select a programming language for development.

- **Familiarity for Developer**: The developer should be able to programming language knowledge in the development process. Lack of knowledge about the programming language can cost the implementation process. So the author decided to select a programming language that is familiar to the author since it will save time for the rest of the project phases.
- **Available of the libraries**: The next fact is the use of external libraries to get the maximum support to implementation. Because develop from scratch is a huge waste of time if we can use open source libraries. For that, the author considers the availability of open-source external libraries in particular programming languages.
- **Efficiency**: Efficiency is more important in coding. The author can get more efficient and accurate results in the implementation process. So efficiency was another considered key factor when selecting a programming language for the development.

- **Popularity and resourcefulness**: If the programming language is more popular it can have a large community gathered around. And it will be an added advantage when solving issues related to the development process. Also, the author can be able to access various kind of tutorials and practical aspects when needed. Because language is more friendly and popular around a huge community.

After considering the above facts, the author decided to use python as the main development programming language for the core features in the prototype because python is a rich source of the above aspects. Also Html, CSS and javascript will be used in the frontend development of the prototype.

7.2.4. Frameworks and Libraries

Following libraries and frameworks used in the implementation process of the prototype.

- **Keras**: Keras is the main library used in the text emotion detection process in the proposed solution since it has a variety of pre-trained models in NLP. Keras is built on top of TensorFlow. The text emotion detection model is using neural networks and Keras have the ability to do fast and more efficient computational developments for the neural networks. Also, the support of Keras can be helpful to write code fragments easily and understandable.
- **NLTK**: Natural Language Tool Kit is one of the most famous libraries for python which used to identify the human language.WordNet, tokenization, stemming are the most common lexical resources build using NLTK. In this proposed solution, the NLTK library is used for the lyrics analysing model to identify the sentiment which carries in the song lyrics. Even though the author suggests using stanfordCore NLP for this project, NLTK was chosen lately because of the availability of more tutorials and resources. Also, Standford Core NLP is built on java so it was the other main reason to select the NLTK library.

NLTK	StanfordCore NLP
Used python to implement	Used Java for implementation
Availability of third-party libraries	Third-party libraries not much accessible
Can be used with various languages	Can not adapt to many languages
Tutorials and resources are available	Tutorial resources are limited
Many algorithms build with NLTK	Does not have many algorithms

Table 7.1: Comparison for NLTK and Stanford Core NLP

- **Word Vectors**: Word vectors have been used in the implementation of the text analysing model to improve the accuracy of the model training. For that one million word vectors trained on Wikipedia(Mikolov et al., 2017) have been used in the model. The author expected to gain distributional similarity using above mentioned word vector.
- **Flask:** As for the UI development, the Flask framework used to develop the user interface for the solution. Flask is the most famous and compatible web framework for python and its support many libraries and packages in python. Learning flask is very easy and faster compared to other python frameworks such as Django. Also, documentation and relevant resources are available for flask than Django. When connecting to the Html template, a module called Jinja is used. So considering all the above facts, the author decided to develop the user interface using the flask framework. The following table briefly summarizes the advantages of the flask.

Flask	Django
Easy to learn and use	Complicated to understand and apply
Resources and tutorials are easily accessible	Resources and tutorials are difficult to find
Suitable to apply for small scale project since the framework is lightweight	Suitable for large scale projects
Security is not up to level	More security available

Table 7.2 Comparison between Web frameworks

7.2.5 Use of Tools and IDE

For the development platform, the author used the PyCharm IDE offered by the Jet Brains. PyCharm was used to build the core functionalities in the system since the author is more familiar with the IDE. In the model-building phase, Google colab was used to run and train the system because the local GPU was not efficient as google cloud GPU. Also, Google colab consists of

inbuilt tools such as tensorboard. So it was helpful to the author to train the model without any time-wasting compared to training in a local environment.

When extracting the social media content, Twitter API was used to make the connection between social media and the system. Twitter was chosen as the social media platform since facebook holds the data privacy related regulations and the author can not get the real-time posts from user timeline using Facebook graph API.

7.2.6 Summary of the Technology selection

The below table summarized the selected tools and technology for the implementation process of the prototype.

Implementation Component	Tools and Technology
Data selection	Kaggle
Programming language	Python
Libraries	Keras, NLTK, Word vectors
IDE	PyChram, google colab
API	Twitter API

Table 7.3: Summary of the tools and technologies

7.3 Implementation of the core functionalities

7.3.1 Getting user details using Twitter API

As for the social media platform, Twitter was chosen by the author since Facebook limits its publicly available data. When extracting social media content, Twitter API was used with the following code segment. After authenticating with Twitter API, the user will be asked to enter the Twitter user name. And then the user name will be validated whether it is existing or not by catching the error.

```
#Twitter API credentials
consumer_key = 'Qp4hH6xgMKjla17LGjMJf4z6C'
consumer_code = 'a9bwmpwfAkLLCiP8Slmtq2JlpFAax1NJcmF1sVJ4ZM2rRgfHk2'
access_token = '2905175149-PbaI3EYOZMdpibDIXgVS9yOA7NUjcrJPeLJx60z'
access_code = 'LW9tGNKTzt4KbReQ3LInTBMNHwWY6uDN0hMFJBtzQhvha'

#Authentication of the Tweeter credentials
authenticate = tweepy.OAuthHandler(consumer_key,consumer_code)

#set the access token
authenticate.set_access_token(access_token,access_code)

#Create the API object
api = tweepy.API(authenticate, wait_on_rate_limit=True)
```

```
userId = userIDA
print("useride", userId)
print("Recent tweets from: ", userId)
try:

    recentPosts = api.user_timeline(screen_name=userId, lang="sn", tweet_mode="extended")
except tweepy.TweepError as e:
    flash("Invalid username")
    return render_template('index.html', form=form)
```

Figure 7.2: Twitter API Authentication and User name validation

7.3.2 Emotion detection for text contents

To detect emotions in English content, the author has used a model build on Keras and TensorFlow.After cleaning the datasets, every word in the training set and test set are cleaned

before adding to encoding. Six categorical emotions values are included in the dataset. So author used six number classes and encoded them accordingly.

```
#num classes is 6 since we identify the 6 unique emotional words
number_of_classes=6
embedded_num_dims=300
max_sequence_len=500
class_names=['anger','sadness','fear','joy','surprise','love']
X_train_pad=pad_sequences(train_sequence,maxlen=max_sequence_len)
X_test_pad=pad_sequences(test_sequence,maxlen=max_sequence_len)
print(X_train_pad)


#emotional words added to 0-5 categorical values to encode the dictionary
encoding={'anger':0,'sadness':1,'fear':2,'joy':3,'surprise':4,'love':5}
y_train=[encoding[x] for x in train_data.Emotion]
y_test=[encoding[x] for x in test_data.Emotion]
y_train=to_categorical(y_train)
y_test=to_categorical(y_test)
```

```
#function to import the 1million word vectors as for embedding purpose
def embedding_matrix(filepath,word_index,embedded_num_dims):
    vocab_size=len(word_index)+1
    embedding_matrix=np.zeros((vocab_size,embedded_num_dims))
    with open(filepath,encoding="utf8") as f:
        for line in f:
            word,*vector=line.split()
            if word in word_index:
                idx=word_index[word]
                embedding_matrix[idx] = np.array(vector,dtype=np.float32)[:embedded_num_dims]
    return embedding_matrix
fname='embeddings/wiki-news-300d-1M.vec'
embedd_matrix=embedding_matrix(fname,index_of_words,embedded_num_dims)
```

Figure 7.3 Adding categorical values for emotions & Word embedding matrix

After adding the categorical values into a dictionary, a pre-trained word vector(Mikolov et al., 2017) used to get more accurate and efficient results for the model.

A similar kind of code to detect the emotions from Sinhala content since the same neural network used.

7.3.3 Lyrics emotion detection and recommendations

To identify the emotions of lyrics, the author used two sentiment categories since the datasets were not available for lyrics. After reading the dataset preprocessing was done to lyrics datasets.

```
# Get the users emotions lyrics as a list
def user_emotions(file):
    file_open = open(file)
    file_read = file_open.read()
    file_split = file_read.split("|")
    result_list = []
    for lyrics in file_split:
        filtered_lyrics = stop_word_from_user(lyrics)
        output = classifier.classify(extract_features(filtered_lyrics))
        result_list.append(output)
    return result_list
```

```
# Functions to get the recommendations according to emotion
def recommendSongs(songsRecords):
    counter = Counter(songsRecords)
    train_file_open = open('LyricsDataset/training_original.txt')
    train_file_read = train_file_open.read()
    collection = ast.literal_eval(train_file_read)
    if counter['P'] >= counter['N']:
        positive_songs = [i for i in collection if i["sentiment"] == 'P']
        return positive_songs[randint(0, len(positive_songs) - 1)]["name"]
    else:
        negative_songs = [i for i in collection if i["sentiment"] == 'N']
    return negative_songs[randint(0, len(negative_songs) - 1)]["name"]

# Train the model
# create tuple and set path to train set
lyrics = tuples('LyricsDataset/training_original.txt')
filtered_corpus = stop_words_removing(lyrics)

word_features = word_features(get_lyrics(filtered_corpus))
# applying the features
training_set = nltk.classify.apply_features(extract_features, filtered_corpus)
# adding to classifier
classifier = nltk.NaiveBayesClassifier.train(training_set)

# Test the model
test_lyrics = tuples('LyricsDataset/testing_original.txt')
test_corpus = stop_words_removing(test_lyrics)
test_set = nltk.classify.apply_features(extract_features, test_corpus)
```

Figure 7.4: Lyrics emotion detection &Songs recommendations

Code snippets in Figure 7.4 show the way recommendations happened. After extracting the emotion from the text model, emotion categories are divided into two main sentiments, positive and negative. From that sentiment pools, the song will be recommended to the user.

7.3.4 Coordination function with models and recommendations

Following code snippets describe the main function which coordinating the entire system with the user interface. After getting the username, Twitter API will get the relevant tweets in the recent

day. Then it will be redirected to relevant methods according to its language. All the modules are trained and loaded into the *englishPredictions* and *sinhalaPrediction* functions.

```
@app.route('/', methods=['GET' ,'POST'])
def submit():
    form =UserInput()
    if form.is_submitted():
        result= request.form['username']
        userIDA= str(result)
        if(userIDA ==""):
            flash("Please enter username")
            return render_template('index.html', form=form)
        else:
            userId = userIDA
            print("useride", userId)
            print("Recent tweets from: ", userId)
            try:
                recentPosts = api.user_timeline(screen_name=userId, lang="sn", tweet_mode="extended")
            except tweepy.TweepError as e:
                flash("Invalid username")
                return render_template('index.html', form=form)

            for tweet in recentPosts:
                language = tweet.lang
```

```
        #get the english tweets
        if (language == "en"):
            englishTweets = tweetAsStr
            emo,reco=englishPrediction(englishTweets)
            songUrl = getYoutubeLink(reco)
            isCompleted=1
        #check the language for sinhala
        elif(language == "si"):
            sinhalaTweets = tweetAsStr
            emo, reco = sinhalaPredictions(sinhalaTweets)
            songUrl = getYoutubeLink(reco)
            isCompleted =1
        elif(isCompleted != 1):
            print("Twitter lang: ",language)
            #If other language expect english and sinhala detected
            flash("Your tweet language is does not support to the system")
            return render_template('index.html', form=form)
    elif(ifAvailable !=1):
        #If the tweets are not posted in past 24 hours
        flash("No Recent Tweets available, Please update your profile and try again")
        return render_template('index.html',form=form)
```

Figure 7.5: User name extracting from UI & Applying the pre-trained models

7.4 Problems encountered with the implementation

The following table will summarize the problems encountered and solutions used to solve the issues in the process of implementation in the proposed solution.

Problem Faced	**Applied Solution to solve**
Extract the recent tweets from Twitter API	Twitter API does not support getting relevant time frame data. So author used created time variable and current time to get the data.
Identify the emotions from lyrics data	Emotions categorized for main two sentiments and define a pool of songs accordingly
Less accuracy for Sinhala model	Tuning the parameters to gain the considerable accuracy
Unsupported language	Identify the unsupported language and avoid them.
Unsupported username and basic validation issues.	Twitter API does not allow to trigger the unsupported user name so the author avoids the error in the frontend itself.

Table 7.4: Summary of the Issued encountered

7.5 Chapter summary

This chapter consists of a discussion of the implementation process of the proposed solution. Initially, the author mentioned the technology stack which chooses to implement the solution. Data selection, frameworks and libraries selection was discussed accordingly. The author used python as the main language in the implementation process. Also, Flask was used to develop the user interface for the solution. In this chapter, the author also discusses the core functionalities with code snippets. Finally, a summary of the problems faced and the solutions which used to encounter was given.

CHAPTER 8: TESTING

8.1 Chapter Overview

This chapter focuses on the testing phase of the proposed solution prototype. There are many methods and testing criteria used to test the system. The author discusses the testing Goals and objective with the testing criteria considered. The results of model testing, functional testing, non-functional testing, integration testing will be discussed and critically evaluated under this chapter. Also, the author will discuss the limitations and issues faced during the test phase with test results.

8.2 Objectives and Goals of Testing

Testing is used to check the implemented prototype is working relevant to functional and non-functional requirements describe in the requirement elicitation process. Following testing objectives and goals are identified to conduct the software testing.

1. To validate the identified functional requirements are satisfied by the implemented system and met all the expectation.
2. To validate the identified non-functional requirements are satisfied by the implemented system and met all the expectation.
3. To validate and identify the bugs and errors and prevent relevant issues.
4. To improve the final output quality, accuracy and reliability.
5. To identify the future enhancement to evaluate the system in future.

8.3 Testing Criteria

The following test criteria have identified to test the implemented prototype. Test criteria are defined to identify the gap between the expected project implementation and the implemented project.

1. System functional quality – Implemented core functional quality will be validated according to the identified requirements. This will minimize the issues in the implementation and will improve the accuracy rate.
2. Software structure quality – Mainly testing will be focused on the non-functional requirements and the overall code structure of the implemented solution.

8.4 Model Testing

Model testing was carried out in the system backend to identify the performance of the developed models. In the prototype, classification matrixes are used to evaluate the performance of the model. Specially confusion matrix was the main classification techniques used by the author. The following topics discuss the results obtained from the training process.

8.4.1 Confusion Matrix

The confusion matrix is mainly used as a classification matrix. In this proposed solution, the model detects six emotional categories. So author used a multilabel classification matrix to get the relevant data. In the confusion matrix, each label represents a class. And each column represents a predicted class.

(A)

Class	Y	N
Y	True positive (VP)	False negative (FN)
N	False positive (FP)	True negative (TN)

(B)

Class	1	2	3	4	Total
1	70	10	15	5	100
2	8	67	20	5	100
3	0	11	88	1	100
4	4	10	14	72	100

Figure 8.1: Example for multiclass classification for the confusion matrix(Confusion Matrix - an overview | ScienceDirect Topics, no date)

As for the above diagram (part B), the middle diagonal value represents the actual values for each class. Unlike the binary classifications, this does not have positive or negative classes. But it is not hard to find the True Positive (TP), True Negative (TN), False Positive(FP) and False Negative (FN).

According to the English text classification model and Sinhala text classification model, the following figure shows the results of the confusion matrix. The classes are numbered as 0,1,2,3,4,5 and the emotions values for the classes are anger, sadness, fear, joy, surprise and love.

```
[[ 527    8   11    4    0    0]
 [  28 1080   15    5    1    2]
 [  21    8  383    1   23    0]
 [   8    4    1 1333    5   48]
 [   1    2   13    9  122    0]
 [   1    0    0   49    0  287]]
```

Figure 8.2: Confusion matrix for English text model.

From the above confusion matrix, the following details were calculated for the proposed implementation

8.4.1.1 Accuracy

Accuracy defines the correctness of the model and it is a non-functional requirement for this implemented prototype. The author expecting an accuracy of more than 70% for the emotion detection models. Accuracy is calculating the confusion matrix results. It can be defined as correct predictions divided by the total number of predictions for the relevant class.

$$Accuracy = \frac{\mathrm{TP} + \mathrm{TN}}{TP + FP + FN + TN}$$

According to the results obtained for English and Sinhala text analyzing models, the following results were achieved for both models. To get these accuracy levels, the author trained the models for 30 epochs.

Lyrics analyzing model achieved an accuracy of 72% for its training.

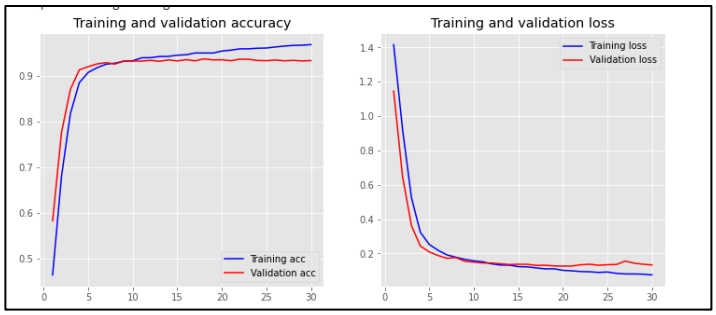

Figure 8.3: Training and validation accuracy and loss for English model

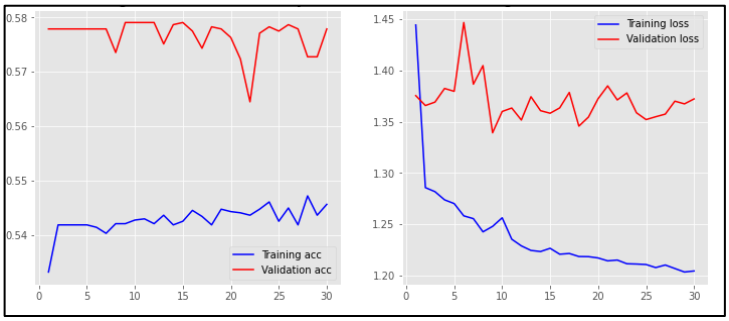

Figure 8.4: Training and validation accuracy and loss for Sinhala model

8.4.1.2 Precision

Precision Describes whether the identified True positive values are correct or not. To calculate the precision from the confusion matrix, the following equation has been used.

$$Precision = \frac{\mathrm{TP}}{TP + FP}$$

According to the results in figure 8.5, lable no 02 (Lable for Sadness) has much higher precision since the model has seen the label for sadness more frequently. The same kind of diversion can be seen in the Sinhala model.

	precision	recall	f1-score	support
0	0.92	0.94	0.93	550
1	0.98	0.95	0.97	1131
2	0.91	0.88	0.89	436
3	0.95	0.95	0.95	1399
4	0.81	0.83	0.82	147
5	0.85	0.85	0.85	337

Figure 8.5: Classification Report

8.4.1.3 Recall

The recall is defined as a measure of how many samples from our model correctly predict over the total amount of sample classes. Recall can be calculated from the below equation.

$$\text{Recall} = \text{True\_Positive} / (\text{True\_Positive} + \text{False\_Negative})$$

According to the results obtained from the English text model, the highest recall value is in the sadness and joy classes. (Figure 8.5).

8.4.1.4 F1 Score

F1 Score can be used as a balanced matrix between precision and recall. Depending on the application researcher can be decided about the priority level that should be given to either precision or recall. In this research, priority was given equally since it is important to combine both results and an F1 score can be helpful to combine both matrices into one matrix. The following equation is used to calculate the F1 score.

$$F1\ score = 2 * \frac{\text{Recall} * \text{Precision}}{Recall + Precision}$$

In this proposed solution, a considerably high F1 score is obtained for some classes. Above figure 8.5 consists of the results of the F1 Score as well.

8.4.2 AUC/ROC Curve

AUC/ROC curve defines the graph which is describing the performance of the classification model for all its thresholds. In this prototype testing, the author had identified the AUC/ROC curves for every emotion classes. To get successful predictions (True positive values) AUC rate must be 1, which means if the AUC value is 1, then the prediction correctness is 100%. The figures given below describe the model AUC /ROC curves and their results.

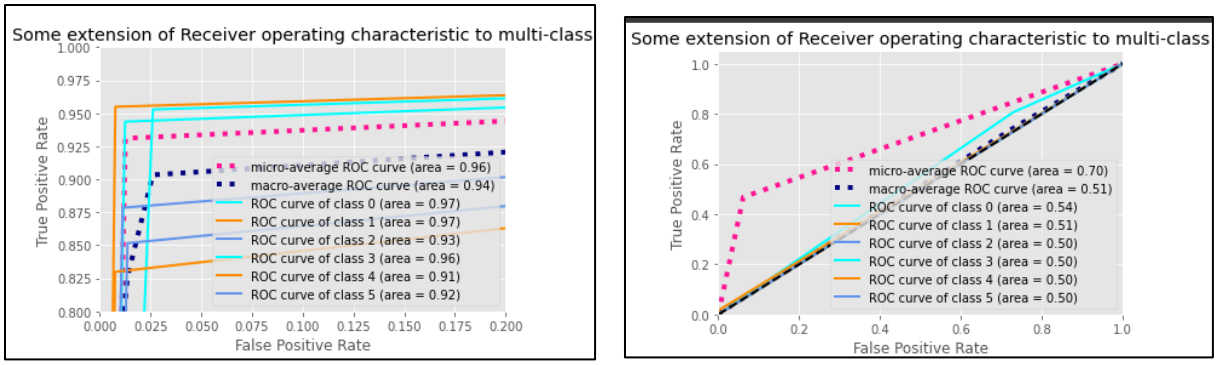

Figure 8.6: AUC/ROC values for English model &Sinhala model

As discuss above English model has significantly accurate results in this application. Less amount of dataset for the Sinhala model caused this average accuracy level in the proposed solution.

8.5 Benchmarking

Competitive benchmarking was done to identified previous research works. The task was to identify the accuracy level of each research outputs. But the author was unable to test the product with the same dataset since the emotional categories are different from others.

Research Name	**Dataset**	**Accuracy**	**Core feature**
Proposed Solution	Kaggle, ACTSEA	97%	Identify emotions and recommend the songs using lyrical emotion
(Udochukwu and He, 2015)	NRC Lexicon	N/A	Identify the emotions whether it's positive or negative
(Radhika and Sankar, 2017)	ISEAR emotion dataset	62%	Corpus-based language-independent system which validates tweets and recommendation is based on songs emotion from music features
(Cheng and Tang, 2016b)	NetEase cloud music data	83%	Using Thayer's arousal-valence emotional plane, identified four emotion categories for Chinese content
(- and -, 2018)	Web scraping from rapid miner website	64,2%	Classified four emotion categories

Table 8.1: Benchmarking summary

8.5 Functional Requirements Testing

Functional Requirements Testing was carried out to identify whether the developed prototype functionalities are working according to functional requirements. It was tested by inserting relevant data into the system. The black-box testing mechanism is used to validate the functional

requirements and it validates whether the expected output is matching according to the requirements gathered. The following table discusses the results of black-box testing.

Test case	Description	User Input	Expected Outcome	Actual Outcome	Status
1	Application User must be validated with the social media account	Username for the social media account	The system proceeds to get content	The system proceeds to get content	Pass
Remarks: System support only for Twitter. Hence if the user does not have a Twitter account should sign up with Twitter. If the username is not valid, the user will be warned					
2	Recent posts of the Application User must be validated	Click submit button in the username field	Recent posts will be extracted if recent posts are not there, the user asked to post something.	Recent posts extracted and if recent posts are not there, the user asked to post something	Pass
Remarks: There should be at least one tweet in the recent 24 hours. Unless the system will display an alert.					
3	Application Users' current emotions must be detected from given inputs	Waiting for system response	User emotion will display	Detected Emotion and displayed in the UI	Pass (Depend on the language accuracy will be changed)
Remarks: Emotion detection will trigger the user inputs and predict the emotion. If the content is English, the prediction accuracy is 97% if it is in Sinhala, the accuracy rate will be capped as 64%					
4	The recommended song must be accessible by the Application User	Waiting for system response	Song and its link will be displayed	Recommended song and its link appeared	Pass

Remarks: Song's YouTube link will be prompted to the user. This recommendation song list is limited due to the dataset issue. The research did not consider the new songs released in the recent past. Results display time can be different with the internet connection.					
5	The system must identify the Music emotions using given features	Pre-trained model	Stored songs will be categorized into Positive and neutral emotions	Stored songs categorized according to Positive and negative emotions	Pass
Remarks: Using sentiment analysis, lyrics categorized under two category, positive and neutral. Emotion identifying accuracy was 72%. The lack of techniques to identify and store the line-by-line sentiment was the main reason for that accuracy level identified by the author.					
6	The emotions identified by the Application operator must be validated with the song's emotion	Pre-trained and loaded model	The system should suggest positive songs to positive emotions	The system suggested positive songs to positive emotions	Pass
Remarks: User emotions are derived from six categories, so when validating with lyrics emotions, it has to be divided into two categories. So when loading the model, it worked well					
7	The system must detect emotions without considering the language	Social media content with Sinhala and English language	Predict the emotions without any error	Predicted the emotion without any error	Pass
Remarks: Project only considered Sinhala and English language. So as mentioned above, the accuracy of the Sinhala model is a bit less than the English model					
8	The system must detect emotions without considering the formality of the language	Social media content with informal content	Predict the emotions without any error	Predicted the emotion without any error	Pass
Remarks: This does not work for the Sinhala language context and Some English language emotion misclassified.Rate identified as 60%					

Table 8.1: Function Testing summary

8.6 Module and Integration Testing

For the module and integration testing, the author decided to consider the system module as individual elements. This method is very reliable to test the small blocks of the prototype. This module and integration testing are relevant white-box-oriented mechanisms. Testing was carried out according to the prototype architecture.

Module 01	Web Interface	**Status**	Pass
Input	Social media user name		
Expected Result	Validate the user name, if it is not correct error message will be thrown. If the validation is correct, emotion and recommended song will appear		
Actual Result	Emotion appeared with the song and the link to youtube. When the credentials are wrong error message was displayed.		
Module 02	Social media extracting module	**Status**	Pass
Input	Social media user name		
Expected Result	Identify the recent posts of the relevant user and extract the content to pre-process		
Actual Result	Recent posts were extracted and processed to remove unnecessary words (Pre-processing)		
Module 03	Text emotion detection module for social media content	**Status**	Pass
Input	Processed text content from social media module		
Expected Result	Detect the relevant emotion from the text content and validate with every tweets emotion. Get the most frequent emotion		
Actual Result	Get the emotions for the relevant text content		
Module 04	Lyrics analysing module	**Status**	Pass
Input	Get the songs list from the dataset		
Expected Result	Detect the emotion whether it is positive or negative and save it in the file		
Actual Result	Lyrics sentiment was identified and save the lyrics and song accordingly.		
Module 05	Song recommendation module	**Status**	Pass
Input	Get the user emotion and lyrical emotion		
Expected Result	Validate user emotion and lyrics emotion according to emotion category and recommend a song with a link for the song		
Actual Result	Song was recommended successfully according to emotion category.		

Table 8.2: Module and Integration Testing

8.7 Non- Functional Requirements Testing

As for the requirement engineering chapter, the author has identified the following non-functionalities and will be discussing how the proposed solution achieved the above non-functionalities.

8.7.1 Compatibility Testing

Scalability testing is used to determine the prototype can run in any web browser. Since the proposed solution is a web application, it should be compatible with any browser. As for the testing done with every browser, the application was run without any issue and every aspect of the User interface displayed as designed.

8.7.2 Accuracy Testing

Accuracy is one of the main requirement for this proposed solution. As discussed under the model testing, accuracy for each model have been identified. According to the testing done by the author, the following results were obtained with the change of epochs level and batch size for the model training.

Number of Epochs	**English Text analysing model**	**Sinhala text analysing model**
5	89%	53%
10	93%	54%
15	94%	54.5%
20	95%	55%
25	95%	58%
30	97%	63%

Table 8.3: Accuracy level for different epochs

The lyrics analysing model is achieved only a 72% of accuracy rate to identify the sentiment polarity of lyrics. **Appendix 2.5** consists of the above-mentioned testing process graphs.

8.7.3 Usability Testing

Usability testing was carried out with selected end-users to check the user interface for the prototype is in a user-friendly manner. In the testing phase, the author mainly considers the UI designing aspects and validate with the user. Also, the time range for getting the results to the UI is very low. As for the following image, the performance of the user interface can be seen.

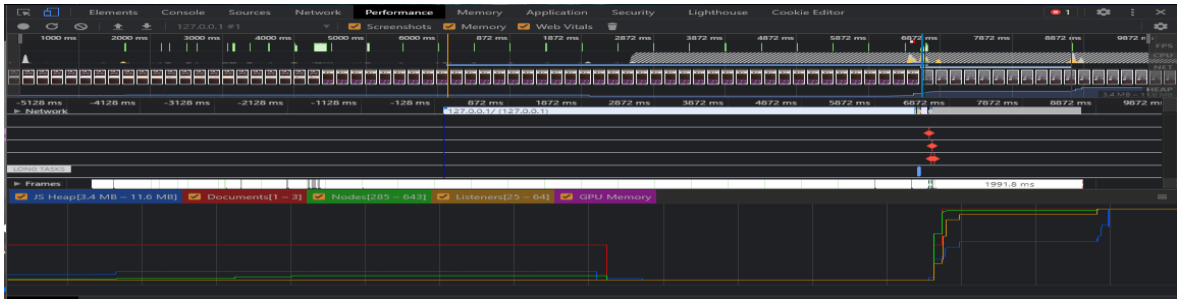

Figure 8.8: UI performance

Using google chrome's performance features, the above matrix was generated. To get the above results for the BBCNews twitter portal, the system took 8872ms which is a considerably low time.

8.7.4 Performance Testing

Performance is the most important aspect of the proposed solution. All the model training process was done using google colabotary since it has inbuilt GPU and takes considerably less time to execute the process. But all the other process was running in the local machine. The following diagrams show the CPU performance while running the system in the background.

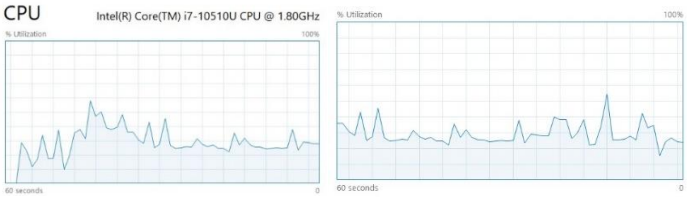

Figure 8.9: Initial starting point for the process

As in figure 8.9, the CPU started to perform its process without depending on the network.

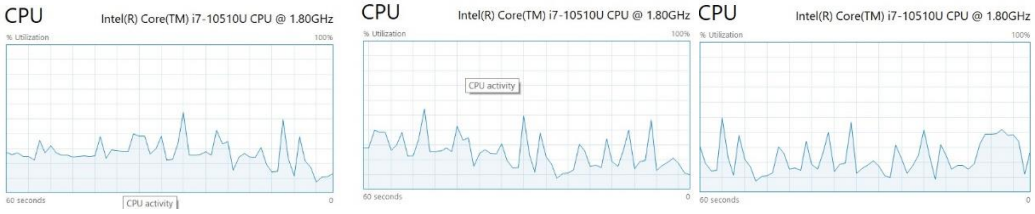

Figure 8.10: After triggering the web app in chrome

In the above figure, the left image shows the performance of the CPU when the system is ready to get the user input, and the right corner images show the final result generating part. Although, 11% of CPU power were used in the whole process. The author chose comparatively large twitter content to generate those performance patterns in the CPU.

Load Testing was done using the *loctus* testing framework. The author has decided to test the application for three user categories, Initially, the test was done for the 10 users and expanded to 100 and 100. The following table will analyse the performance results.

No. of useres	Average Response time(seconds)	Peak Response Time(seconds)	Error Rate	Requests per Second (RPS)
10	2.06	2.312s	0	0.8
100	2.03	2.093	0	8.2
1000	2.06	**4.17**	1	78.7

Table 8.4: Comparison of Load test results

Network strength was a factor to decide the response time. As pre-planned by the author, when system testing against 1000 users, the connection was closed to check whether the crashes happened to the application. But it slows down the process and continues to work as it is after getting into a stable RPS rate. **Appendix 2.5** will consist of the above load testing results

8.8 Limitation of the Test process

- **Testing was carried out in the local machine**

  The author used a personal computer to test the above testings to validate the system features. But to gain more accurate test results, the application should be hosted in real web servers like amazon.

- **Bugs can appear in future**

  This prototype testing was covered only the relevant functional and non-functional requirements. Therefore, there can be unidentified bugs in future with the use of this prototype. It can not be validated yet.

8.9 Chapter Summary

In this chapter, the author describes the goals of the testing phase at the beginning. Also, the test criteria were defined before the test process to get a clear view of the test process. After the testing criteria, the author discusses the results obtained from model testing. Model testing was done by using a classification matrix. The most important phase of functional testing was conducted after that. The author has evaluated the functional features which are developed in the prototype and the module and integration test and results are thoroughly reviewed. Later, the chapter discusses the non-functional testing and limitations for the testing. The next chapter will evaluate the proposed solution using evaluation methods.

CHAPTER 9: EVALUATION

9.1 Chapter Overview

This chapter mainly covers the views of domain experts, technical experts and the end-users about the proposed solution. The evaluation for the problem, design, implementation and usability is discussed with experts and mentioned here. Also, the author's self-evaluation and the limitations of the evaluation are discussed in this chapter.

9.2 Evaluation Methodology and Approach

Considering the project domain, the author has identified that the evaluation is essential to ensure the proposed solution is achieving its aim. Most people do not aware of the Text emotion detection and they are new to songs recommendation as well. So for the evaluation of the proposed solution author has shared an introductory video of the prototype which integrates with the problem and the solution details. For evaluation purposes, the author chose both quantitative and qualitative approaches after analysing evaluation approaches. A Quantitative approach was conducted during the test phase of the prototype using several tools and techniques. There can be different ideas from the evaluators about the research project. So after the author collects the feedback from the evaluators suggested changes have been done to the prototype. The author chose online surveys, online demo and online interviews as evaluation techniques for the research project with the time constraint and the current pandemic situation. Also, the author has proposed a thematic analysing method to follow the evaluation process in relevant components. **Appendix 2.6** will consist of the online survey form and the analysis of quantitative and qualitative approaches. The music recommendation system introductory video link is given below.

Video link: *https://www.youtube.com/watch?v=gyTbWV2lcU8*

9.3 Evaluation Criteria

The following criteria were proposed by the author to gather the qualitative evaluation from the selected evaluators. Each criteria is representing a theme that was important to validate the system quality.

Criteria	Purpose of evaluating
The overall concept of the project	To critically evaluate the importance of solving the identified problem and the proposed solution

Project scope and depth	Project scope should be validated from the domain and technical experts
System Design and architecture	Evaluate the system design and architecture that has followed the proper software development standards.
Implementation and the Prototype	To validate the implementation is consists of the functional and non-functional requirements and prototype defined as a proof of concept based on the proposed hypothesis and scope.
Usability of the system	To evaluate the prototype is in a user-friendly manner and the given non-functional requirements are considered and achieved the expected outcome
Limitations and future enhancements	To validate and identify the limitations of the system from the evaluators perspective and to identify the future enhancements to make the solution more stable and accurate manner.

Table 9.1: Evaluation Criteria

9.4 Selection of Evaluators

For the qualitative approach of the evaluate systems, the following user groups have decided from the target audience to get the feedback for the proposed solution.

1. Domain experts and people who have an interest in the music industry.

2. Technical and industry experts who have experience in the Natural language processing domain

3. Focused group users to get feedback about the user experience.

Permission obtained from the evaluators before the evaluation process and with the evaluation survey to mention their name and designations in the dissertation.

Evaluator Category	**Name and Designation**	**Justification**
Domain Experts	**Mr Mahim Dissanayaka** Journalist at UNCTAD, CEO/ Music Producer, MFIx Media	Mahim is a song producer and writer who collaborate with a well-known product and brand, IRAJ. He has composed many songs and has vast knowledge in the music domain.
	Miss. Anuradha Weerakkody	Anuradha is a multitalented violinist and songwriter. She has won many awards in the song producing and

	Violinist, Singer University of Kelaniya	singing category in Sinhala folk music. Her feedbacks will be an asset to the proposed solution.
	Mr Chenuka Madawela Lead singer, Song composer, HotHouse Production	Chenuka is a singer, song composer in his HotHouse production startup. Also, he has participated in several competition as well. And he is currently an undergraduate at the University of Colombo, School of computing.
Technical and Industry experts	**Mrs. Janani Nayanthara** Lead Engineer and Project Manager TakumiTech Pvt LTD	Janani has over 10 years of experience as a senior software engineer. She has experience in the NLP area with her involvement in projects based on natural language processing.
	Mr Lakindu Gunasekara Software Engineer 99X	A well-talented software engineer at 99X and have a broad understanding of novel technologies in the industry.
	Miss. Ravinga Perera Software Engineer Enactor LTD	Ravinga is an NLP researcher and software engineer. She had implemented an algorithm for Sinhala-English transfer learning. Her experience in the NLP domain will be useful to evaluate this project
	Mr Isuru Amantha Software Engineer SyscoLabs	Isuru is a software engineer at Sysco lab in have 2 years of research experience in the natural language processing area.
	Mrs Piumi Lokuge Junior Manager – Software development Srilanka Tourism Development Authority	Piumi is a junior manager and she had worked as a software engineer recently in Srilanka tourism development authority. Her ideas on the domain and technical aspects will be useful to improve the system functionalities.
	Mr Ashen Sudaraka Software Engineer Kingslake Engineering Systems (Pvt) Ltd	Ashen is working at kingslake as a software engineer. Also, he is well capable of design and develops user interfaces and he has a good understanding of the usability of systems and the ways to improve that.

	Miss Sandaru Jathunge Software Quality Assurance Engineer Kingslake Engineering Systems (Pvt) Ltd	Sandaru is QA engineer at kingslake. She has more knowledge in software testing and analysing. The author will be expecting her quantitative and qualitative evaluation feedback about the system
Focused user Group	**Miss Binoli Gunawardena** Medical Student University of Colombo	Binoli is a Third-year medical student who works in so much of a stressful environment. She is asked to evaluate the system with her experience.
	Mr Dinuka Dias Undergraduate University of Colombo	Dinuka is an undergraduate at the University of Colombo and he will evaluate the system after experience the prototype.
	Mrs. Hiruni Rathnayaka Marketing Executive Kelly Felder	Hiruni is a marketing executive at Kelly Felder and her inputs will be important to improve the system.
	Miss. Savishka Aththanayaka Software Engineering undergraduate ICBT Campus	Savishka is a second-year student at the ICBT campus and she will evaluate the system as a user.
	Mr Savindu Dimal Undergraduate University of Moratuwa	Savindu is a final year engineering student from the University of Moratuwa. His technical experience will be validated with user experience.

Table 9.2: Selection of Evaluators

9.5 Evaluation Results

9.5.1 Experts Opinion

The following table discusses the findings from the Experts feedbacks and evaluations. Experts are divided into two categories, Domain experts and Technical experts.

9.6.1.1 Domain Experts Opinion

9.6.1.1.1 Project Concept

Evaluator	Feedback
Mahim Dissanayaka	The proposed solution is quite good even to composers like us when composing songs. But as I feel not only the lyrics but also

	the music features can be added to analysing the emotions of the songs. Overall good concept.
Anuradha Weerakkody	Addressed problem is very essential and the concept is good. Because nowadays the new generation thinks about the song's meaning as well. So recommending songs according to their emotion is a good concept.
Chenuka Madawela	According to my idea, we sing songs for people to entertain them. Yes, it can sometimes heal them. So the proposed concept is very unique and identified the needs of people.

Table 9.3: Evaluation results for project concept

Evaluation Summary:

Evaluators feel that the proposed concept is interesting and it can be more useful. Furthermore, they suggest considering the music features as well to improve the results.

9.5.1.1.2 Proposed Solution

Evaluator	Feedback
Mahim Dissanayaka	I believe that from a music industry perspective if there is a way to analyze every song on a real-time basis would be more accurate
Anuradha Weerakkody	The solution is good and can be improved if you have a feature like real-time songs emotion detecting.
Chenuka Madawela	Since it analyzes social media content based on different languages users can experience any kind of song irrespective of the language. so the solution has directly addressed the problem of the users

Table 9.4: Evaluation results for Solution

Evaluation Summary:

Evaluators believe that the proposed solution is unique and address the problem directly. And they have commented about the relvent of the solution for their industry

9.5.1.2 Technical and Industry Experts Opinion

9.5.1.2.1 Project Scope and depth

Evaluator	Feedback
Janani Nayanthara	The scope is more than enough since you’re an undergraduate student. Although it covers a broader area of the music domain. But

	I suggesting that if you have considered one language, it would be better for you. But the defined scope is okay.
Lakindu Gunasekara	The scope is defined well
Ravinga Perera	This is a one-year individual research project and due to that reason, I suppose the scope is significant. nowadays social media users share other users' posts also. But it would be very useful to Sri Lankan users if the system can capture the Sinhala language written using English letters as many of the users tend to use it that way.
Isuru Amantha	Should have focused only on the English language. Because implementing the Sinhala language is another research. (Due to tokenization, lemmatization and all)
Piumi Lokuge	According to my opinion, The solution covers the scope of the problem
Ashen Sudaraka	The scope is quite remarkable and it is good to achieve all the defined functions, also I would like to recommend that if you considering ML techniques, it can be better.
Sandaru Jathunge	The proposed solution and scope is good for the person who try to relax with music. Also, make sure to validate the Sinhala language identification process since it is a common theme nowadays.

Table 9.5: Evaluation of project scope and depth

Evaluation Summary:

Evaluators suggest that the selected scope is covered during the implementation process and they satisfied with the improving results of the prototype. And they suggested that the project depth can be enhanced with further improvements in future works. Also suggested that if the language selection is done for one is better since it can be a wide research area.

9.5.1.2.2 Architecture of the Solution

Evaluator	**Feedback**
Janani Nayanthara	The selection of tools are good and more resources can be chosen. But considering the time frame, it's okay. The architecture diagram is

	good and it has a detailed picture of the whole system. Also, you can improve more from your design if you wish to do so.
Lakindu Gunasekara	The provided design looks great.
Ravinga Perera	Overall good for the solution.
Isuru Amantha	Design and architecture is good
Piumi Lokuge	System architecture supports the system goals and requirements, also could cover long term requirements
Ashen Sudaraka	Quite simple and easy to understand. Simplicity will be a plus point if the product is further developed
Sandaru Jathunge	Design is good for the users and compatible with to design of the software. The use of software development techniques can be seen.

Table 9.6: Evaluation of Architecture and design

Evaluation Summary:

Evaluators feel that the design and the architecture for the solution are suitable and can be enhanced with additional feature and thems.

9.5.1.2.3 Implementation of the Solution

Evaluator	Feedback
Janani Nayanthara	As an innovative solution, it is way better than I expected after scene the initial video. Also, you could have more focused on the datasets collected and I recommend you to think about more neural network features as well. Overall good solution and I prefer a mobile application.
Lakindu Gunasekara	The overall solution is good and addressing the domain problem well. Better if you can focus on the IT contribution as well. Can improve the UI and can include more features since you get to know the mood of the person such as a quote based on the mood and maybe autoplay of the song or integration of a free music search and play (Ex: Youtube API if free) would be great
Ravinga Perera	The overall solution developed is good but the solution can be further improved to make it more usable and advantageous to the user. The places where the solution can be improved are given in prior questions. The prototype has given the overall idea about the project. It would be

	better if the song can be auto-play or at least provide a web URL, so the user can click and play the song instantly.
Isuru Amantha	Seems like a good solution. It would be great if you can add more social media platforms as well. (For a prototype this is okay). From a usability perspective, an end-user might not enter multiple usernames like in your video. So it would be a one-time thing(Signing to your social media platform) and then if a new tweet popup or FB post shared, the suggested song is changed. (Like listening to an event stream). Rather than giving only one song, I'd like to see similar songs according to the emotion identified.
Piumi Lokuge	The prototype seems to be a good approach for the project. I am quite satisfied with the project concept and scope, Prototype seems a good beginning.
Ashen Sudaraka	The implementation concept is quite good and truly satisfied with the developed solution
Sandaru Jathunge	The research concept is great. Because these days people are very busy with their day to day life. So finding some songs for getting relax for the moment is not an easy task. So this kind of suggestion can support them. and the prototype describing the user flow very well.

Table 9.7: Evaluation of implementation and prototype

Evaluation Summary:

Implementation is the most important aspect to provide proof of concepts. All the evaluators are satisfied with the implementation. Also, they have suggested few changes to the initial prototype and the author has improved the prototype using those feedbacks.

9.5.2 Focus Group Evaluation

The following topics will summarize the focus group evaluation. The author selected few university undergraduates as end-users who took part in the requirement gathering process and their feedback for the prototype has been summarized.

9.5.2.1 Prototype Features

End-user name	Feedback
Binoli Gunawardena	Prototype features are very simple and suitable for the solution
Savidu Dimal	Good, but it will be better to give them access to listen to the relevant song (play the song, give YouTube or Spotify link to the song), instead of giving the name of the song. Also, it will be better to have a mobile app rather than a web interface.
Dinuka Dias	It's a very good prototype and user-friendly interface.
Hiruni Rathnayaka	A good concept to make it easy for us to find music and songs we prefer to listen to daily
Savishka Aththanayaka	The solution concept is very good because it's not a compulsory thing to mention our emotional status anywhere to select/play the song. It automatically indicates the mental situation according to our social media posts & activity. So I think this concept is also good, especially if it's more responsible about our privacy. and a nice solution for music streaming according to the emotions. I love it because it suggests discovering new music & artists I never knew.

Table 9.8: Feedback for Prototype features

Evaluation Summary:

All the end-users are satisfied with the given prototype and they have suggested that they would prefer to use the mobile application as well. The suggested features are added accordingly and features did not implement will be discussed.

9.5.2.2. Usability of the prototype

According to the feedback from every evaluator, they are happy with the usability of the prototype. And they satisfied with the design and the themes in the user interface as well. Also, they suggested that they would prefer some additional features as well.

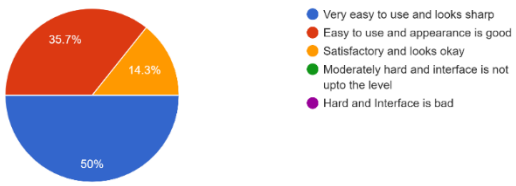

Figure 9.1: User experience analysis

9.6 Limitations of Evaluation

The following limitations are identified during the evaluation process for the prototype.

- The author was unable to conduct online interviews with evaluators since the most of evaluators were busy and hard to allocate a time slot for evaluation. So, the author used an online survey to get the feedbacks
- When conducting an online survey there were so many issues and things need to be clarified for the evaluators. So the author had to explain the whole project sometime.
- The author was unable to contact domain experts who are familiar with the music therapy area to evaluate the project

9.7 Evaluation on Completion of Functional Requirements

Completion of functional requirements is validated by the author. Some of the desired functionalities not implemented in the proposed solution due to time constraint. To get a better evaluation measure, the author has defined the value of Requirement Completion Rate (RCR).RCR defined by the following equation.

$$\mathbf{RCR = (NRI / TNR) \times 100}$$

NRI = Number of Requirements Implemented
TNR = Total Number of Requirements

FR No	Description	Priority Level	Evaluation
FR1	Application User must be validated with the social media account	C	Implemented
FR2	Recent posts of the Application User must be validated	C	Implemented
FR3	Application Users' current emotions must be detected from given inputs	C	Implemented
FR4	The recommended song must be accessible by the Application User	C	Implemented
FR5	The system must identify the Music emotions using given features	C	Implemented
FR6	The emotions identified by the Application operator must be validated with songs emotions	C	Implemented

FR7	The system must detect emotions without considering the language	C	Implemented (Scope was based only for English and Sinhala language only)
FR8	The system must detect emotions without considering the formality of the language	C	Implemented
FR9	The application operator must develop a UI interface for the solution	I	Implemented
FR10	The system must be able to store the recommended music list	I	Not Implemented
FR11	Application User must be able to ignore their emotions and select songs according to the music emotion	D	Not Implemented
FR12	Application User must be able to rate the songs	D	Not Implemented
RCR Rate = (9 /12) ×100= 75			**75%**

Table 9.9: Evaluation of Functional Requirements

9.8 Evaluation on Completion of Non-Functional Requirements

The following table summarizes the evaluation of the non-functional requirements implemented.

The requirement Completion rate has been calculated accordingly.

NFR ID	Description	Evaluation
NFR1	The proposed music recommendation system must maintain good compatibility with every browser such as Firefox, Microsoft Edge. Since the end-users are using a different kind of browsers, Compatibility is important.	Implemented
NFR2	Recommendation systems must have a higher accuracy level. This music recommendation system is expected to achieve an accuracy of more than 70% in the final stages of the research. High accuracy can strengthen the reputation of the solution	Implemented
NFR3	The user interface should be very simple and easy to understand. Also, the system should ensure a higher level of usability and the system	Implemented

	should be able to reduce the time to get familiar with functionalities in the system for new users.	
NFR4	The system should get more accurate results when it open to a lot of real-time users. Also, it should keep loading without considering the number of users. Most social media users will use this app. So Performance is important.	Implemented
RCR = (4/4)×100		**100%**

Table 9.10: Evaluation of Non-Functional Requirements

9.9 Self Evaluation

Criteria	Author's Self-evaluation
The overall concept of the project	The concept was chosen after evaluating the recent works in the music domains also need for an emotional recommendation system was self-experienced by the author. Even though there were existing recommendation systems, the author proposed a more unique concept to overcome the problem faced in his experience.
Project scope and depth	As in the initial phase of the research, the author defined broader scope relevant to the master's level in the particular domain. But considering the requirements and the existing work, the scope was narrowed down to an implemented solution. Also, time constraint was a limitation to implement the scope defined initially.
System Design and architecture	Define and design the software design and architecture was a bit difficult because of the elements in the scope finalized. But with the requirement gathering process and the feedback from the target audience were helped to design the software architecture for the proposed solution. The tired architecture was followed due to the system components working as tiers.
Implementation and Prototype	Lack of knowledge and experience for the NLP domain wasted many hours in the implementation process. But with the continuous feedback and the knowledge gain from the requirement engineering phase helped the author to implement the proposed functional in the system
Usability of the system	Since the research project is based on music recommendation, the user interface of the project must be user friendly. The author has designed a very basic but simple user interface to achieve the above user-friendly aspects and attract user to use the application

Limitations and future enhancements	As for the limitations of the system, the accuracy of the lyrics analysing model identified. Since the lyrics data consist of old songs, the author had identified the limitation of enhancing the solution to recommend new songs. For future enhancement author listed the out of scope features and the functional requirements which are not implemented in the system. In the music recommendations, the author has discovered that the songs emotion detection accuracy can be improved if he considers the music features as well.

Table 9.11: Self-evaluation of the author

9.10 Chater Summary

This chapter consists of the evaluations gathered from selected Domain, Technical experts and end-users. Initially, the author discussed the evaluation methods and approach. And authors self-evaluation is added in this chapter. Also the evaluation criteria, Thematic analysis was defined as well. The selection of evaluators was discussed in the first section of this chapter. After that, the evaluation process was discussed. Project concept and solution evaluated from domain experts. More technical aspects such as project scope, system design and architecture, implementation were evaluated with technical and industry expert. And end-users did their feedbacks for the prototype. After the evaluation from the above parties, functional and non-functional requirements were evaluated with the limitations of the evaluation process.

CHAPTER 10: CONCLUSION

10.1 Chapter Overview

This chapter will provide the final remarks about the project. Initially, the chapter will make a review about the achievements from the initial project Aim and objectives. After that chapter will be discussing the knowledge utilization and use of existing skills and new skills. Also, the way the author overcome the challenges, limitations of the research domain and future enhancements will be discussed. Also, the contribution of the research will be documented in this chapter.

10.2 Achievements of Research Aim and Objectives

10.2.1 Research Aim

> *This research project aims to design, develop & evaluate a system that recommends the music, based on emotions in the songs extracted from the lyrics and matching them to the user's emotional states which analyzed from social media content with English and Sinhala languages.*

The aim of the research was successfully achieved in the development process. Music recommendation system designed, developed and evaluated and the recommendation based on English and Sinhala language text emotion analysing can be done.

10.2.2 Research Objectives

Complete Objectives can be found in chapter 01.

Description	**Status**
Literature Review	
An in-depth review has been done on the identified literature of the research	**Completed**
Requirements Gathering	
User requirements gathering phase carried out to identify the detailed requirements	**Completed**
Submission of Ethical clearance	
An ethical clearance form submitted, and permission was obtained to conduct the research	**Completed**
Design the Prototype	
Designed the proposed music recommendation system	**Completed**
Development of the Prototype	

The prototype was developed according to user requirements using appropriate software development methods and tools	**Completed**
Testing and Evaluation	
The prototype was tested and Evaluated	**Completed**

Table 10.1: Completion of the Research Objectives

10.3 Utilization of Knowledge from the Course Module

Module Name	**Description**
Programming Principales I and II	All the fundamentals of the programming concept were used in this research implementation. Therefore basic understanding gain from these modules was the main foundation for the implementation.
Object-Oriented Programming	Basic Object oriented concept was used in this implementation even though the design paradigm was based on the Structured System analysis method
Web Design and Development	The fundamentals of web design and development were used in user interface designing. The module taught the concepts of web designing and used them in the prototype design and the user interface. Markup languages such as Html have used in the prototype development.
Software Development Group Project	The software development group project was the main basement for the research environment. Skills and knowledge from simple research were helpful to conduct the final year research. Documentation skills were used as well.
Algorithms: Theory Design and Implementation	The knowledge gain from the algorithms module helped to understand the algorithms and the different ways of applying the concepts of sorting and searching in this research.
Database Systems	This module was helpful to gain knowledge about data storing in the research. But prototype did not use the facility of databases.

Concurrent Programming	Concepts of concurrent were used throughout this research. Not even theory wise, but also the muli tasking concepts were adapted to manages the research process.

Table 10.2 Course Knowledge utilization

10.4 Use of Existing Skills

- Existing skills learn from the course content and self-learning were used in this research project. Specially programming languages, frameworks, markup languages were used.
- The knowledge of designing and diagrams were used in the designing process of the software. Usecase diagram, activity diagram, sequence diagrams were drawn with prior knowledge and experience.
- The skill acquired from the internship at kingslake Pvt. LTD was used to completion of this project.

10.5 Use of New Skills

1. **Natural Language Processing Techniques** – The author was able to understand the NLP concepts throughout the research process. Before the research, the author has followed Coursera courses to get some hands-on experience about NLP. So these skills were used in the development of the core of the project.
2. **Testing Criteria** – The author has learned several methods of testing software which he was not familiar with. It was helped in the testing process of the prototype. Also, the testing techniques like load testing, stress testing knowledge was used to successful for the project.
3. **Improved Soft Skills** - The author has developed the soft skills to keep the success of the project.

10.6 Achievements of Learning Outcomes

Improved Skills	**Learning Outcomes**
The author has improved the researcher skills and he was able to change his mindset from software developer to researcher. Analytical skills have been improved and critical evaluation skills are developed throughout this research process. Also author	LO1 LO4

had to update with new techniques in the relevant domain and he had to follow the correct methodologies. So it was a lifetime experience to the career.	
This project domain was common to normal people. So the requirements gathered needs to be more valid and accurate. The author improved his analytical skills and the requirement gathering aspects. Especially when dealing with experts and other people, the approaches should be different. So the author had identified all the aspects and achieve the expected goals	LO2
The planning skills need to be at the top level to achieve all the deadlines. So the author has improved that and planned the work accordingly. Also, the well-designed software is very is to implement. The author has followed that concept and used the designing skills to achieve the design goals	L03
Prototype development with new techniques is never is. Adapting to the failures and solving the issues, the author has developed those skills as well. This project is based on music recommendations and emotion analysing. So the understanding of relevant technologies and tools is a must. The author learn relevant techniques and it is an added value to his knowledge base	L05, L06
This module taught the author the way of handling people, getting their ideas and feedback and how to conduct surveys and interviews without harming the privacy of others. Those kind of techniques are very useful in future career	L07
When writing the dissertation, the author had followed instructions and limitations. Also had to follow quality content to keep the effectiveness of the research. The author has gained mentioned skills and was able to well-structured documentation	L08
Presentation of the findings and prototype was done in several phases in the research process. So the author had developed soft skills like presenting and facing feedback sessions	L09

Table 10.3: Learning Outcomes

10.7 Problems and Challenges Faced

The following table discusses the problems faced during the research process and the solutions taken to overcome the problem.

Problem Faced	**Solution Applied**
Confirming the project idea and scope	The initial project idea was changed after the PID submissions since the author had identified that the post from Facebook can not be obtained. So as for social media platform, Twitter was isolated
Lack of Sinhala resources	Sinhala datasets were gathered from the existing system and necessary changes were done. Also, use the same network to identify the Sinhala emotions
Lack of music feature data	As planned in the initial stage, the Author decided to continue with the lyrics analysing
Lack of knowledge base about the technologies and algorithms	When the research process is ongoing, the author followed youtube tutorials to fulfil the knowledge gap. When the implementation process there was an issue with model loading in pycharm. The author had contacted technical experts and Keras documentation to solve that issue.
The issue with the Twitter API	The author was not able to get the recent tweets since the Twitter API does not support such a feature. So he had to check the time frame and validate the tweets.
Only two categories for lyrics emotions	The author had to deal with that issue and he divided identified user emotions into two categories and get the recommendations since the lack of data for the music features.
The document was crashed in a stage of the process	The author daily took several backups locally and in cloud storage. The local backup also crashed but was able to recover and continue the process
Contacting Evaluators for the evaluation	Initial domain experts contact was lost due to unavoidable issue so the author had contacted with few of his friends in the school

	to get their mutual contacts from relevant university to identify the domain experts.
COVID-19	The global pandemic caused the complete lockdown several time. Had to stuck at home and the stress was high. But the author managed to divide the time and work schedule to keep the mental health free to process the workload.

Table 10.4: Problems and solutions

10.8 Deviations from Initial plan

- The initial plan was to identify the emotions from both Facebook and Twitter. But after submitting the PID, the author had followed the test phases to get the user details from Facebook using Facebook graph API. As for the new privacy policy,(Platform Terms, no date) they are not providing personal data through graph API. So the author had to keep Facebook and limited it to Twitter.
- The author proposed to identify the complex emotions from the user. But the lack of data related to text analysing was limited to six emotional category

10.9 Limitations of the Research

- **Limitations of accuracy –** The lyrics analysing model had only 72% of accuracy as discussed in the testing chapter due to lack of music features. And Sinhala model did not work as expected. Also during the test phase author was not able to test these datasets with existing datasets. So this limitation could have been overcome if the author had selected a different approach such as music feature extraction. But the lack of time to develop the system was identified as a limitation.
- **Limitations of Scope –** The author was only able to identify simple emotional categories rather than complex emotions. As mentioned above, the dataset and the technical stack was not enough to identify the complex emotions. From the initial steps, if the author creates the dataset manually this limitation can be overcome.

10.10 Future Enhancements

Following enhancements have been identified in the evaluation process.

- To music emotion recognition, it is better to use music features such as rhythm, melody to get the exact feeling to users
- Review more on Sinhala language contents which write in English letters because most social media users have used Sinhala contents with English letters.
- Try on more complex emotional categories detection to identified extract therapy users need.
- It is better to give a choice of songs that is related to users' emotion so users have the freedom to select any songs as they wish.
- To improve the Sinhala emotion detection accuracy it is better to use a unique dataset that covers all the emotional categories.
- Improve to other language aspects
- Expand the solution for mobile applications since most people using mobile applications rather than web applications

10.11 Achievement of the contribution to the body of knowledge

10.11.1 Contribution to the Domain

This system was designed to address the problem of not having a proper way to select a song according to users emotion. Even though there are many music recommendation applications, they did not consider the user current emotion or the emotion which can be generated after listening to a particular song. So this project gives a proper solution to that issue. If the user has posted in their social media account, it will be considered to identify the emotions. The language of the social media content did not consider (but only for Sinhala and English) to identify the emotions. Also, lyrics analysing to identify the emotion is a novel method since most platforms used music features. But most users pay attention to song meaning as well. So this novel solution can close the gap between getting proper music to listen to according to users mood without making any conflicts.

10.11.2 Contribution to the Technical domain

Comparing to all the methods used in text analysing, they did not have a language-independent system to analyse any kind of language content. But as this solution suggests, using the same neural network, it can be done. But the dataset should be more accurate. Also as expected English language emotion detection accuracy was improved but the Sinhala context needs more data to achieve the higher value of accuracy. The author identified that the Natural language processing techniques can be applied to social media contents not only to identify the polarity of the sentiments but to identify the hidden emotional feelings which can be further useful to recommendation systems.

10.12 Concluding Remarks

Music recommendation system based on Emotions in users' social media behaviour research project implemented by the author is a new approach to identify the emotions in users social media content and recommend songs related to songs emotions which were identified from the lyrics analysing. This project has gain positive and improving feedbacks from both evaluators and end-users. This research was developed targeting people who struggle to find the most suitable songs for their emotional status to relieve their pain and stress. It can minimize the gap between people and music by adding a matching aspect.

By conducting this research, a new path has been open to all the developers to use social media and its content more productively.

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Appendix 2.1: Concept map

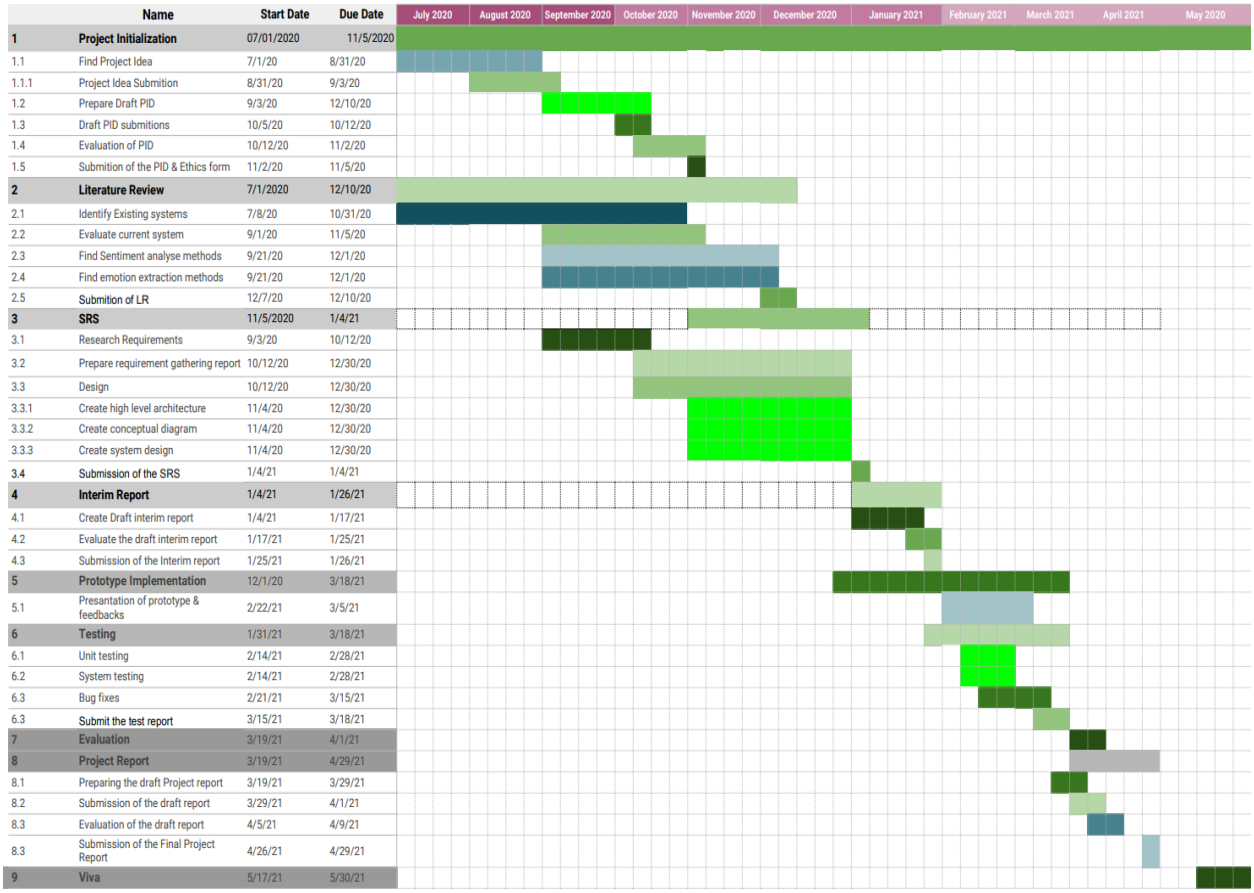
Figure A: Concept Map

Appendix 2.2: Project Deliverable and Gannt Chart

Deliverable	Due Date
Project Initiation Document The initial proposal of the research	5th November 2020
Ethics Form Validation form for the ethics	5th November 2020
Literature Review Document The Critical review of existing work and solutions in the domain	10th December 2020
Software Requirement Specification (SRS) The document specifying the requirements of the prototype and the design of the prototype	21st January 2021
Interim Progress Report (IPR) Progress evaluation report for the project	28th January 2021
Prototype	5th March 2021

The working prototype with main core features functional to proof of concept	
Test Report The report consists of the test results of the prototype	18th March 2021
Final Thesis The final documented report of the project with the research process and decisions	29th April 2021

Table A: Project deliverable



	Name	Start Date	Due Date
1	**Project Initialization**	07/01/2020	11/5/2020
1.1	Find Project Idea	7/1/20	8/31/20
1.1.1	Project Idea Submition	8/31/20	9/3/20
1.2	Prepare Draft PID	9/3/20	12/10/20
1.3	Draft PID submitions	10/5/20	10/12/20
1.4	Evaluation of PID	10/12/20	11/2/20
1.5	Submition of the PID & Ethics form	11/2/20	11/5/20
2	**Literature Review**	7/1/2020	12/10/20
2.1	Identify Existing systems	7/8/20	10/31/20
2.2	Evaluate current system	9/1/20	11/5/20
2.3	Find Sentiment analyse methods	9/21/20	12/1/20
2.4	Find emotion extraction methods	9/21/20	12/1/20
2.5	Submition of LR	12/7/20	12/10/20
3	**SRS**	11/5/2020	1/4/21
3.1	Research Requirements	9/3/20	10/12/20
3.2	Prepare requirement gathering report	10/12/20	12/30/20
3.3	Design	10/12/20	12/30/20
3.3.1	Create high level architecture	11/4/20	12/30/20
3.3.2	Create conceptual diagram	11/4/20	12/30/20
3.3.3	Create system design	11/4/20	12/30/20
3.4	Submission of the SRS	1/4/21	1/4/21
4	**Interim Report**	1/4/21	1/26/21
4.1	Create Draft interim report	1/4/21	1/17/21
4.2	Evaluate the draft interim report	1/17/21	1/25/21
4.3	Submission of the Interim report	1/25/21	1/26/21
5	**Prototype Implementation**	12/1/20	3/18/21
5.1	Presantation of prototype & feedbacks	2/22/21	3/5/21
6	**Testing**	1/31/21	3/18/21
6.1	Unit testing	2/14/21	2/28/21
6.2	System testing	2/14/21	2/28/21
6.3	Bug fixes	2/21/21	3/15/21
6.3	Submit the test report	3/15/21	3/18/21
7	**Evaluation**	3/19/21	4/1/21
8	**Project Report**	3/19/21	4/29/21
8.1	Preparing the draft Project report	3/19/21	3/29/21
8.2	Submission of the draft report	3/29/21	4/1/21
8.3	Evaluation of the draft report	4/5/21	4/9/21
8.3	Submission of the Final Project Report	4/26/21	4/29/21
9	**Viva**	5/17/21	5/30/21

Figure B: Gannt Chart

Appendix 2.3: Requirements gathering survey and Findings

Survey form for Music section:

Music Recommendation System Based on User's Emotions-Music Part

Hello,
I am Ravidu Shehan Perera, Final year undergraduate following the BEng (Hons) Software Engineering degree at the Informatics Institute of Technology affiliated with the University of Westminster, UK.

This questionnaire is to provide detailed insight into my final year project based on Music recommendation system based on the user's emotions.

Kindly note that the information gathered will be used for academic purposes only, and the data retrieved will be anonymous and kept confidential.

Your valuable response is greatly appreciated.

Feel free to contact me if you have any other question related to the research

Email: ravidu.2017486@iit.ac.lk

* Required

1. What is your Age? *

Mark only one oval.

- ◯ 15 to19
- ◯ 20 to 24
- ◯ 24 to 29
- ◯ 30 to 34
- ◯ Above 34

2. Gender *

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Prefer not to say

3. Occupation *

Mark only one oval.

- ◯ Student
- ◯ Undergraduate
- ◯ Doing a Job
- ◯ Other: _____

4. Do you listen to songs? *

Mark only one oval.

- ◯ Yes
- ◯ No

5. Do you consider the language of the song? *

Mark only one oval.

- ◯ Yes
- ◯ No

6. In which Occasions do you listen to songs? *

Check all that apply.

- [ ] While Studying
- [ ] As a Leisure time activity
- [ ] While Driving/ walking
- [ ] As a Relaxing exercise

7. How do you select Songs to Listen? *

Check all that apply.

- [ ] Randomly
- [ ] Play only favorite music
- [ ] Search for new music
- [ ] Songs suggest by Someone

8. What kind of music you like to listen *

Check all that apply.

- [ ] Classical
- [ ] Hip hop
- [ ] Jazz
- [ ] Rock
- [ ] Folk Music

Other: [ ] _____

9. When you listening to songs, what will attract your attention most? *

Check all that apply.

- [ ] Meaning of Lyrics
- [ ] Tempo
- [ ] Rhythm
- [ ] Melody

10. Do you think a song can change your current mood and help you to relax from stress? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

11. Have you experienced such a situation? *

Mark only one oval.

- ◯ Yes
- ◯ No

12. Have you heard about any kind of App which suggest a song according to your current mood? *

Mark only one oval.

- ◯ Yes
- ◯ No

13. If "Yes" , what is the name of the Application?

4/23/2021 Music Recommendation System Based on User's Emotions-Music Part

14. Do you like to use an Application which suggests a song for you according to your current mood? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ May be

Social Media requirements collection form

Music Recommendation System Based on Emotions in Users social Media Behaviour

Hello,

I am Ravidu Shehan Perera, Final year undergraduate following the BEng (Hons) Software Engineering degree at the Informatics Institute of Technology affiliated with the University of Westminster, UK.

This questionnaire is to provide detailed insight into my final year research on Music recommendation system based on the user's emotions.

Kindly note that the information gathered will be used for academic purposes only, and the data retrieved will be anonymous and kept confidential.

Your valuable response is greatly appreciated.

Feel free to contact me if you have any other question related to the research

Email: ravidu.2017486@iit.ac.lk

* Required

1. What is Your Age? *

Mark only one oval.

- ◯ 15 -20
- ◯ 21-25
- ◯ 26-30
- ◯ 30 and above
- ◯ Prefer not to say

2. Which of the following social media platforms fo you currently have an account? *

Check all that apply.

- [ ] Facebook
- [ ] Twitter
- [ ] Instagram
- [ ] Pinterest
- [ ] LinkedIn
- [ ] Other

3. Choose the best answer that describes your actions in social media networks *

Mark only one oval per row.

	Very rare	Rare	Moderate	Often	Very Often
Post status or Tweets	◯	◯	◯	◯	◯
Photos uploading	◯	◯	◯	◯	◯
Check Ins	◯	◯	◯	◯	◯
Comments and Likes on posts	◯	◯	◯	◯	◯
Sharing Posts	◯	◯	◯	◯	◯
Just scrolling through the App	◯	◯	◯	◯	◯

4. How often do you share or post anything into social media networks? (e.g. Facebook, Instagram) *

Mark only one oval.

- ◯ Everytime
- ◯ A few times per day
- ◯ A few times per week
- ◯ A few times per month

5. What are the situations you tend to share your views, thoughts into social media? *

Check all that apply.

- [ ] After Journey/Trip
- [ ] Life events (Birthday Parties etc)
- [ ] Show the excitement about particular event (Eg : Cricket match, social event)
- [ ] Emotional situations (Eg: After and heated argument with a friend/relative)
- [ ] Just for time wasting
- [ ] To get relaxed after stressful situation

6. Do you think sharing posts and social media engagement can help you to relaxed yourself in the emotional situation? *

Mark only one oval.

- ◯ yes
- ◯ No
- ◯ Maybe

7. If "No", Please state the reason?

_____

8. What do you think about an application, which detects your moody situations through your social media behaviour and help you to get relaxed?

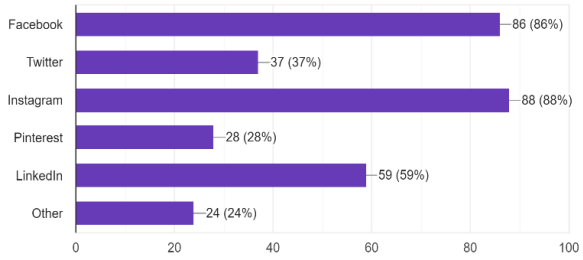
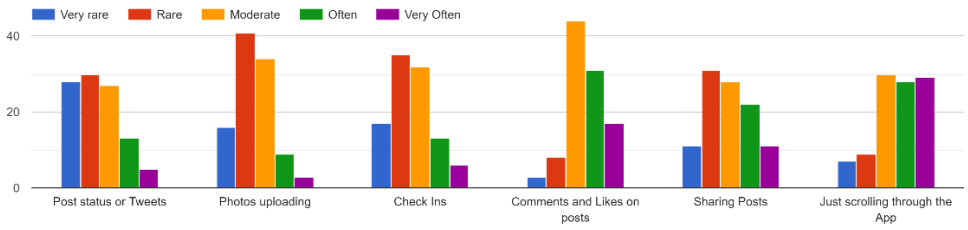
_____

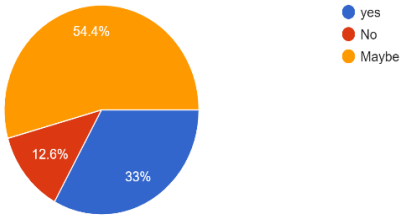
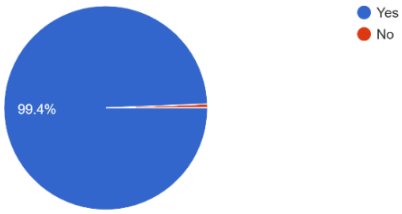
_____

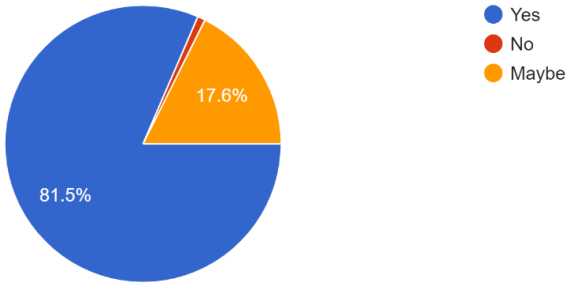
_____

_____

_____

Question	**Which of the following social media platforms you currently have an account?**
Aim of the Question	To identify the audience of the social media platforms
Observations  Most of the users are using Facebook and Instagram as social media platforms. Also, there are a considerable amount of LinkedIn users as well	
Conclusion	The researchers have selected Twitter and Facebook as the research platform for the studies. Since it was the main platforms that can get the emotions using sentiments
Question	**Choose the best answer that describes your actions in social media networks?**
Aim of the Question	Identify the common activities of the users
Observations  Most users upload and share posts on social media platforms, and they are using social media as time passing platform as well.	
Conclusion	The author can get the current mood status of a person since they have sharing posts occasionally to the social networking platforms

Question	Do you think sharing posts and social media engagement can help you to relaxed in an emotional situation?
Aim of the Question	Get personal views about getting relaxing using social media
Observations	 The majority of people (87%) believes they can be relaxed after using social media when they in a stressful situation and they think posting to social media can gain some relaxation for them.
Conclusion	This proves the authors' intention is accurate. It will be more useful to analyze their post and details to identify the emotional status users are in. This result will make an impact to identify the emotions from social media contents.
Question	**Do you listen to Songs?**
Aim of the Question	Identify the music listener audience
Observations	 Almost 99.4% of users like to listen to songs.
Conclusion	Everyone loves to listen to music. So, it may be a good point for the research since it based on the music listeners as well.
Question	**Do you think a song can change your current mood and help you to relax from stress?**
Aim of the question	Identify the user opinion about the music therapy

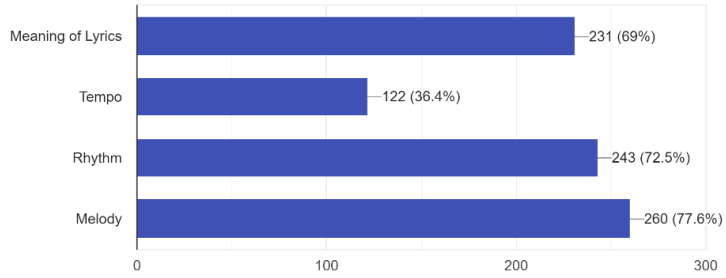


Observations

Most users believe that music can help to get relaxed from a stressful situation.81.5% of users directly agreed with the statement and 17.6% users are having hybrid opinions related to that. Only 3 (0.9%) believe that music cannot heal people.

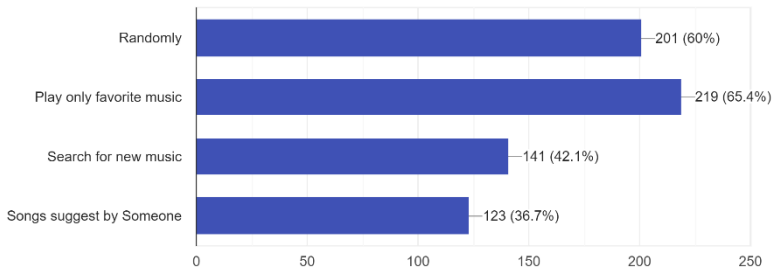
Conclusion	People believe music can heal their stress and can be used as a stress releasing method. It proves that the authors' hypothesis about the music emotions is valid by considering this survey.
Question	**When you listening to songs, what will attract your attention most?**
Aim of the Question	Identify the song features to which users are giving more attention when they enjoy the music

Observations



Around 70% of people keep their attention on the meaning of the lyrics in a song. Also, Rhythm and melody will be another main factor user keep their attention

Conclusion	Users not only listen to music but also, they have thought about the meaning and the rhythm to heal themselves using music.
Question	**How do you select Songs to Listen?**
Aim of the question	Identify the methods of getting the songs to listen to by the users.



Observations

Most of the users (65%) tend to play their favourite music when they willing to listen to songs. And more than 60% of people also use randomly suggesting music to listen to. Only 36.7% of people consider listening to their relatives suggested music.

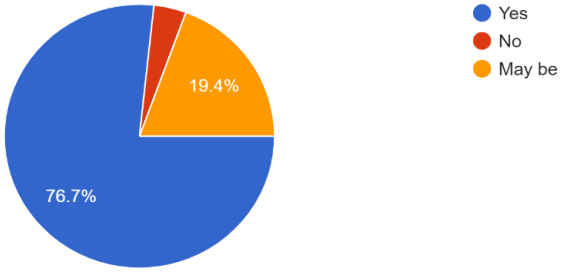
Conclusion	Most of the users' does not have a proper method to identify a song to listen to when they want to relax. So sometimes randomly suggesting song can change their mood as well as can worsen the situation.
Question	**Do you like to use an Application that suggests a song for you according to your current mood?**
Aim of the question	Validate whether users have any intentions to use the application
Observations  76.7% of users willing to use the application which suggests a song according to their mood. About 8% of users do not have any interest in the related application	
Conclusion	It is suggested that the target audience are excited about the proposed project idea

Table B: Findings from the conducted survey

Appendix 2.4: Testing process

The accuracy rate for the Sinhala model :

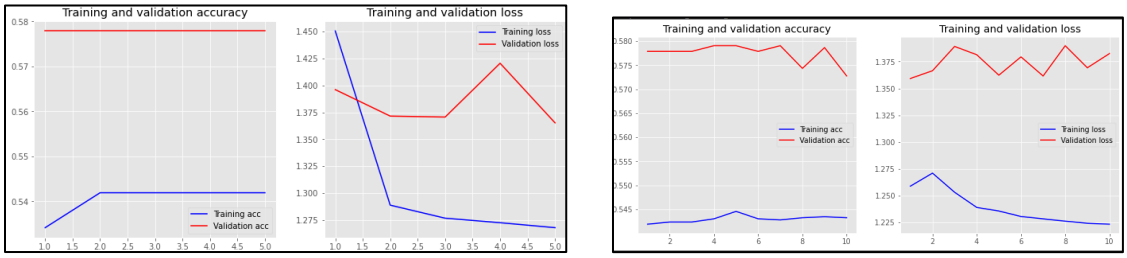


Figure C-1: Accuracy rate for 5 epochs & 10 epochs

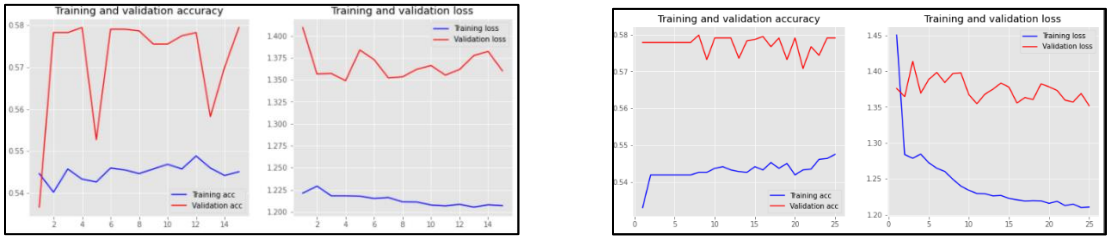
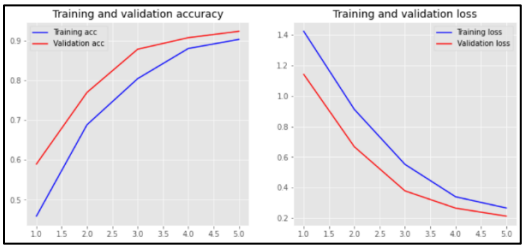


Figure C-2: Accuracy for 15 epochs &25 epochs

Figure C-3: Accuracy for 30 epochs

Test results for English Model:



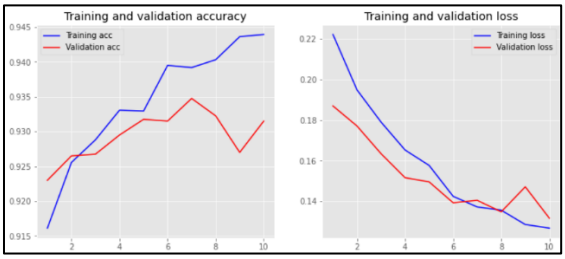
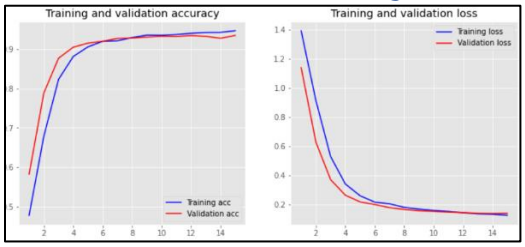


Figure D-1: Accuracy for 5 epochs & 10 epochs



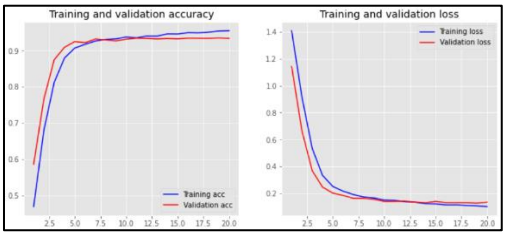


Figure D-2: Accuracy for 15 epochs &25 epochs

Test Results obtained for Load testing:

10 Users:

100 users:

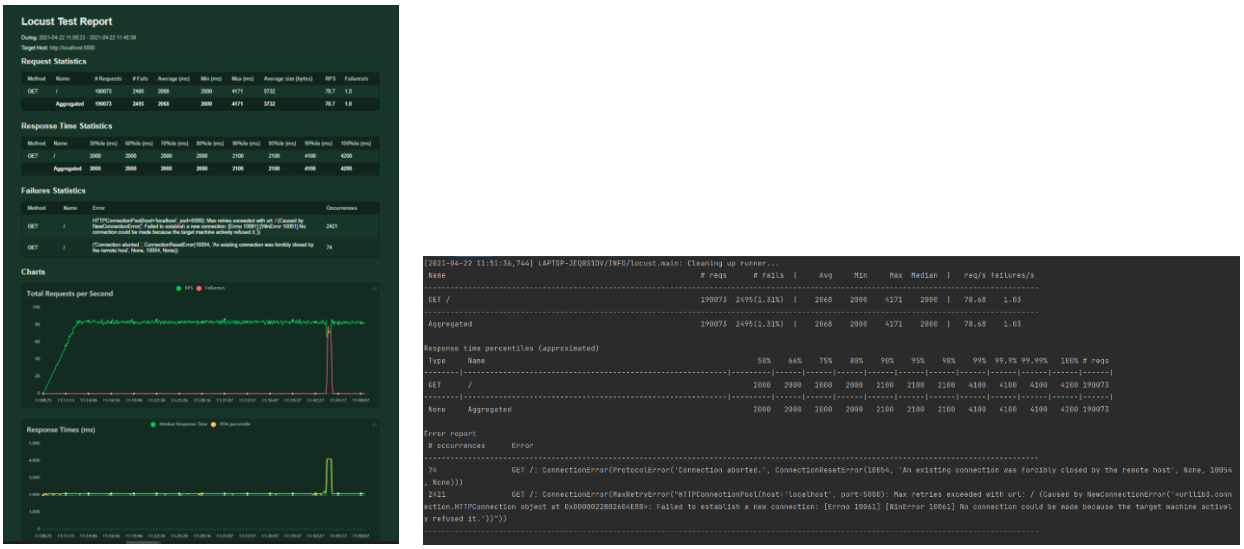
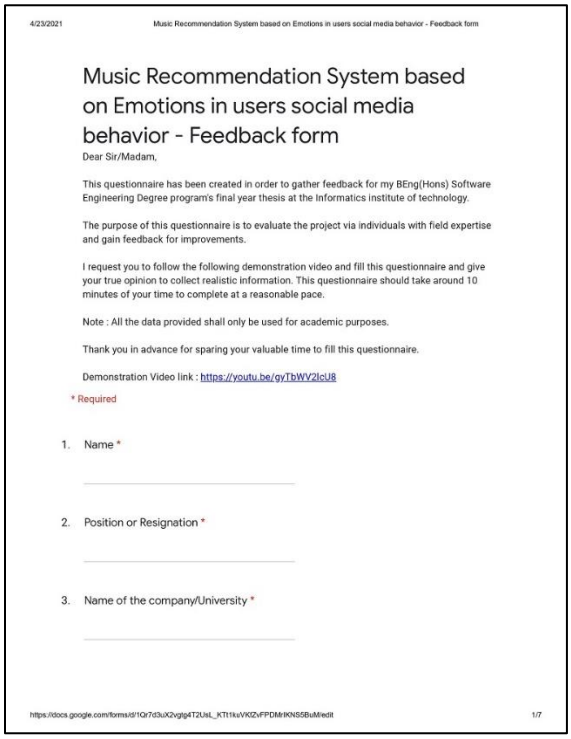


Figure E: Load test results

Appendix 2.5: Evaluation Form



4/23/2021 Music Recommendation System based on Emotions in users social media behavior - Feedback form

Music Recommendation System based on Emotions in users social media behavior - Feedback form

Dear Sir/Madam,

This questionnaire has been created in order to gather feedback for my BEng(Hons) Software Engineering Degree program's final year thesis at the Informatics institute of technology.

The purpose of this questionnaire is to evaluate the project via individuals with field expertise and gain feedback for improvements.

I request you to follow the following demonstration video and fill this questionnaire and give your true opinion to collect realistic information. This questionnaire should take around 10 minutes of your time to complete at a reasonable pace.

Note : All the data provided shall only be used for academic purposes.

Thank you in advance for sparing your valuable time to fill this questionnaire.

Demonstration Video link : https://youtu.be/gyTbWV2IcU8

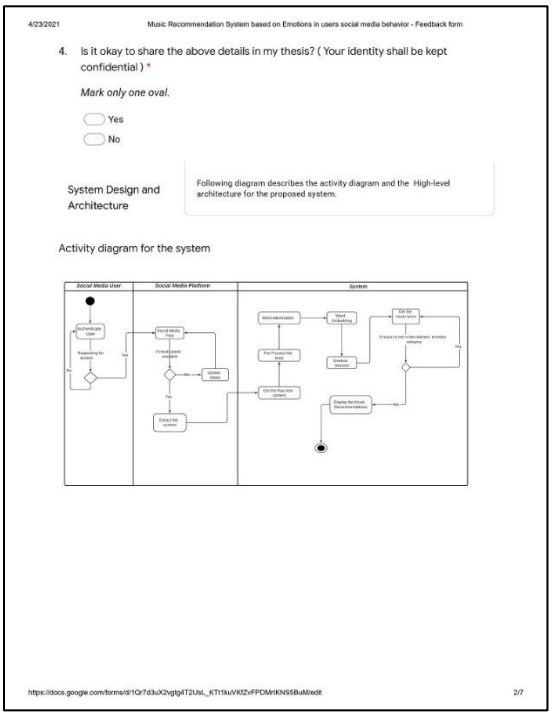
* Required

1. Name *

2. Position or Resignation *

3. Name of the company/University *

https://docs.google.com/forms/d/1Qr7d3uX2vgtg4T2UsL_KT1IkuVKfZvFPDMrIKNS5BuM/edit 1/7



4/23/2021 Music Recommendation System based on Emotions in users social media behavior - Feedback form

4. Is it okay to share the above details in my thesis? (Your identity shall be kept confidential) *

Mark only one oval.

Yes
No

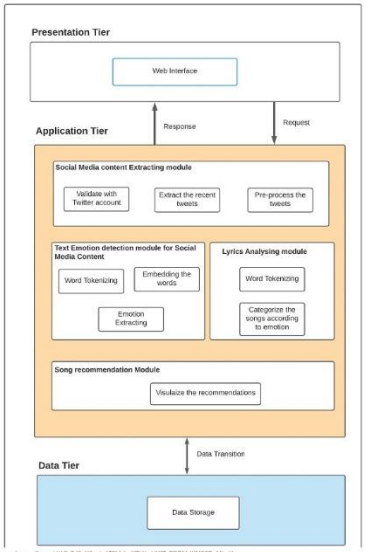
System Design and Architecture

Following diagram describes the activity diagram and the High-level architecture for the proposed system.

Activity diagram for the system

https://docs.google.com/forms/d/1Qr7d3uX2vgtg4T2UsL_KT1IkuVKfZvFPDMrIKNS5BuM/edit 2/7

High-level architecture



5. How would you rate the difficulty of the Application? *

Mark only one oval.

- Very Easy
- Easy
- Satisfactonary
- Moderately Hard
- Hard

6. How would you rate the user experience and the user interface of the application *

Mark only one oval.

- Very easy to use and looks sharp
- Easy to use and appearance is good
- Satisfactory and looks okay
- Moderately hard and interface is not upto the level
- Hard and Interface is bad

7. Do you think this application can help users to find the more accurate songs according to their emotions? *

Mark only one oval.

- Yes
- Maybe
- No

8. What do you think about the Problem addressing in this research? *

9. What do you think about the proposed solution concept? *

10. What do you think about the scope for the solution? *

11. Your feedback about the design and architecture about the system *

12. What do you think about the prototype ? *

13. What is your opinion about User Interface for the Application? *

14. What is your overall feedback about the research concept and developed solution? *

15. Overall satisfactionary scale (1- minimum and 5- maximum) *

Mark only one oval per row.

	1	2	3	4	5
Project Concept	◯	◯	◯	◯	◯
Project Scope	◯	◯	◯	◯	◯
Proposed User interface	◯	◯	◯	◯	◯
Prototype Features	◯	◯	◯	◯	◯

16. Any other feedbacks, recommendations, limitations and future enhancements? *

Appendix 2.6 : Submissions

The following abstract was submitted **to IESL Young Members Section Technical Conference 2021**

MUSIC RECOMMENDATION SYSTEM BASED ON EMOTIONS IN USERS' SOCIAL MEDIA BEHAVIOUR

Perera M.R.S
Informatics Institute of Technology
No 57, Ramakrishna Road,
Colombo 06,Srilanka
ravidu.2017486@iit.ac.lk

Rupasinghe S.
Informatics Institute of Technology
No 57, Ramakrishna Road,
Colombo 06,Srilanka
sulochana.r@iit.ac.lk

ABSTRACT

The modern lifestyle makes people more competitive. It can lead to more stressful situations in our lifestyle. With the changes in human emotional behaviour, they tend to share their feelings on social media platforms rather than communicating with relatives. Studies proved that people used to listen to music to avoid emotional situations in their life. But there is no proper way to get the most accurate music to listen to and avoid emotional conflicts. Resolving these conflicts, the music recommendation system based on emotion introduced. It analyses the users' recent social media content and detects the various kind of emotions. To ensure that the suggested music is relevant to users emotions, the lyrics analysing was done using natural language processing techniques to identify the music emotions. Most people pay attention to the meaning of the songs, that was the major reason to consider the emotions of the lyrics. The research was considered on a language-independent platform for both English and Sinhala. A labelled emotional dataset was chosen to evaluate the model. Using the English emotional detection model it was achieved a higher accuracy level than the Sinhala module. The researcher found that if music features can be added to consideration of the emotion detections for lyrics, It can be more accurate to recommend the songs. Furthermore, research revealed that there is no proper way to identify the exact emotion categories in lyrics due to different lines can give a different set of sentiment value. Therefore, the lyrics were categorised into positives and neutral to combined with the user's emotions.The researchers emphasize that the detection of complex emotion categories could be done using a more accurate dataset and by adding more music features. The outcome of the recommendation system proved that the recommended songs are relevant to identified emotion categories.

Keywords: Natural Language Processing, Text emotion detection, Music recommendations, Text analysing

Cover Page of the Paper submitted to **IEEE Transactions on Big Data: Special Issue on Social Media Computing**

Music Recommendation System based on Emotions in User's Social Media behaviour

M.Ravidu Shehan Perera
University of Westminster
No 115, New Cavendish Street,
London,UK
+94(0)702349514
w1699671@my.westminster.ac.uk

Sulochana Rupasinghe
Informatics Institute of Technology
No 7, Ramakrishna Road,
Colombo 06,Srilanka
+94(0)768209889
sulochana.r@iit.ac.lk

***Abstract*—The modern lifestyle makes people more competitive. It can lead to more stressful situations in our lifestyle. With the changes in human emotional behaviour, they tend to share their feelings on social media platforms rather than communicating with relatives. Studies proved that people used to listen to music to avoid emotional situations in their life. But there is no proper way to get the most accurate music to listen to and avoid emotional conflicts. Resolving these conflicts, the music recommendation system based on emotion introduced. It analyses the users' recent social media content and detects the various kind of emotions. The research was considered on a language-independent platform for both English and Sinhala. A labelled emotional dataset was chosen to evaluate the model. Using the English emotional detection model it was achieved a higher accuracy level than the Sinhala module.Furthermore, research revealed that there is no proper way to identify the exact emotion categories in lyrics due to different lines can give a different set of sentiment value. Therefore, the lyrics were categorised into positives and neutral to combined with the user's emotions.**

1. Introduction

This Introduction section define the domain "Music recommendation system based on emotion in users social media behaviour" with some background information , identified problem in the domain and the use of addressing the problem.

1.1. Background

Social media networks in the 21st century, are playing a vital role in almost every person's lifestyle. Since the development of technology, social media trends can be seen in people's lives. When something is happening around, posting, and sharing about that incident has become a very common practice within people.[1] Early days, people had television, radio and newspapers for entertainment, and they had time to relax. Also, people had good interpersonal relationships with society. But due to the competition of modern society, people have lost their interest to entertain themselves. Because of that reason, social media networks have become the most widely used communication method in human life. Using social networks people tend to make strong relationships with virtual friends, even some people find their soul mates through social networks. Complex life schedules force people to be stressed and make their lives complicated. They used social media networks to relieve the pressure they face and share their feelings. The influence of social media networks become a major technical aspect to control the human lifestyle.[2] Music is a universal language that can help people to relax their souls in a complicated life schedule. [3]Quality music can heal someone's pain and keep them happy throughout the day with a happy mood. The taste of music can be different from person to person. Even Though music can be used as a treatment for issues like dementia. [4] With the development of technology, the current lifestyle has turned out to be more complex and busier. Children must pay attention to their studies until the end of their educational career. After that, they have to engage in higher studies which brings much tension to their mind while the employers have to work with a stressful schedule in their workplaces. Human beings can be suffering from serious traumatic situations due to this busy life schedule. Though mental pressure cannot be considered as a serious illness it can be the root problems such as Depression. In this kind of situation, Music will be the best medicine [5] Music and emotions have a very close relationship since music can completely change the feelings and emotions of a person. [6] [7] Emotions can be a very sensitive aspect of different personalities. So, when suggesting a song, it should be very carefully selected.

1.2. Problem and Motivation

With modern complex lifestyle, people always try to be relaxed. Listening to music is one of the popular methods to relieve stress and have a fresh start. They must search for quality music to listen to and heal themselves. Music recommendation systems have been helped in various stages of people and suggest them a various range of music. Some