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Name: **Samarasinghe Methmal**
Student Reference Number: **10898561**

Module Code: **PUSL3190**	Module Name: **Computing Project**
Coursework Title: **Project Proposal**	
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Programme: **BSc. (Hons) Software Engineering**	

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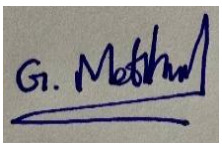
Signed: 

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UNIVERSITY OF PLYMOUTH

PUSL3190 – Computing Project

Project Proposal

MoodSync - Mental Health Monitoring System

Supervisor: Mr. Gayan Perera

Name: Samarasinghe Methmal

Plymouth Index Number: 10898561

Degree Program: BSc. (Hons) Software Engineering

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Chapter 1 – Problem Statement

Mental health problems are highly active in Sri Lanka, affecting people of various demographics. According to a research study conducted by the Centers for Disease Control and Prevention (CDC), over 1 in 5 people experience mental health-related disorders at some point in their lives, mostly with disorders such as anxiety and depression being common *(Centers for Disease Control and Prevention, 2024).* Moreover, the social stigma associated with mental health can discourage people from seeking health from professionals, leading to untreated conditions that get severe with time which can lead to a loss of life.

In past years, prioritizing effective mental health through support systems has gained recognition. Despite the existence of different mental health resources, many people remain unaware of the available support and are unable to access it due to regional and economic barriers. Many of the population lacks mental health professionals, mostly in rural areas like Anuradhapura, Badulla districts, etc. where healthcare infrastructure is mostly limited. In addition, traditional ways of treating mental health problems such as in-person consultation can be intimidating as they are hesitating to discuss their feelings and matters openly. This hesitation is worsened by cultural attitudes that view mental health problems as a display of weakness and shame.

Current mental health applications and resources fail to address the unique needs of Sri Lankans. Many existing solutions are not designed to address needs in the local context, and they lack regionally relevant content and support. Due to this reason, the existing systems fall short of providing personalized mental health recommendations or connecting mental health professionals to the users. As a result of this issue, people find it difficult to seek help and use the existing resources effectively.

The lack of fully developed mental health monitoring tools heightens these challenges. Many people do not have a way to understand feelings, track their moods, or get immediate support when needed. Without the ability to monitor mental health, users struggle to know the patterns that could display the worsening conditions. Additionally,

there is a need for a system to provide anonymity, allowing people to discuss their problems openly without any fear or judgment.

In this given background, there is a higher need for a mental health monitoring system that uses advanced technology to provide personalized and accessible support for people in Sri Lanka. This system will use sentiment analysis and mood predictions based on user input, where users can identify their mental health much better. By filling the gap between users and mental health professionals, this system's main goal is to create a supportive surrounding and encourage users to get help and improve their mental wellbeing.

In conclusion, the current mental health support in Sri Lanka needs a good solution that addresses these challenges as mentioned above. By developing a mental health monitoring system that focuses on accessibility, personalization, and anonymity, this project aims to contribute positively to the mental health landscape and encourage users to have better mental health and awareness.

Chapter 2 – Project Description

The main goal of this proposed mental health monitoring system is to provide an innovative platform that uses modern technologies to improve mental health support for users in Sri Lanka. By using sentiment analysis and mood predictions based on user inputs, this system helps users track their daily mental well-being, connect with mental health professionals, and get access to unique and personalized coping plans. This project aims to create user-friendly web and mobile applications that provide users anonymity, real-time alerts for loved ones and get access to motivational quotes and resources.

Objectives:

1. **User-Friendly Application** – The main objective is to create an intuitive web application that allows users to easily log their moods and sentiments through social media posts, text inputs, and other interactive ways. The user interface will be designed so that users will be encouraged for daily engagement and simplify the tracking progress with graphical visualizations.

2. **Sentiment Analysis and Mood Tracking Models** – This system will use Natural Language Processing (NLP) libraries, combined with machine learning algorithms that analyze user inputs via social media or normal text to mood prediction and sentiment detection. This analysis will provide user their unique and personalized insights considering their emotional patterns.

3. **Provides connections with Mental Health Professionals** – This application will have a directory of the best mental health professionals which will allow users to connect with based on their needs and available hospital locations with times for channeling with ease.

4. **Unique Recommendations** – From analyzed user data, this system will provide mental health recommendations and coping steps. These may include mind exercises, resources for reading, and targets to promote effective mental health management.

5. **Real-Time Alert System** – This project will have a feature that lets users set up emergency contacts where users will receive an SMS if their mental health condition gets considerably negative / worse based on the output score. This

functionality would prevent self-harm and ensure support from the user's family and friends when needed.

6. **Health Trends Visualization** – To help users understand their mental health progress, this application will display the represented mood trends and sentiment analysis. Graphs and charts will allow the user to see the changes over time, encouraging personal awareness and reflection.

Project Keywords: Mental Health, Sentiment Analysis, Natural Language Processing (NLP) in Mental Health, Mood Tracking and Mental Health Technology.

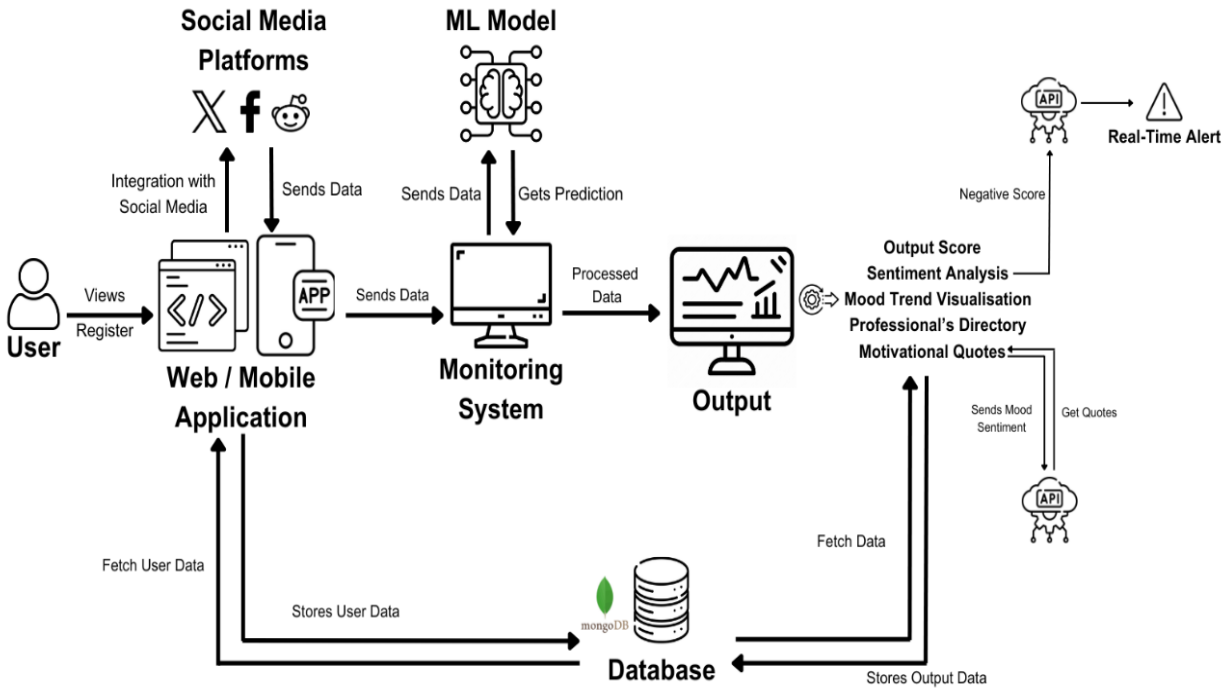

Figure 1: System Design

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Chapter 3 – Research Gap

Research and literature reviews conducted show that this field of mental health technology has undergone major updates during the past couple of years, with different applications developed to support mental health. However, though there are many solutions for mental health apps and resources, there are notable gaps in addressing the specific needs of users, especially in an underdeveloped country like Sri Lanka and its rural areas.

Existing Solutions and Limitations

According to research studies conducted it shows applications just provide general features like mood tracking and guided meditation, The main examples of applications are Calm, Headspace, and Moodfit. While these applications have made an impact in promoting mental health, they lack cultural relevance and localization, which doesn't encourage user engagement and effectiveness in local areas. Almost every application is developed to tailor to Western audiences failing to address the unique sociocultural dynamics that are present in the current Sri Lankan mental health context.

Additionally, many existing solutions do not offer personalization to users. While sentiment analysis features are working in some applications, they have not trained their models with localized datasets where cultural surrounding plays a massive role in mental health. For instance, Sri Lankan users express their feelings and emotions in a different way than users in Western countries, and existing applications do not address these gaps to be equipped or identify the differences accurately.

1. **Personalized Support** – Most applications don't provide a unique response to users instead they provide a common generic response. To address this gap the

proposed system aims to use advanced machine learning algorithms trained with localized datasets to offer unique personalized responses with an overall score.

2. **Real-Time Support** – Current applications don't have real time support/alerts to users' loved ones in immediate health needs. This proposed system will plan to include real-time alerts using SMS to get immediate support in need.

3. **Cultural Context** – There is a lack of mental health applications that represent users in the Sri Lankan context. The proposed system will address this gap by using local languages and cultural backgrounds in its design and functionalities. By engaging with a mental health professional, this application will be tailored and ensured for local users.

4. **Professional Support** – No application connects mental health professionals with their users, to address this gap the proposed system will showcase the directory list of professionals with times and locations that will be available for channeling.

5. **Anonymity** – Unlike other applications, this proposed system will have a feature to chat with a representative for quick support without exposing the user as it cuts off the user's fear of getting support.

Literature Review

This literature review consists of 11 modern research papers used to identify the research gap as mentioned above.

This research paper explores the recent upgradation of machine learning and natural language processing (NLP) that has improved capacity in mental health monitoring through sentiment analysis on social media platforms such as X. The usage of X's large and complex datasets provides valuable insights into public sentiments facilitating timely responses to health crises. Within mental health, it has been seen that sentiment analysis has become a critical tool. This paper shows that traditional machine learning techniques like SVM and Naïve Bayes efficiently analyze user sentiments in real time though there have been challenges with slang and informal languages which is relatively common in a social media platform like X. Recent studies have clearly shown that deep learning models like Long Short Term Memory networks, which improve sentiment analysis by complex feature extraction. Although advancements have been made, according to this research paper there are gaps in research of sentiment analysis. The framework proposed by the authors shows the importance of historical tweets but hasn't done an in-depth analysis though they highlight more significant predictions regarding users' mental health. As a solution to in-depth analysis and to fill this gap, we could get the tweets data from users who are mentally suffering state and come up with identifying more accurate patterns to predict effectively. Finally, this research paper underscores the need for user-driven data collection methods to improve data reliability and to provide cloud-based solutions for mental health monitoring *(Hinduja et al., 2022).*

This advanced research study named "Machine Learning Techniques for Prediction of Mental Health" explores the way machine learning algorithms can be applied to predict current mental health status by gathering different attributes like financial and household data. Machine learning techniques have shown good results in detecting mental health issues earlier, the authors have used different datasets to identify the patterns that have been missed using the normal traditional methods. The authors have used many algorithms like Decision Tree, Random Forest, Support Vector Machine (SVM), Naive Bayes, Logistic Regression, XGBoost, Gradient Boosting Classifier, and Artificial Neural Networks to enhance the accuracy in predicting mental health. This dataset that has been used contains 76 attributes in total and the data has been split into a 70/30 ratio for training and testing. It included metrics like Precision, F1 Score, and false negative rate and accuracy. Among these algorithms, SVM has achieved a good overall accuracy of

87.38% whereas Gradient Boosting Classifier has obtained the highest F1 score showing a balanced precision. Naïve Bayes achieved a lesser accuracy of all algorithms which is 21.67% assuming that it has feature independence and is not suitable for big and complex datasets. This analysis clearly shows that SVM is the most ideal algorithm with high accuracy performed with data as no other algorithm has this level of accuracy. However, there are gaps identified in this research where there is no mention about imbalanced dataset which can be identified to improve model performances more. To fill this gap synthetic data can be used representing minority class for more balanced dataset. The findings from the research study indicate that machine learning techniques can be effectively used in mental health predictions though future research should aim more to improve the model to have a good performance. *(Jain et al., 2021).*

Another research study by Vidhi Mody highlights AI/ML-based approaches for identifying mental health issues, focusing on methods like multi-view clustering, expert systems, and wearable sensor integration. This paper shows how impactful physiological signals and smartphone data can be in detecting early mental issues such as stress, using techniques like fuzzy logic and multi-view bi-clustering. This paper showcases multi-view learning by combining perspectives like average activity, daily trends, and location variability resulting in an overall prediction of 87.1% accuracy. However, simpler classifiers like linear naïve Bayes were used in stress detection and achieved a lower accuracy of 80% which models can be improved more. The study highlights that current expert systems utilize rule-based reasoning and fuzzy genetic algorithms (fuzzy-GA) for identifying and planning treatments. These systems aim to mimic decision-making and provide personalized and therapeutic recommendations. This algorithm shows moderate accuracy and has limitations in boundary cases compared with the results obtained, where unreliability is often seen in the table of results. Although there is an algorithm upgrade, there is a gap in integrating multiple AI methodologies for diagnostic systems. The discussed existing methods have limitations in precision, which this proposed product will address with good precision and adaptability to evolving user states. My product will address this gap using an advanced machine learning model using traditional expert systems and to improve conditional handling well. This proposed product will be integrated with feedback and

overall scores to deliver effective and personalized mental health recommendations *(Mody, 2019)*.

Another paper shows the progression made through machine learning algorithms and the way wearable devices help in detecting mental health disorders such as depression and anxiety, however there are gaps in these existing methods. This research study highlights a good accuracy rate in detecting health symptoms with the aid of KNN – K Nearest Neighbor, SVM – Support Vector Machines, and Naïve Bayes algorithms. However, most models are trained in controlled environments, making it overlook the real-world applicability of certain socio-economic conditions and cultural contexts, which affect the reliability of the product and mental health patterns, to fill this gap the proposed product will endorse the Sri Lankan local context. Additionally, the previous models have shown a limitation of scalability and practical issues when applied to resource-constrained settings which would have been better if continuous and real-time monitoring were used. However, the integration of these devices is challenging for low-income regions in Asia as the cost is high. This research shows how models and wearables can be utilized for impactful mental health detection *(Kumar et al., 2021).*

Another research study conducted does a systematic review of examining machine learning applications in detecting mental health issues, with a focus on features, classifiers, and challenges faced with using these methods. This review shows the key techniques used in mental health detection such as feature extraction models like TF-IDF, Word2Vec, and N-Gram models as well as supervised machine learning techniques like SVM, logistic regression, and decision trees. The study shows a gap in handling data sparsity, multilingual content, and privacy constraints, especially for datasets sourced from Online Social Networks (OSNs). Though machine learning provides solutions to these concerns, there are issues like biased data, data preprocessing, generalizability, and model interpretation remain significant obstacles. To address this gap, the proposed system will include localized data gathered from trusted government sources that eliminate biased data. Overall, the authors provide a review emphasizing the need for a good reliable model that addresses these challenges to improve health predictions *(Rahman et al., 2020).*

This paper demonstrates the effectiveness of Machine Learning models, specifically SVM and XGBoost, in categorizing depression-related content from social media platforms. The authors show that SVM is highlighted above all other algorithms in terms of its high precision, making it the most reliable algorithm for mental health monitoring. However, the advancements gaps remain with the interpretability of ML models, especially concerning the language use of social media platforms which can lead to errors and misclassifications. Additionally, the class imbalance raises a challenge, which limits the generalization of the findings across user populations. Compared with previous research studies they have not shown a consideration in integrating a Large Language Model (LLM) which could've enhanced accuracy and understanding. To address these gaps as mentioned above the proposed system will be focused on an ML model ensuring a good performance in mental health detection indicators minimizing bias data *(Shatte, Hutchinson and Teague, 2019).*

In this advanced study, the authors have emphasized the recent upgradation of Natural Language Processing (NLP) has made the way for innovative approaches to mental health analysis through social media. Traditional methods of mental health monitoring depend on face-to-face interviews which are not different from everyday emotional expressions found online. This paper has focused more on using ML techniques to classify emotions and states by user-generated content. For instance, the authors used a supervised algorithm to identify mental health indicators in social media posts and achieved good results. Similarly, it also demonstrated the effectiveness of deep learning models in identifying anxiety and depression-related content, highlighting the capability of automated systems in detecting real-time mental health status. Apart from these upgrades, gaps remain in interpretability of ML models and their generalizability from diverse populations. It is to be seen that these authors' main goal was to improve accuracy however they have missed addressing underlying reasons for misclassifications. This study aims to use LLM-large language models with SVM – Support Vector Machines to improve accuracy in stress-related posts. However, this is not the ideal solution as they lack generalizability of the findings though models accuracy is good, in the proposed project, it will closely align to cultural context. In addition, the model outputs will be analyzed to identify language indicators that cause mental distress thus completing the

gap between accuracy and practical interpretation. This research carried out highlights the advanced technical possibilities in mental health analysis and contributes to a good system design before development. *(Radwan et al., 2024)*.

An advanced study carried out by Ruba Skaik and Diana Inkpen from University of Ottawa shows the use of social media for real-time mental health surveillance and they explore the strategies to extract information using social media platforms. The authors discussed the growing trends of people using social media platforms such as X, Reddit, and Facebook capturing public user sentiment and identifying early warnings of related mental health issues such as anxiety, depression, and suicidal thoughts. This review shows the searches into different techniques used to extract and analyze obtained social media data, with a focus on techniques like Natural Language Processing (NLP) and Machine Learning. Further, these methods use sentiment analysis and modeling to break down topics to classify user-uploaded posts by mental health categories, which helps to detect the user's symptoms related to the disorder. The authors has considered more about detection speed in the approach which is a gap because it lacks longitudinal data analysis where in the proposed solution it will be addressed by using longitudinal analysis to get a understanding of crisis points and mental health trends more accurately. The authors further point out the advantages of using social media platforms for mental health detection. This is carried out by storing large amounts of data from the user over a period of time, which allows for the detection of disorders faster than traditional methods like surveys and clinical exercises. This research paper also discusses privacy concerns and the difficulty of ensuring the reliability of data to train the ML models, However there is gap of not considering how user respond to the model and there is no professional experience tailored in training the model, to address this gap constant user feedback will be taken in development of ML model making it more user centric backed by a professional. The authors seems more concerned about the ethical rules of collecting social media data and discuss other researchers to ensure the privacy protections of users and if data is collected responsibly. This review highlights how social media can be used to predict a user's mental health using techniques like NLP and ML models instead of old traditional methods. However, these authors suggest protecting privacy and checking the accuracy of the data obtained. *(Skaik and Inkpen, 2021).*

This research study highlights a review of existing approaches to mental health monitoring and shows a special importance on sentiment analysis and machine learning for mood tracking and predictions. This research paper shows the effectiveness of various ML models in understanding users emotional states by social media and other inputs. However, these solutions are mostly tailored to western user context limiting its applicability. While these models use sentiment analysis, very few integrate real time support system for user's needs, mostly in developing country like Sri Lanka. This research study lacks a approach of combining sentiment analysis and support mechanisms. By addressing the above-mentioned gaps could enhance the effectiveness of the proposed mental health monitoring system. By developing a cultural framework that has real time alerts and mental health advice can contribute to a better health care solution. *(Alanazi et al., 2022).*

This research paper shows the use of machine learning and Arduino on mental health monitoring systems with important metrics like precision, accuracy, and sensitivity. The authors got a 96.6% higher accuracy rate in stress detection, showcasing the model's effectiveness with sensor integration with machine learning to obtain real-time health insights. However, there are gaps identified as there are different health conditions that are not limited to stress, where advanced machine learning and deep neural networks should be used. Additionally, integrating Natural Language Processing (NLP) could allow systems to interpret sentiments and interactions more deeply to offer personalized insights. By addressing these mentioned gaps, additional research would enhance monitoring systems facilitating early detection. Also, the models should be tested in a cultural context like in Sri Lanka, which would add depth where tools should be accurate and culturally sensitive to have a higher impact on the end product *(VENKATARAMANAIAH et al., 2024).*

This research study showcases a different transfer learning framework being used for mental health monitoring and the importance of stress detection as a case study. The integration of transfer learning addresses gaps in existing mental health monitoring methods, which raises consideration of data privacy and insufficiency. Previously conducted research suggested that the use of federated learning techniques causes

attacks and threats to vulnerability, limiting effectiveness for real-world scenarios. In addition, the existing models struggle with limited culture-specific training data leading to bad performance in models. The authors address issues by pre-training on large randomly picked datasets where it is obtained before getting tuned with user-specific data, if it is done therefore the model can be enhanced while protecting users' privacy. However, more exploration and tests should be conducted to ensure the scalability of this framework across diverse users and its various mental health conditions like depression to maximize utility in mental health monitoring practices *(Wang et al., 2024).*

Chapter 4 – Requirements Analysis

A full-scale requirements analysis is essential to the development of this project. This analysis includes technical, functional, and non-functional requirements, as well as the knowledge and skills needed to deliver the end product successfully.

Technical Requirements

1. **Programming Languages and Frameworks:**

    - **Python** - This is the main language that will be used in this project to complete the backend development. I will use different libraries for sentiment analysis and machine learning models.

    - **JavaScript** - This language is used to develop the application's front end using the MERN Stack web framework (MongoDB, Express.js, React.js, and Node.js). React Native framework will be used to develop the mobile application. In addition, chart and graphs libraries will be used.

- **HTML and CSS** – This will be used for structuring content and for the styling of web applications to ensure a user-friendly interface. Tailwind CSS open-source CSS framework will be also used to enhance styling**.**

2. **NLP Libraries:**

    - **NLTK (Natural Language Toolkit)** – Mainly will be used for language processing tasks and tokenization.

    - **spaCy** – Will be used for advanced features like analyzing user's input and for efficient processing.

    - **scikit-learn** – To develop machine learning algorithms for mood predictions and sentiment analysis.

3. **Database Management:**

    - **MongoDB** – Using a NoSQL database that will store user information such as user profile data, analysis results, and mood track data for efficient information management and retrieval.

4. **Data Visualization Tools:**

    - **Chart.js / D3.js** – Use of JavaScript libraries for data visualization such as charts and graphs to visualize sentiment analysis and mood trends over time.

5. **API's:**

    - **Health Data API** – To provide mental health information to enhance application functionality and for offering valuable content for users.

    - **Quotable API** – API planning to fetch motivational quotes.

Knowledge Requirements

1. **Machine Learning and Data Analysis** – Knowing machine learning techniques such as supervised learning techniques for sentiment analysis and model development.

2. **Natural Language Processing** - Knowing NLP techniques to process and analyze user inputs for sentiment detection.

3. **Applications Development** – Experienced in MERN Stack web framework and React Native for frontend and backend development with other services.

4. **User Experience (UX) Design** – Knowing design principles and applying best UX practices to create a good user experience.

Functional Requirements

1. **User Authentication** – Users should be able to create an account and log in securely.

2. **Mood Logging** – Users should be able to provide text inputs for sentiment analysis and have the capability to log their moods.

3. **Sentiment Analysis** – This system will provide feedback on mental health state by automatically analyzing user inputs.

4. **Professional Directory** – A feature that allows users to see the best mental health professionals and provide their hospital locations and times they're available for channeling.

5. **Emergency Alerts** – Users should be able to set up an emergency contact so that they will receive an SMS alert if the user's condition gets worse to prevent self-harm.

6. **Recommendation System** – With analysis done, the app should suggest personalized coping strategies.

7. **Data Visualization** – Users should be able to view their sentiment analysis and mood trends through interactive charts and graphs.

8. **Motivational Quotes** – Daily personalized motivational quotes will be displayed to the user for motivation.

Non-Functional Requirements

1. **Security:**
    - User's privacy should be ensured with login and health data.

2. **Performance:**
    - The system should be able to handle many users without any latency issues.
    - Sentiment analysis results should be delivered within less than five seconds after user submission.

3. **Reliability:**
    - The system should be reliable with good uptime and minimal disruptions.
    - Real-time alerts should be delivered without a delay.

4. **Usability:**
    - The dashboard and other user interfaces should be simple and easy to navigate.
    - The application should have English and Sinhala languages to represent Sri Lankan users.

Special Devices: *No special devices will be used in this project.*

Chapter 5 – Finance

Free Tiers / Plans

- **Jet Brains PyCharm (Professional Edition)** – It's a Python IDE where project backend and models will be developed. Facilitated by University of Plymouth student account credentials for up to a year.

- **X, Reddit, and Facebook API's.**

- **Amazon Web Service (EC2)** – Hosting service. One instance, 750 Hours for 30 Days Free.

There will be no finance/budget involved to complete this project as free tiers and open-source software / tools are adequate. However, for the data collection from Psychiatrists and External organizations may charge a fee of less than LKR 5,000 (£13.10). It will be covered by my personal funds.

Chapter 6 – External Organizations

Successful completion of this project depends on collaboration with organizations and stakeholders. The below content outlines the external organizations that may contribute to data collection and any additional support with insights that may contribute to successful project completion.

1. **Mental Health Clinics and Professionals**

    - **Local Hospital Clinics** – Planning to partner with mental health clinics that will provide data to access mental health professionals who also can support providing critical insights. This information certifies an accurate and reliable system that is developed from a professional's perspective to tailor the patients/users.

    - **Psychiatrists** – Collaborating with a licensed mental health doctor to develop the recommendations feature and content in the application. They can assist in validating parameters of sentiment analysis algorithm development in the project and make sure that coping steps are evidence-based and approved by a professional before development.

2. **Organizations**

Sri Lanka Sumithrayo / Sri Lankan Mental Health Foundation – Planning to get localized data from these government organizations. These organizations work to promote mental health care and provide support to people suffering from mental health illnesses.

Psychiatrist Information (Confirmed):

- Dr. Saman Weerawardhane – (MBBS) Psychiatrist / Mental Health Specialist.
  National Institute of Mental Health (NIMH)
  NIMH, Mulleriyawa New Town, Angoda

Details of the Local Hospital (Data Collection):

- Mana Suwa Piyasa (මන සුව පියස) – Mental Health Clinic
  Colombo South Teaching Hospital – Kalubowila
  B229 Hospital Rd, Dehiwala-Mount Lavinia 10350

Chapter 7 – Time Frame / Timeline

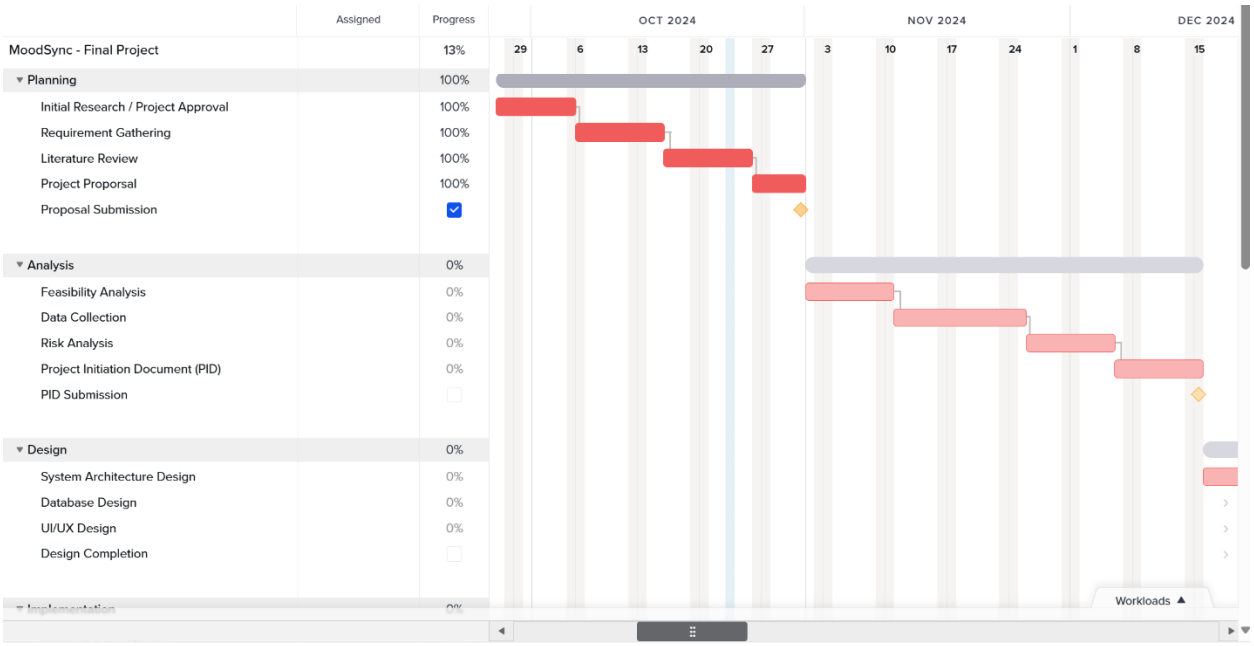

Figure 2: Gantt Chart (1)

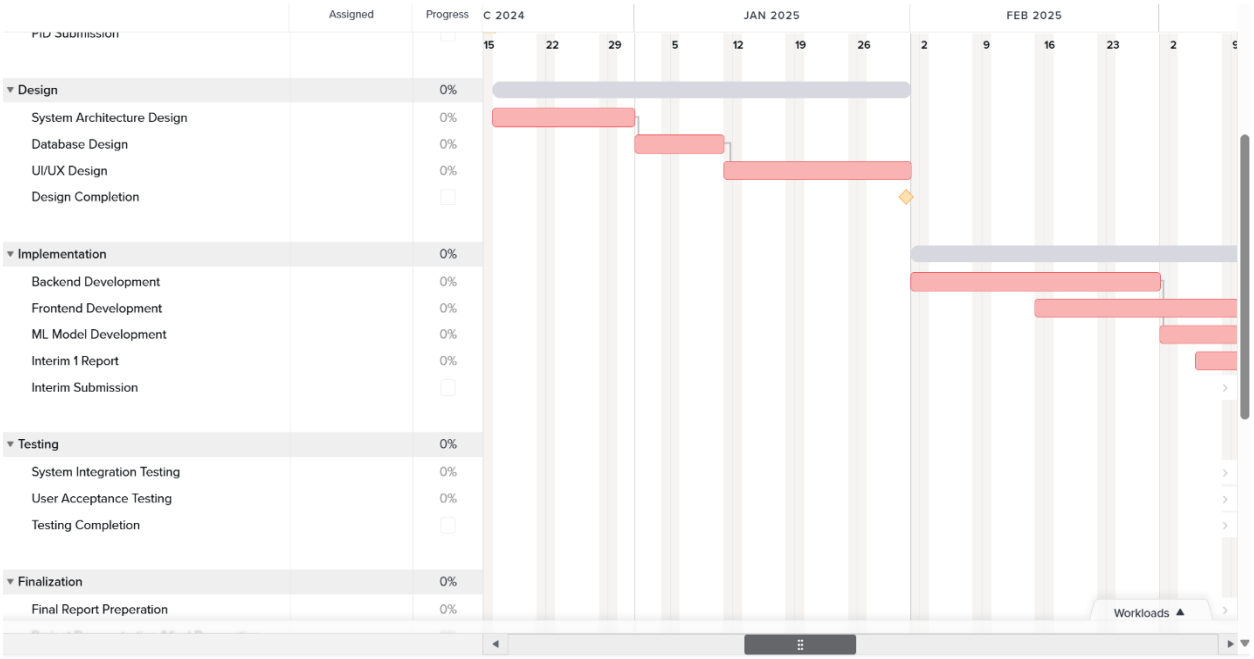

Figure 3: Gantt Chart (2)

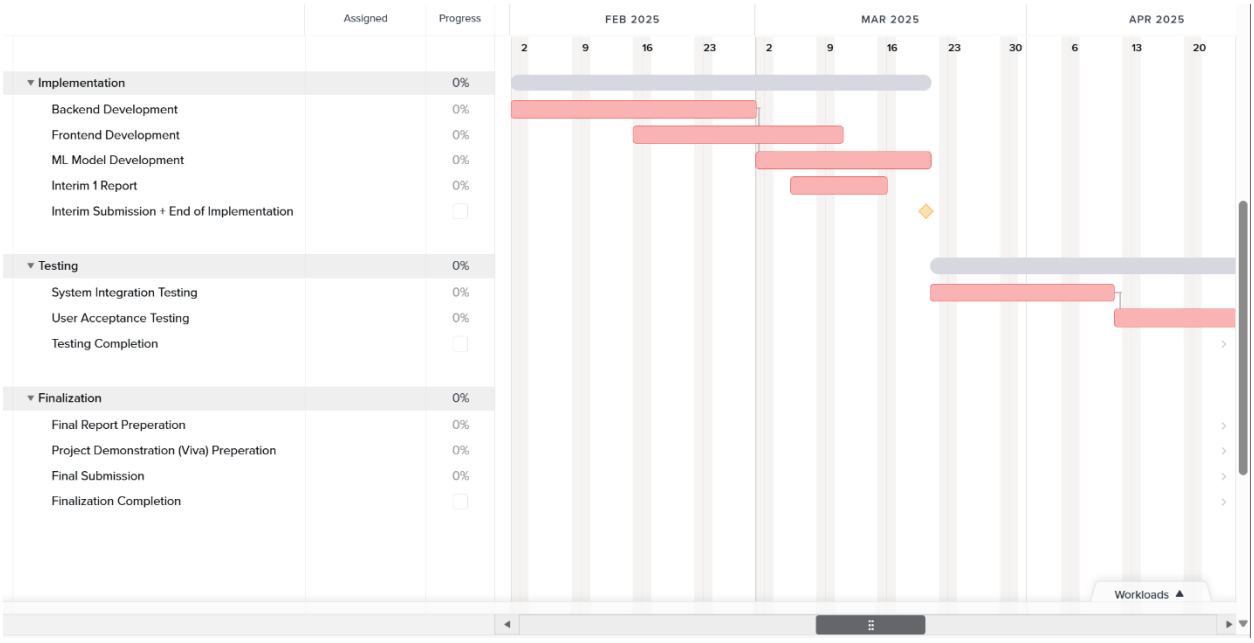

Figure 4: Gantt Chart (3)

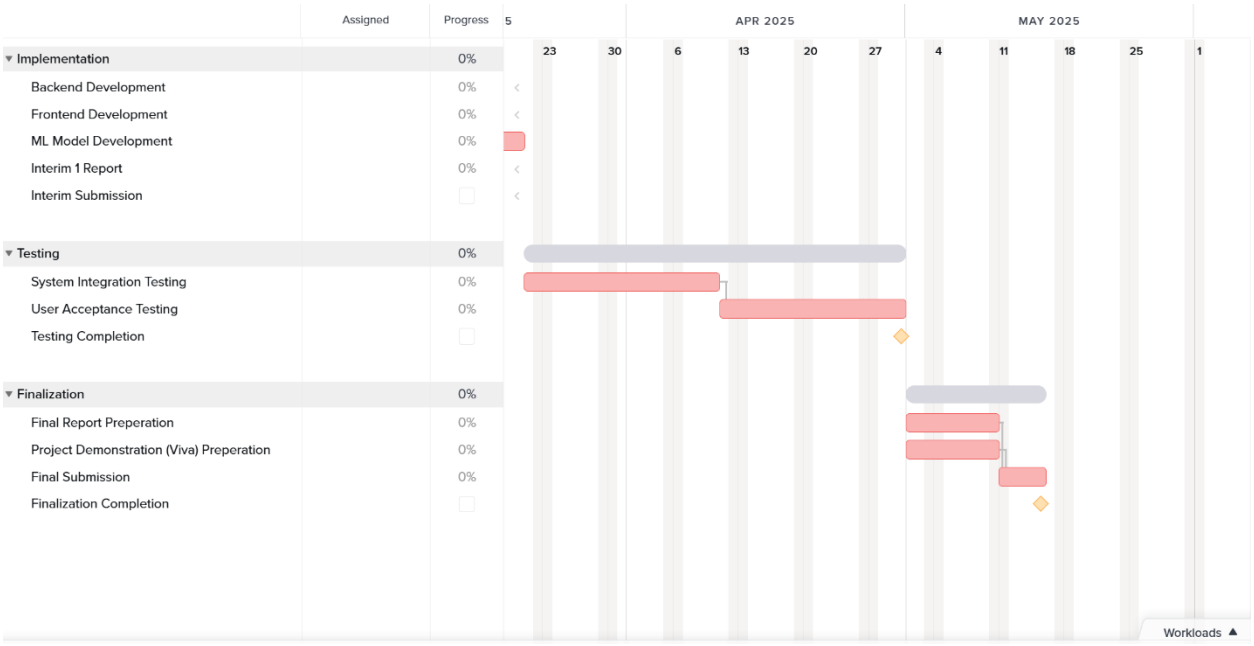

Figure 5: Gantt Chart (4)

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