

**BEHAVIOR ANALYSIS FOR DEPRESSION
DETECTION.**

Project Id: 2021-073

Project Proposal Report

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B.Sc. (Hons) Degree in Information Technology Specialized in
Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

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Dr. Pradeepa Samarasinghe

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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The supervisor/s should certify the proposal report with the following declaration. The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

.....

Signature of the Supervisor:

[Dr. Pradeepa Samarasinghe]

.....

Date

.....

Signature of the Co-Supervisor:

[Ms. Vijani Piyawardana]

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Date

ABSTRACT

Depression disorder is (dd) mental health disorder that has been affecting worldwide people. When it comes to long-lasting and severe stage depression become a serious health condition that causes suicides. Therefore, identifying depression with an individual's behavioral changes in the early stages is crucial. The methods used to identify depression patients are not been updated with new technologies. On a clinical basis still uses self-report assessments like surveys, questioners, or daily diaries. Consequently, accuracy and reliability can have limitations with the above methods. In Sri Lanka there is another concern, we should focus on that is social negative opinions towards mental health disorders. Therefore, individuals tend to hide their symptoms, avoiding meeting a doctor can become common.

There are ae mobile applications that have been developed for a solution as track individual with new methods and give possible solutions and activities for depressed individuals. Yet there is a chance that we can develop applications with more deep analyzing methods and possible depression identification parameters.

The proposed research paper aims to develop a mobile application for adolescents in order to analyze the unexpected behavior changes that might have a high chance of having depression. The result will be evaluated by tracking an individual's phone usage data and the machine learning algorithms will use unexpected behavior analysis.

Keywords: depression disorder, machine learning, mobile phone usage data analysis, mobile application

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1. INTRODUCTION

In society, depression has become a common mental health disorder. Worldwide more than 264 million people of all ages suffer from depression [1]. The disorder is most common among the 18 – 29 age group which is 21.0% [2]. Last long symptoms and severe stage depression are cause for suicide. With these conditions it is crucial to identify individuals that suffer from depression in the early stages, however, methods that identify depression has been designed more than 50 years ago which are face to face interviews, structured interviews conducted by clinical professionals But last decade researches have shown interest in understanding depression connections with technological growth because the technological impact on a daily basis is getting more absolute. Researchers have proved with few longitudinal studies' bidirectional associations between mobile phone addiction depression [3] [4]. therefore, individuals can be recognized using an individual's phone usage activities since depression and phone addiction are bidirectional factors.

Phone usage addiction can depend on the frequency and time spent on mobile phones therefore Several studies have found relationships between the frequency or duration of mobile phone use and mobile phone addiction [5] [6]. 49.0 % which is more than 3.80 billion people active daily on social medial to keep relationships, access information, and for leisure there for social media directly shows impact our emotions. studies have found a positive relationship between social media addiction and depression, social media usage, and depression [7] [8]. When we consider phone usage late-night phone usage as another special area, we should consider researchers have found mantel health of teens that use late at night is at risk [9]. When we try to accomplish identify early depression by behavioral changes using phone usage, we must acknowledge social media use, late-night phone usage as important parameters.

1.1 Background & Literature survey

Studies have proved that high phone usage among students and depression links together positively, some of them are studied by Kadir Demirci et al. “Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students” [10], The research “Relationship between the Manner of Mobile Phone Use and Depression, Anxiety, and Stress in University Students” by Aleksandar Višnjić, Vladica Veličković et al. [11] and the study by Sara Thomée et al. “Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults” [12].

Furthermore, the School of Health and Social Development, Deakin University has researched to evaluate the relationship between the duration of time spent using the Internet for leisure, depressive symptoms among Australian adolescents they have shown depressive symptoms were most frequent among higher users of the Internet (3 or more hours per day) among females only Compared to adolescents reporting Internet use for two hours or less [13]. Addiction to social media can reflect suffering from depression disorder. The study by Amit Chowdhry shows that compare to people who use social media less frequently participants that use social media very frequently have 2.7 times the likelihood of depression and compared to people that spent less time, participants that spent the most total time on social media throughout the day had 1.7 times the risks of depression [14].

When it comes to app development for depression using phone usage data, we can find a study by Rafail-Evangelos Mastoras¹, Dimitrios Iakovakis¹, et al. track depression using Touchscreen typing pattern analysis data from the “TypeOfMood” app [15]. There is a study from Dartmouth College, USA to tack depression using a mobile phone and wearable they took overuse phone usage from Student Life app as a factor to track depression [16].

In conclusion, most of the existing studies have proposed to prove the link between depression and phone usage and track depression symptoms according to phone usage data acquired using mobile apps. It will be an effective move if we can develop a mobile application that includes phone usage data obtained using phone activities log to behavior analysis for depressive disorder, may help people for self-awareness on the mental health state. In Sri Lanka studies have not been observed that concentrated on a similar approach of automated analysis on depressive disorder identification using unexpected behavioral shifts.

1.2 Research Gap

When we concentrate on previous studies approaches to detect depression the study by Kadir Demirci [10], the study by Aleksandar Višnjić [11], and Sara Thomée studies [12] proved that high phone usage among students and depression links together positively. Furthermore, the research team from Social Development, Deakin University has explored the relationship between the internet and depression symptoms they have. Rafail-Evangelos Mastoras¹ [15] has implemented an app called “TypeOfMood” to track depression. As we can observe most of the studies have been conducted to prove relationships between depression and parameters.

Table (1.1) indicates the summary of previous studies' limitations.

Table 1. 1: Existing study Summary for Depression Detection.

	[10], [11], [12]	[13]	[14]	[15]	Proposed System
Depression analysis based on phone usage pattern.	✗	✗	✓	✓	✓
Collect data without user contribution for the analysis.	✗	✗	✗	✓	✓
Explore the key factors that link depression.	✓	✓	✓	✗	✓
Probability of early depression analysis based on phone usage pattern data.	✗	✗	✗	✗	✓

The apps that have developed considering identify early depression using is really little and most of them have designed only for research data collection purpose.

The app “**PROSIT**” is an app that has been used to gather data for research conducted by Dalhousie University they have collected data through both apps and using self-report from individuals. When it comes to the features of the app it supports track data like exercise, sleep, call frequency, messages, user can self-report the details of the week. The app has only used for the research cannot collect from the app store or the play store [17].

“**App Usage**” is an app developed to control the phone addiction of individuals. The app collects data related to phone usage which are the most used Apps, screen time. Features of the app are Screen time and control mobile use, Control, limit screen time and digital habits, Digital history and Daily usage statistics, and Compare and limit screen time with previous data [18].

The app “**TypeOfMood app**” is developed by Rafail-Evangelos Mastoras et al to track depression using Touchscreen typing pattern analysis. In analysis app to collect data which are key pixel coordinates, timestamps of keypresses and releases, typing metadata (number of deletes, number of characters typed, typing session duration, deliberate long-press events, and the application where the user typed). The app is only used for research purposes can be found in the app store and the play store but not installable [15].

The below table (Table 1.2) indicates the summary of an existing app that related to depression analysis based on phone usage

Table 1. 2: Existing App Summary for Phone Usage.

	PROSIT [17]	App Usage [18]	Type of Mood [15]	Proposed App
Track parameters most related to depression	✓	✓	✓	✓
Collect data without user collaboration	✗	✓	✓	✓
Depression analysis based on Phone usage data	✗	✗	✗	✓
Extensive reports	✓	✗	✓	✓

1.3 Research Problem

Depression has become a common mental health disorder all around the world and most frequent among the younger generation. Academic problems, career achievements, social life, and habits that negatively impact health are some of the reasons for depression. If symptoms could not identify and hidden for long time life damages can occur therefore, identify depression in the early stage is crucial.

Sri Lanka has a huge negative thought toward mental health disorder individuals that suffer from depression commonly moved on hiding symptomatic behaviors and decline the medications with the fear of social scaling towards mental disorders. This problem can be led huge life damages. The methods that have using in clinics include self-assessment reports, interviews, surveys, and questioners, therefore, the accuracy is based on a human since the process is conducted at clinics and hospitals people more likely to avoid visit psychiatrists. On the other hand, people need to identify behavioral changes of depression disorder before visit a psychiatrist because of the poor medical knowledge about depression most people don't have an idea they are suffering from depression or not.

Studies have proved that overuse of mobile phones can lead to depression and also it is a behavioral change of a person who suffers from depression. There are apps that have been designed to collect phone usage data for reach purposes and also Apps have been designed to limit the phone usage of individuals by blocking the overuse of apps and activities.

To address the above issues, it would be effective if we can implement a self-awareness app based on Mobile usage data of individuals using machine learning analysis to identify early-stage depression.

Industrial shortcomings regarding depression disorder can be summaries as below,

- Two-week manual monitoring of individual difficulty.
- Lack of the automated applications that focus on identify early depression disorder using Phone usage data.
- Lack of systems that acquire data without the user's contribution
- Individuals tend to avoid medications due to the negative impact on society.

2. OBJECTIVE

The main objective of the proposed study is to analyze the early signs of behavioral changes that may lead to depressive disorder. The study has focused on developing a mobile application that can identify behavioral changes that could highly possibly contrast with depressive disorder.

1.1 Main Objective

The main objective of the proposed study is to identify the individuals that have a change in the lead to depression disorder based on their phone usage pattern changes.

2.2 Sub Objectives

The main object is dividing into sub-objectives based on the steps to achieve the main objective.

- **Recognize the key factors of phone usage to identify depressive disorder changes.**

There are several parameters that we can use to identify depression using phone usage, but we need to recognize the most important parameters therefore the accuracy of the system will be high.

- **Build a service to run in the mobile in order to log the key factor's data.**

Build service to run on the background of the mobile phone and through the designed app and collect the parameter data that necessary.

- **Based on data build a classifier to model, abnormal phone use based on mobile phone usage.**

After the data preprocess model will be trained with the choose machine learning algorithm in order to understand the abnormal phone usage patterns of the individuals.

- **Predict the probability of abnormal phone use towards depression with the designed model.**

Using the designed model Abnormal behavior towards depression will be predicted. The probability of the analysis will be provided in the designed model.

- **Integrate the classifier to the mobile app.**

The prediction based on phone usage will be serialized and retrieve to the designed mobile application.

Following are the additional objective that needs to proceed the main objective.

- **Implementing interfaces of the mobile application.**

Proposed mobile application interface design and development will consider.

- **Mobile Application development.**

The backend development includes access phone usage data which need to analyze the early depression probability

3. METHODOLOGY

3.1 Introduction

This section explains the implementation methodology in identifying the early depression symptoms. Figure 3.1 depicts the system diagram explaining the way of achieving research objectives.

Collect Data

Time and frequency use on social media and gaming apps and late-night usage will be considered as important parameters. In order to collect data of apps, there is a recognition of available social media and gaming apps installed in the individual's device there for Parameter data will be collected through the designed app from the device using flutter dependencies [19]. When collecting usage of apps background running activities of the apps will be eliminated.

Preprocess

Preprocess is important because in this stage data will be modified into a standard way to carry out the machine learning algorithm [20]. This stage will conduct with subprocess which are

- Select necessary data and collect to separate CSV
- Clean data
 - there are several data cleaning methods therefore select methods and data will be cleaned.

Methods to clean data.

- Delete Rows with Missing Values
 - Replacing with Mean/Median/Mode
 - Assigning A Unique Category
 - Predicting the Missing Values
 - Using Algorithms Which Support Missing Values [21].
- Encode data
 - Trainset splitting
 - Data splitting will be according to industrial Nome which is 8/2. 80% to train the model and 20% for testing. Python machine learning library the “scikit-learn” provides an implementation of the train-test split evaluation procedure [22].

Train the model and prediction.

Feature extraction and storage into a vector is conducted using 80% of data that splatted in the preprocessing stage. Vector is using as a privacy ensuring method because the system is working with confidential data. There are several decision-making algorithms and the most accurate algorithm will be selected after multiple evaluations, After the model training evaluation is managed using 20% testing data. As the last steps

prediction base on phone usage data will be serialized using python object serialization and retrieve to the design app [23].

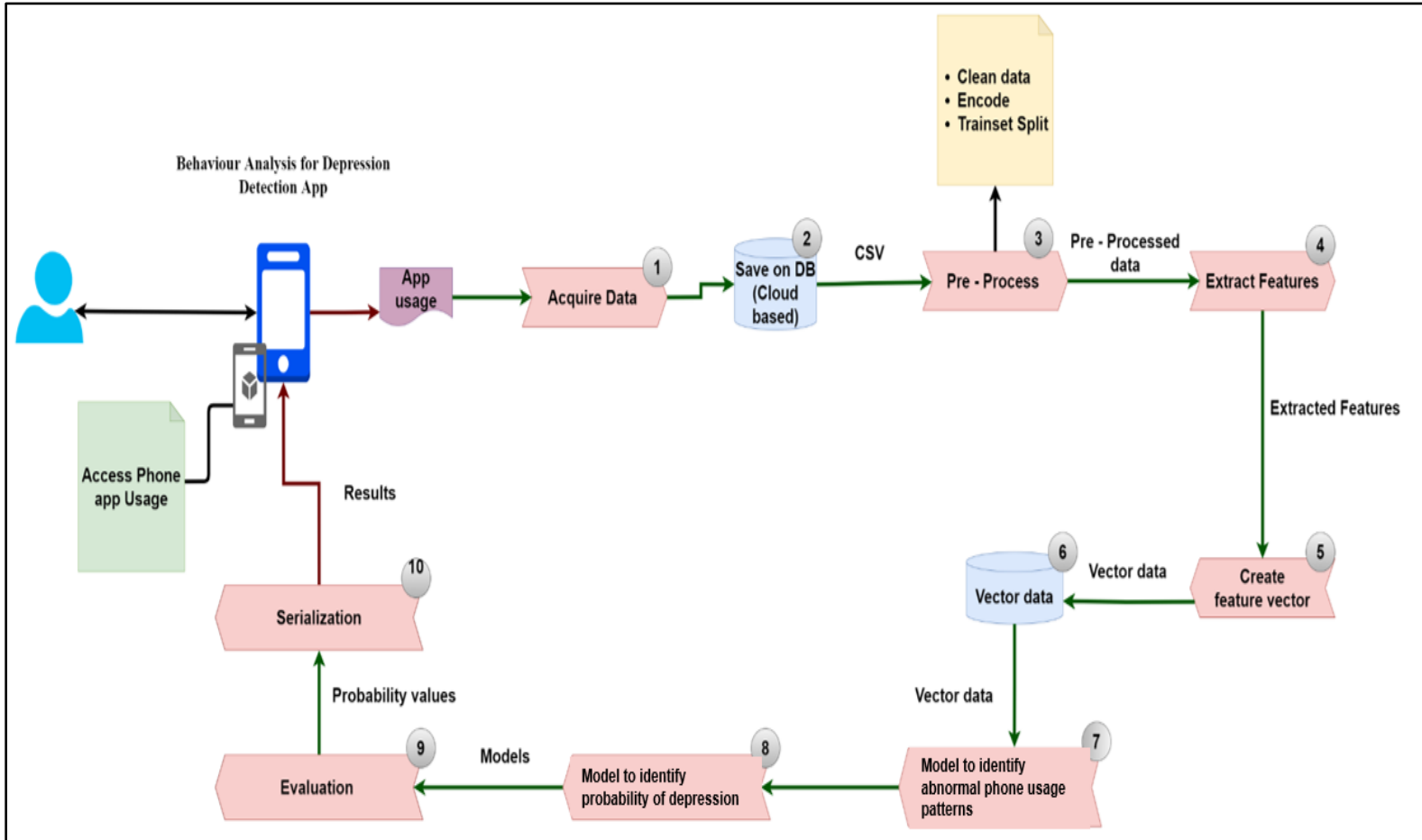


Figure 3. 1: System Diagram of Abnormal Phone Usage analysis.

3.2 Diagram of the Project Flow

The below figure (Figure 3.2) will explain the process of the model training.

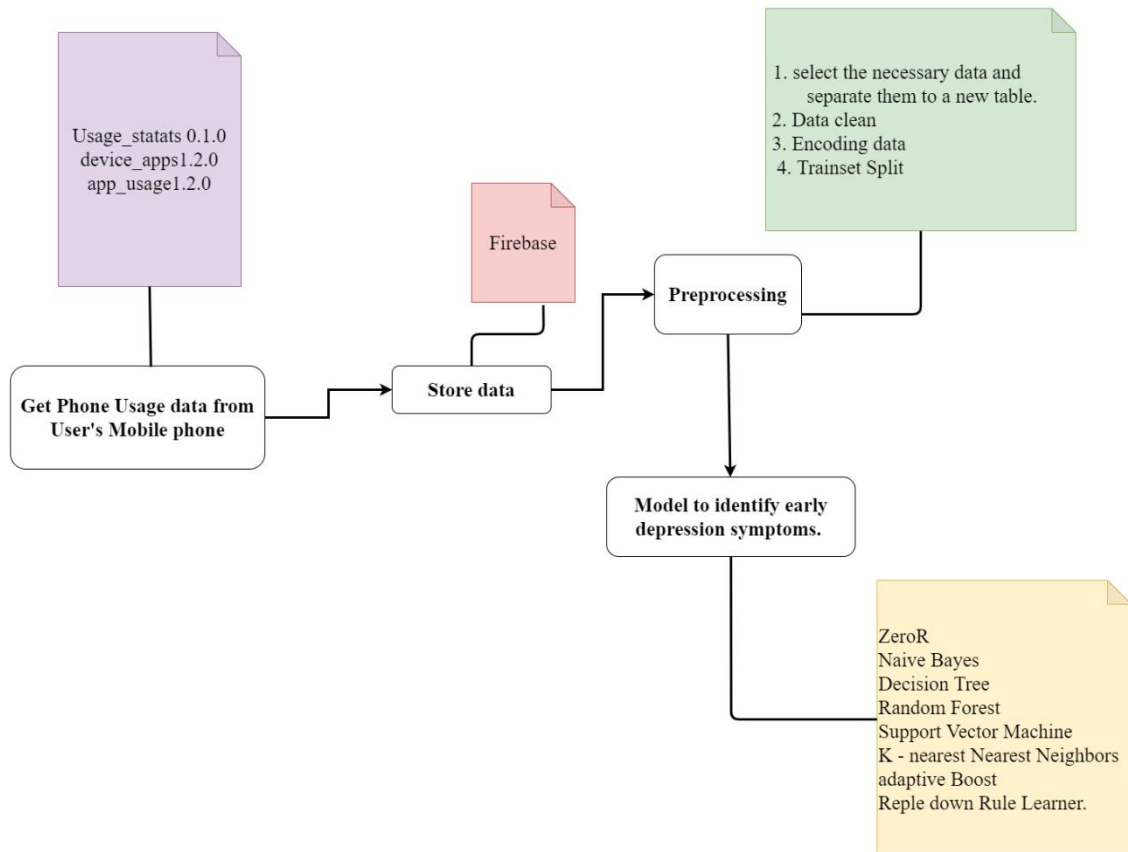


Figure 3. 2: Implementation Process for abnormal phone usage analysis model.

In Figure 3.3. explain the flow of the mobile application for phone usage using interfaces.

Step 01 – User registration process to lunch the application.

Step 02 –Login interface to log into the mobile application.

Step 03 – User agreement for curtain access that is required for the analysis process.

Step 04 –Summarize the accurate track details in the dashboard.

Step 05 – User can check the daily usage and summery.



Figure 3. 3: Mobile Application Flow of Phone Usage.

3.3 Technology

- **System implementation Technology**

Machine learning will be used to train the model to identify early depression disorder based on phone usage.

- **Libraries, tools, technologies need to implementations.**

This section describes the tools, libraries, and programming languages that will use in the proposed system implementation.

Table 3. 1: Technologies, tools, libraries for the proposed system.

Technology	Description.
Flutter & dart	UI development kit and drat is the backend programming language. Open-source Software.
Firebase	A mobile app development platform that acts as the database.
Spyder/Jupyter Notebook	open-source IDE that can perform scientific programming in python.
Python pickle	The module is used to serialize the data from the build model.
Anaconda 3	The environment that used to conduct python processes and manage all requirements for implementation.
Scikit-Learn	Free software machine learning library that use for python and it support clustering, classification, regression and support vector machines.
Python Flask	API for implement endpoints that is a micro web framework written in Python.
Pdfkit	Python library that use to generating PDF document.

3.4 Testing of the System

Performing several test phases like testing, component testing, integration testing, and system testing we can ensure that the designed system has satisfied the requirements that we proposed.

3.4.1 Testing of the Model

Applying test data, we can evaluate the machine learning model performance. The most fundamental approach that can be used for evaluation is classification accuracy.

3.4.2 Testing of the Mobile Application

The proposed mobile application must perform necessary evaluation methods before commercial use therefore we can ensure the application has met the requirements that have been proposed.

- **User interfaces testing** – We can guarantee usability, visibility, consistency, and compatibility of the final application by executing GUI testing on the application.
- **Functionality testing** – The Model analysis accuracy is based on the inputs that acquiring from the mobile application. Therefore, the application must undergo feature testing.

4. PROJECT REQUIREMENTS

In this part, we will be observing the required functionalities of the mobile-based application. Figure 4.1 explains the Gantt chart of the development process and Figure 4.2 shows the work breakdown structure

4.1 Functional Requirements

- Analysis of individual's phone usage data to identify individuals with abnormal behavioral changes toward depression.
- Predict the probability of having early depression symptoms based on analysis of phone usage data collected through the app.
- Users should be able to check a daily summary of His/her daily usage of phone usage.
- Users must provide necessary notifications when accessing the phone data.
- The user should be able to connect warble to the mobile application.
- Generate the comprehensive report summary.
- Notify the guardian or mental health care provider.

4.2 Non-functional requirements

- **Security** – The system must be checking the app's information before getting into collect data.
- **Availability** – The application must gather necessary data (Phone usage data) that require analysis.
- **Reliability** –Phone usage data analysis must highly accurate that provide results about depression.
- **Privacy** - Users' confidential data which is user data and depression analysis information must be protected by the system.

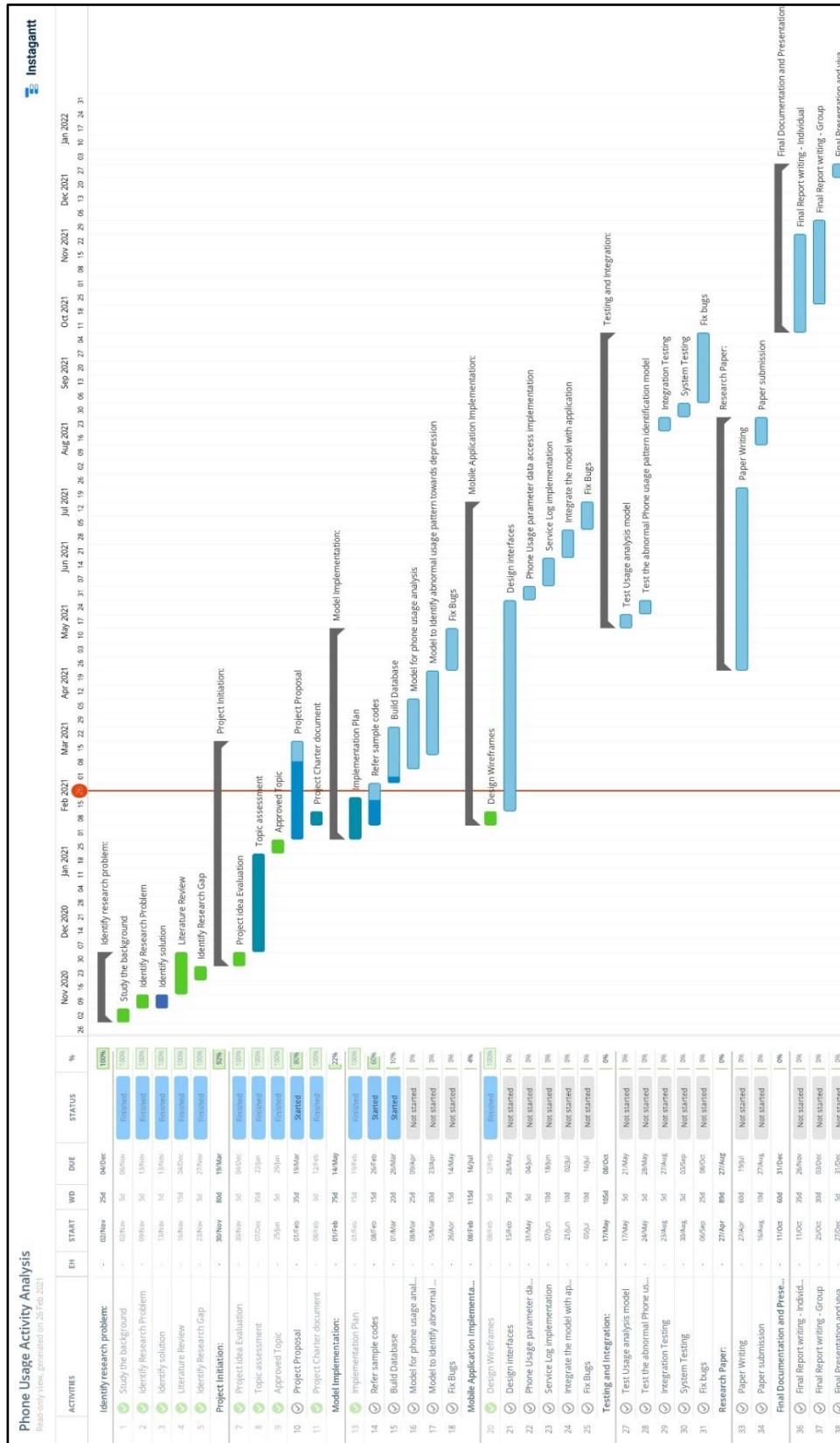


Figure 4. 1: Gantt Chart

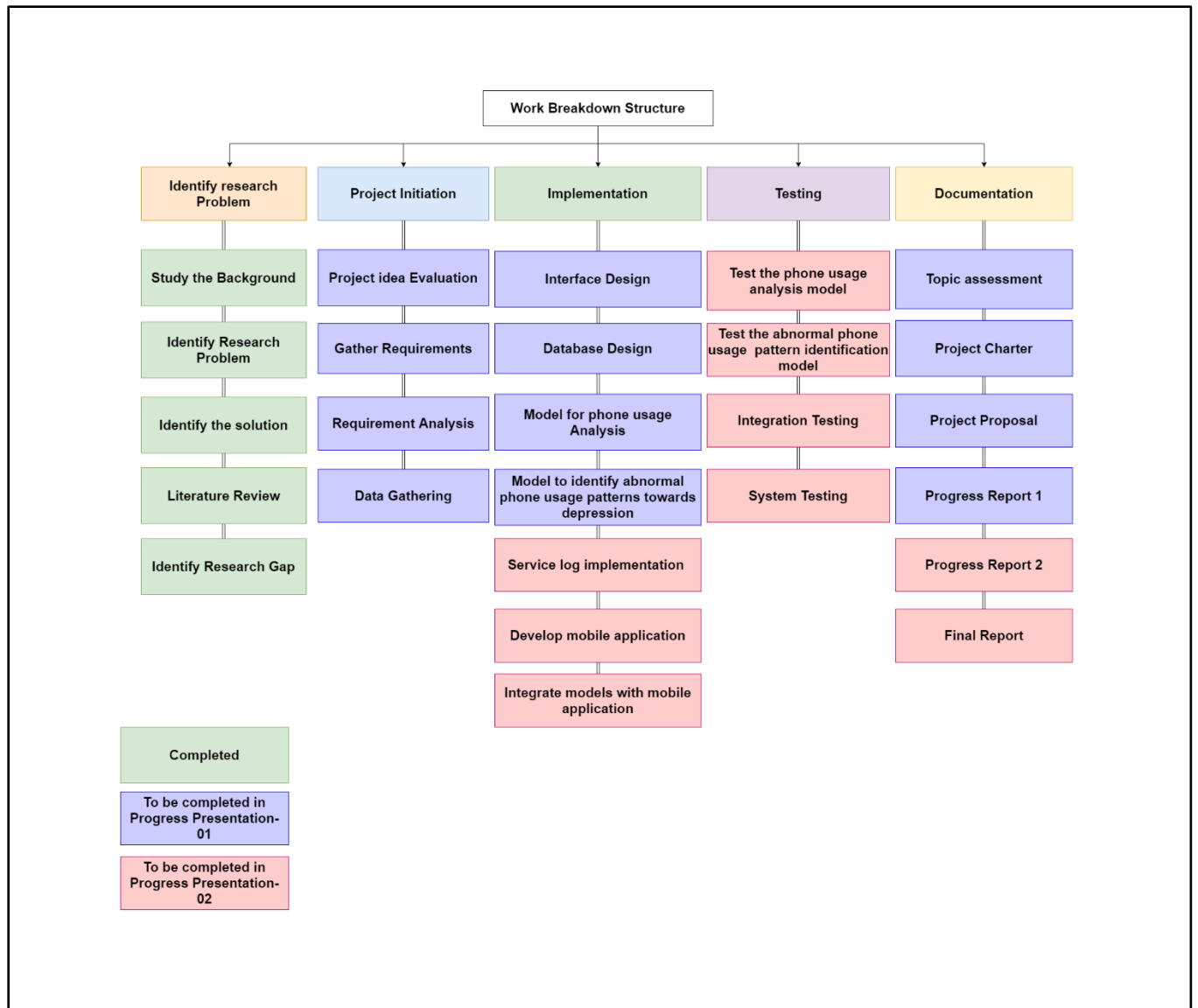


Figure 4. 2: Work Breakdown Structure

5. COMMERCIALIZATION

Monitor abnormal behavioral changes of the individual are crucial to identify early depression symptoms therefore individuals can receive treatment efficiently as well as a high possibility of saving lives that can lead to suicides. However negative society sales toward depression are reason to individuals hide their symptoms and avoid medications.

The proposed system will address individuals' issues and help them to get an understanding about mental health level as not only that system notifies about individual's guardian or health provider about his/ her mental health level. The economic value of the proposed mobile application describes as follows.

5.1 Community Value of the Study.

5.1.1 Public Benefits.

- Daily review about phone usage data that lead to depression.
- A spanned evaluation of behavioral changes without user contribution.
- Two weeks behavioral analysis without user contribution.
- Automated notifications system to notify guardian or health provider about individuals' behavioral analysis.

5.1.2 The Mantel Healthcare Provider Benefits.

- Two weeks of the individual behavioral monitoring.
- Notification about an individual's mental health level.
- Help to start fast medication soon as analysis.
- Comprehensive report regarding user's abnormal behaviors toward depression.

5.2 The Validity of the Research.

5.2.1 The scientific value from the Study.

- Early depression detection based on abnormal phone usage pattern changes towards depression is not yet studied in Sri Lanka.
- Social media usage, mobile gaming app usage pattern analysis identify early depressive symptoms and develop mobile application not been designed.

5.3 Risk and Benefits Assessment

5.3.1 Research Risks.

- Personal information can be disclosed to the public.
 - Personal data use for analysis will be protected.
 - The user's health status and the summary will be only shared with a trusted person that the user allowing.

5.3.2 Research Benefits

- The Whole analysis process will conduct without user involvement.
- The proposed system will Monitor the abnormal behaviors of the patients for high accuracy results.
- The individual can be focused on medication immediately.
- Mental health providers can expand summary about individual's mental health status easily.
- Doctors can use more time on the treatments of the user.

5.4 Confidentiality and privacy

5.4.1 Personal Details

The User information and personal data that collecting for analysis purposes will be protected.

5.4.2 Report Summary Analysis

The user's mental health status and a summary will be only shared with trusted parties that the user allowed.

5.5 Budget and Budget Justification.

The cost of appointments and the cost of the internet packages have been added to the table Table (5.1).

Table 5. 1: Quoted Cost for the overall System.

Event	Amount (LKR)
Appointments cost for the Mental Healthcare Provider	2500.00
Internet Packages	500.00 * 12
Total (Approximately)	= 2500.00 + 6000.00 = 9500.00 //

The App will be realized to the public with the support of installation to user's mobile phones and the application packages details have explained in the table Table(5.2).

Table 5. 2: Quoted revenue for the monthly.

Users	Package	Price (Monthly)	Product Description
Public	Basic	-	<ul style="list-style-type: none">• Free of cost installation from “Play Store”.• Daily phone usage description.• Monitor phone usage for two weeks.• A summary report regarding phone usage changes can be leads to depression.
	Premium	Rs. 500.00	<ul style="list-style-type: none">• Basic package +• A comparative report indicating daily emotions and probability of depressive symptoms.
Mental HealthCare Provider	Premium	Rs. 750.00	<ul style="list-style-type: none">• Patient mental health status changes the Notifications receiving feature.• Comparative report regarding Patient's behavioral changes of two weeks.

6. DESCRIPTION OF PERSONAL AND FACILITIES.

Shalindi Pandithakoralage - Clinical Psychologist

An accomplished clinical psychologist, trained in Cognitive Behavioral Therapy (CBT), Psychological Evaluation, Statistics, Social Care, and Reaches. She earned her first degree from the University of Science and Technology of Missouri. The University of Colombo has obtained an MPhil based on Clinical Psychology.

In addition, her areas of focus and experience include dealing with clients who have trouble with depression, anxiety, obsessive-compulsive disorder, trauma, and marriage and relationship problems. Depending on the client's needs, she engages in both humanistic and cognitive-behavioral values and retains a client-focused approach.

With her manufacturing experience and involvement in science, she will externally supervise the research. The accuracy of the depressing data collected would verify and direct the research team to a precise study.

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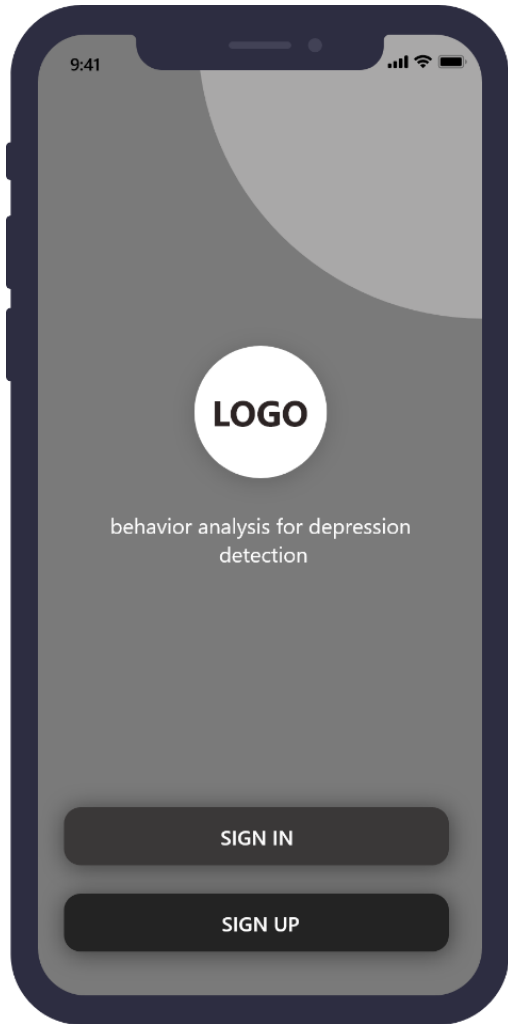
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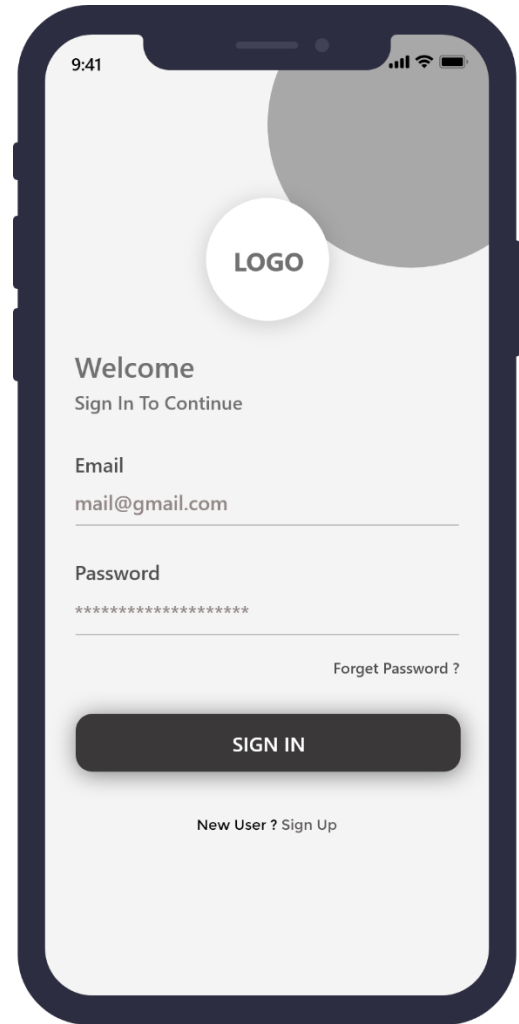
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Appendix A: Final Application Design Flow

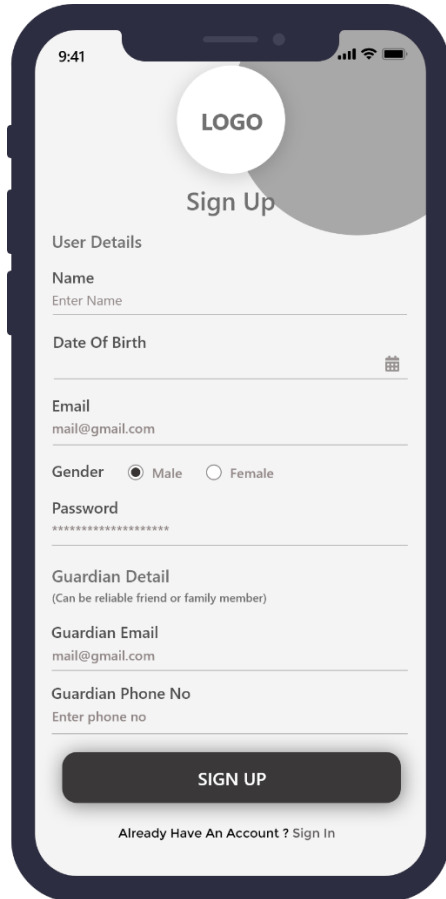
Logo



Login



Signup



9:41

LOGO

Sign Up

User Details

Name
Enter Name

Date Of Birth

Email
mail@gmail.com

Gender ☒ Male ☐ Female

Password

Guardian Detail
(Can be reliable friend or family member)

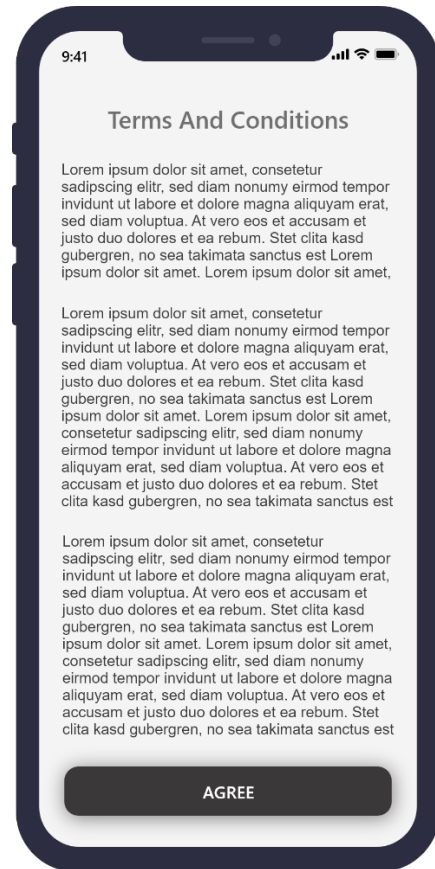
Guardian Email
mail@gmail.com

Guardian Phone No
Enter phone no

SIGN UP

Already Have An Account ? Sign In

User Agreement



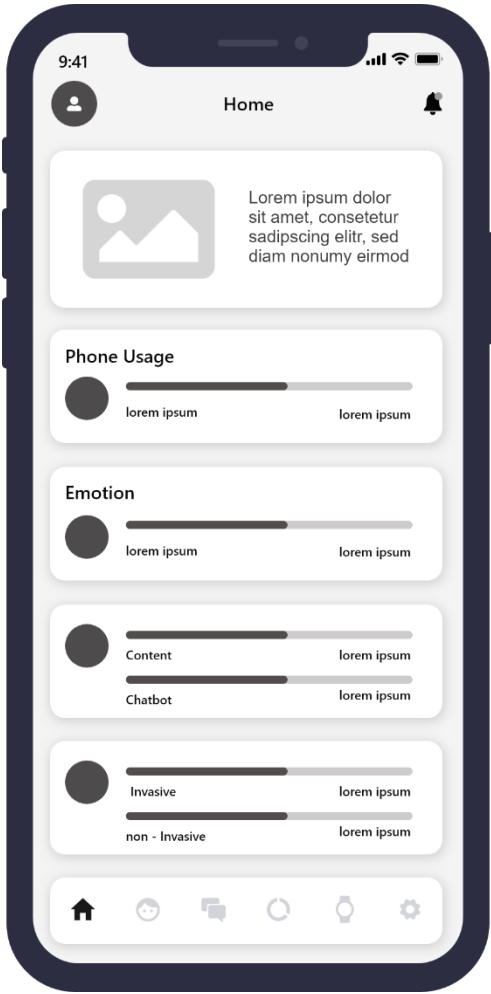
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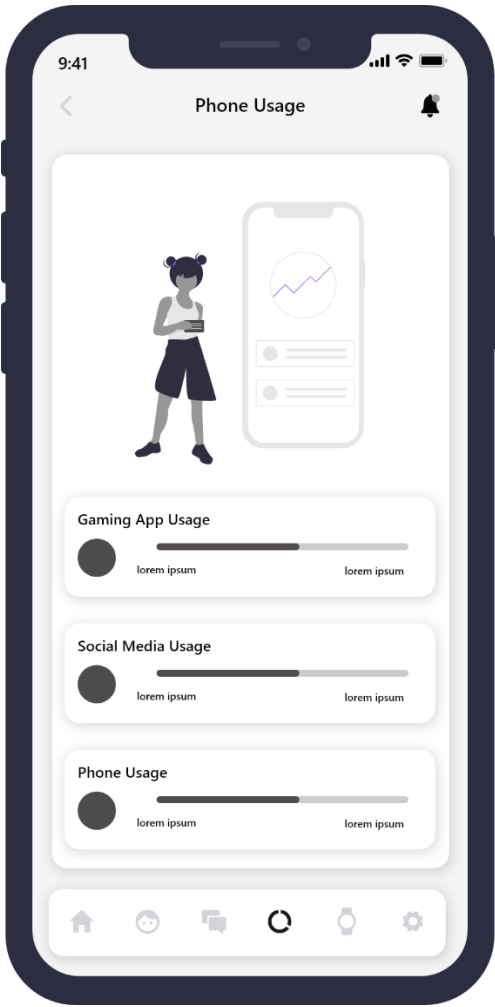
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AGREE

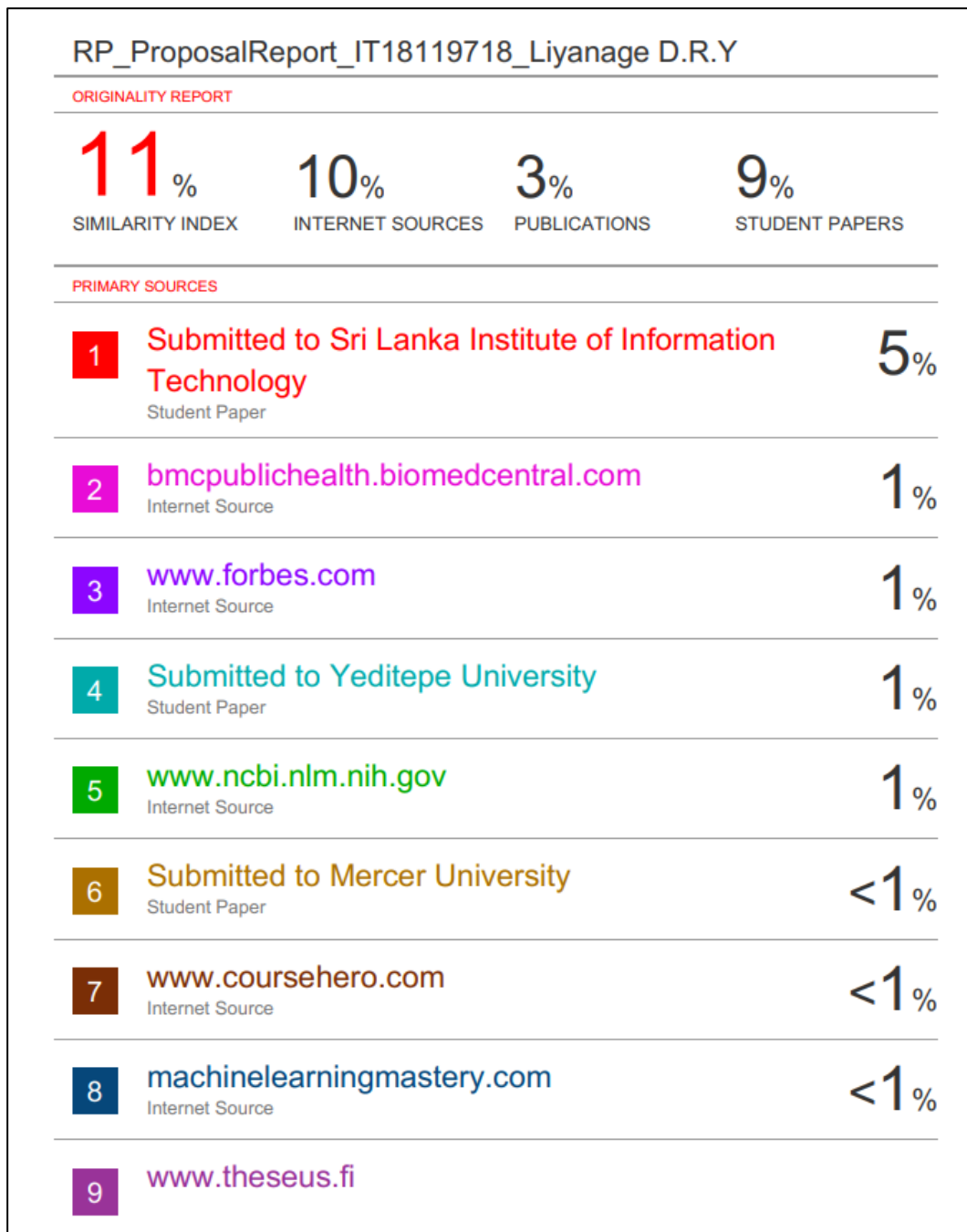
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Phone Usage



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