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Enhancing Migraine Management System through Weather Forecasting for a Better Daily Life

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Abstract - A migraine is a severe, throbbing, or pulsing headache that typically affects one side of the head. A migraine attack can be so painful that it interferes with daily activities and can last for hours or even days. Migraine is a common health issue that affects approximately 1 in every 5 women and 1 in every 15 men. Additionally, millions of people worldwide suffer from migraine attacks due to the inability to anticipate or adapt to their environment. In today's globalized world, mobile phones have become a necessity for the general public, enabling communication, internet shopping, food purchases, and even health applications. Therefore, the purpose of this research is to develop a mobile application that serves as an online migraine management system that is responsive to meteorological conditions. The app was created using development tools such as Android Studio, Visual Code Studio, Flutter framework, and Firebase Firestore, which act as databases. This report also includes essential information on migraines and a comparison of similar or existing applications. In addition, the research is designed to provide a reliable and user-friendly interface for collecting migraine data for robust evidence, processing relevant demographic features such as medical history, and generating reports. While researching topics relevant to the application, we found a scarcity of data on weather-based migraines. As a result, the system will predict the impact and risk of migraine based on Headache Impact Test (HIT-6) data provided by migraine patients as well as weather forecasts. With the features of this research, migraine patients can hopefully better prepare themselves for their daily routine and manage their symptoms more effectively.

Keywords— Migraine, Weather Forecasts, Headache Impact Test (HIT-6), Mobile Application, Flutter

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I. INTRODUCTION

A. Overview

In recent years, mobile phones have become increasingly ubiquitous and essential, with people all over the world embracing their potential. With more individuals relying on smartphones, they often check their phones within five minutes of waking up in the morning, and 20 percent of them check their phones more than 50 times a day [1]. The COVID-19 pandemic has also made it more important to have access to information on-the-go, with many turning to their mobile phones to surf the internet for news and updates. Similarly, when people experience health issues, they often turn to the internet to identify their symptoms and seek medical advice.

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Migraine is a common condition characterized by moderate to severe headaches that typically occur on one side of the head. While it affects a large number of adolescents, frequent migraine attacks can also contribute to mental health issues such as mood and anxiety disorders. The condition can be exacerbated by extreme weather conditions, including severe heat or cold, certain locations, and altitudes.

To address these issues, a dedicated mobile application has been developed to help individuals suffering from weather-related migraine. The application is specifically designed to fulfill several functions which include tracking weather changes, offering health advice based on the weather conditions, collecting migraine data from patients, and generating a Headache Impact Test (HIT-6) to evaluate the impact of migraines on an individual's daily life. The mobile application also includes a feature that generates reports for doctor evaluation based on the recorded migraine data. This application will enable individuals to take necessary precautions in accordance with the weather forecast to manage their condition more effectively.

B. Problem Statement

Migraine, a prevalent neurological disorder affecting millions of individuals globally, can be triggered by various factors, including changes in weather. While online migraine management systems have gained popularity, only a limited number of studies have investigated the connection between migraines and weather conditions. Furthermore, existing mobile applications for migraine management are often cluttered with advertisements and lack an organized interface. In addition, there is currently no mobile application available that can detect weather changes and provide personalized health recommendations to reduce the risk of migraine exacerbation. Therefore, there is a need for a comprehensive and user-friendly mobile application that can monitor weather conditions and provide tailored recommendations for individuals with migraines.

C. Objectives

The objective of this journal paper is to address the current limitations in online migraine management systems and mobile applications by conducting research on the workflow of an online migraine experience system related to weather conditions. The paper aims to design a user-friendly mobile application interface that allows users to conveniently record their migraine details, including the time of onset and duration, as well as any related symptoms. Additionally, the paper seeks to develop a mobile system that can detect and indicate the user's chances of migraine deterioration based on the weather conditions. By incorporating this feature, the mobile application can provide personalized health recommendations to reduce the risk of migraine exacerbation. Finally, the paper aims to generate a report based on the user input migraine data, which can be used to monitor the effectiveness of the recommendations and provide insights for future research.

II. LITERATURE REVIEW

A. Migraine

Migraine is a complicated genetic disorder characterized by episodes of moderate-to-severe headaches that are usually unilateral and are frequently accompanied by nausea and increased sensitivity to sound and light. A migraine attack can cause intense pain that affects a person from carrying on their daily activities and can last for hours or even days [2],[3],[4].

There are several types of migraines, each with its own unique symptoms and characteristics. The most common type of migraine is migraines without aura, which accounts for about 70-90% of all migraines [5]. This type of migraine is characterized by moderate to severe pulsating headaches, which can last from a few hours to several days. Individuals may also experience other symptoms, such as nausea, vomiting, and sensitivity to light and sound [6], [7].

Another type of migraine is the migraine with aura, which occurs in approximately 25% of people with migraines. This type of migraine is characterized by a warning sign or aura, which can include visual disturbances, such as seeing flashing lights or zigzag lines, or sensory disturbances, such as tingling or numbness. The aura typically lasts for 20-60 minutes and is followed by a headache [8].

There are also other less common types of migraines, such as chronic migraines, which occur for more than 15 days per month, and vestibular migraines, which are characterized by dizziness and balance problems [9]. Additionally, some individuals may experience migraines triggered by specific factors, such as menstruation, stress, or certain foods.

In conclusion, migraines are a complex and multifactorial neurological disorder that affects a significant portion of the population. Understanding the different types of migraines and their unique symptoms can help individuals and healthcare professionals better manage this condition and improve the quality of life for those affected.

B. Weather Forecasting and Prediction

Weather forecasting is the application of science and technology that involves the collection and analysis of meteorological observations to formulate and disseminate information about future atmospheric conditions [10]. In addition to predicting weather patterns, forecasting also involves predicting changes on Earth's surface caused by atmospheric conditions, such as temperature, wind speed, ice cover, and floods. These predictions can be used to provide current readings and updates to the public, which can assist migraine patients in adjusting their daily activities, farmers and gardeners in crop irrigation planning, and promote transportation safety.

C. Weather Influence on Migraine Exacerbation

"Weather is a common trigger for migraines," said by Vincent Martin, MD, director of the University of Cincinnati Gardner Neuroscience Institute's Headache and Facial Pain Centre and president of the National Headache Foundation [11]. According to Masahito Katsuki et al. (2023), specific weather factors that are associated with migraines include barometric pressure changes, temperature changes, humidity, rainfall, seasons, and time zone [12]. Studies have shown that certain weather conditions can lead to an increase in migraine patients seeking treatment at emergency departments. According to the Environmental Protection Agency, the rising global average temperature continues to cause significant changes in weather patterns, leading to an increase in the frequency or intensity of extreme weather events such as heat waves and hurricanes. Experts suggest that the stress associated with these events can trigger headaches [13]. Tanik et al. (2020) also discovered that hot weather caused headaches more frequently than cold weather did in obese patients with tension-type headaches [14]. Dehydration due to fluid loss through sweating in extreme temperatures can also cause heat-related headaches.

Chinook winds occur when warm winds blow over the mountains from the west, resulting in a significant rise in temperatures, even during the winter months. The effects of Chinooks vary among people, with some experiencing seasonal allergies, while others endure severe migraine headaches. Dr. Werner Becker, a professor emeritus of clinical neurosciences and medicine at the University of Calgary, highlights that although not all individuals with migraines are impacted by Chinook winds, a notable proportion of them demonstrate sensitivity to these weather phenomena [15]. Extensive research has established a correlation between Chinook winds and migraines, leveraging the sudden and forceful nature of these winds to confirm the susceptibility of many individuals to Chinook-related migraine triggers [16].

Barometric pressure may also be another factor, with migraines more likely to occur as atmospheric pressure rises. A study conducted by researchers at the University of Toronto examined a group of 20 patients and discovered a positive correlation between migraine pain levels and both temperature and atmospheric pressure. Over a span of 14 days, participants recorded their pain levels using the visual analogue scale (VAS). The study revealed a significant positive association between VAS scores and atmospheric pressure ($p = 0.027$). However, the study did not provide a clear explanation for this observation. Another study by Zebenholzer et al. involved a prospective analysis based on headache diaries of 238 patients with migraines, with or without aura, over a period of 90 days. The results indicated an increase in headache occurrence when there was high barometric pressure and lower mean daily wind speeds [17], [18].

Further research by Akgun et al. [19] compared the effects of weather variables on episodic tension-type headache (ETTH) and episodic migraine (EM) attacks to gain a better understanding of the connection between weather and migraine. The experiment involved 50 patients diagnosed with ETTH and 50 patients diagnosed with EM, with the

patients' headache diaries used to assess the link between headache attacks and meteorological parameters. Humidity, temperature, pressure, wind speed, wind direction, ultraviolet index, and sunshine duration were found to have an effect on migraine symptoms [20]. Table 1 compares migraine attacks among groups based on weather parameters [19].

Table 1. The Comparison Of Migraine Attacks Among Groups Based On The Weather Parameters

		Migrainen = 188 attacks	TTHn = 233 attacks	p
Temperature (°C)		10.3 ± 6.4	11.6 ± 7.1	0.059
Humidity percentage (%)		76.1 ± 20.0	75.6 ± 19.1	0.505
Pressure (mm Hg)		11.4 ± 1.0	1.0 ± 24.3	0.172
Wind speed (km/h)		7.4 ± 3.8	6.8 ± 4.2	0.018
Sunshine duration (h/y)		632.1 ± 95.9	650.1 ± 106.8	0.175
UV index		2.8 ± 1.5	3.2 ± 1.7	0.039
Wind direction	North	34 (18.1%)	34 (14.6%)	0.655
	South	26 (13.8%)	24 (10.3%)	
	East	30 (16%)	32 (13.7%)	
	West	33 (17.6%)	54 (23.2%)	
	Northwest	34 (18.1%)	46 (19.7%)	
	Northeast	14 (7.4%)	24 (10.3%)	
	Southeast	5 (2.7%)	6 (2.6%)	
	Southwest	12 (6.4%)	13 (5.6%)	

D. Headache Impact Test (HIT-6)

The six-item Headache Impact Test (HIT-6) was developed specifically for assessing the impact of headaches and has been validated in patients experiencing various types of headache disorders. [20]. According to the research [21], we can determine that all items in the HIT-6 questionnaire were effectively capture the range of impact caused by headaches and migraines. The questionnaire provides reliable and unique information that contributes to the overall score, thereby confirming its validity in assessing the impact of headaches on individuals with chronic migraines. Besides, clinicians can use it as a simple tool to gather patient feedback on headache aspects beyond just frequency [22].

The six HIT-6 questions are shown in Table 2 which are pain, social functioning, role functioning, vitality, cognitive functioning, and psychological distress. Patients respond to each question by selecting one of five options: 'never', 'rarely', 'sometimes', 'very often', or 'always'. These responses are totalled to generate a HIT-6 score ranging from 36 to 78. A higher score indicates a greater impact of headaches on the patient's daily life.

The HIT-6 interpretation guide provides score ranges to categorize headache impact severity. There are four categories: 'little or no impact' with a score range of 0 to 49, 'some impact' with a score range of 50 to 55, 'substantial impact' with a score range of 56 to 59, and 'severe impact' with a score range of 60 to 78. The test is recommended every four weeks.By using the HIT-6, we can predict the likelihood of migraine exacerbation. A high HIT-6 score indicates a higher chance of exacerbation, while a low HIT-6 score indicates a lower chance of exacerbation.

Table 2. HIT-6 Questions

No.	Questions
1.	When do you have headaches, how often is the pain severe?
2.	When you have a headache, how often do you wish t you could lie down?
3.	How often do headaches limit your ability to do usual daily activities including household work, work, school, or social activities?
4.	In the past 4 weeks, how often did headaches limit your ability to concentrate on work or daily activities?
5.	In the past 4 weeks, how often you felt too tired to do work or daily activities because of your headaches?
6.	In the past 4 weeks, how often have you felt fed up or irritated because of your headaches?

E. Comparison of Applications

Based on Table 3, the proposed mobile applications have been compared with several existing applications, revealing several notable improvements in the field of migraine-related mobile applications. One of the key enhancements is the inclusion of weather forecasts and wind speeds as essential features. Additionally, the systems incorporate the Headache Impact Test to assess migraine conditions and introduce a unique indicator for Chances of Migraine Exacerbation. HIT-6 Records are also implemented to keep track of the user's migraine condition. Lastly, the system offers health recommendations to reduce users' chances of migraine exacerbation based on weather.

Table 3. Comparison Between Existing Applications And The Proposed Application

Functions / Materials	**Mobile Application**			
	Migraine and headache diary	Headache Track n Test	Migraine Monitor	Proposed Mobile Application
Weather Forecast	No	No	No	Yes
Temperature	No	No	Yes	Yes
Humidity	No	No	Yes	Yes
Pressure	No	No	Yes	Yes
Wind Speed	No	No	No	Yes
Headache Impact Test	No	No	No	Yes
HIT-6 Records	No	No	No	Yes
Migraine Diary	Yes	Yes	Yes	Yes
Report Generation	Yes	Yes	Yes	Yes
Chances of Migraine Exacerbation Indicator	No	No	No	Yes
Health Recommendation	No	No	No	Yes

III. RESEARCH METHODOLOGY

The proposed system for this research, the Treat Migraine Weather Experience System (TMWES), is an Android-based mobile system designed to assist users in managing their migraine records and assessing the severity of their migraines using weather data. The system relies on internet connectivity to facilitate communication between the user's smartphone [23], Firebase Firestore, and the OpenWeather API.

Firebase Firestore is utilized as the platform for storing user information, including their location, HIT-6 results (a measure of migraine impact), and migraine records. This enables users to securely access and manage their data within the system. The integration of the OpenWeather API allows the system to retrieve current and forecasted weather data, which is a crucial factor in understanding potential triggers for migraines.

By leveraging the internet, Firebase Firestore, and the OpenWeather API, TMWES provides users with a comprehensive tool for recording and assessing their migraines based on weather conditions. This methodology ensures the system's ability to offer personalized recommendations and insights to users [24], enhancing their ability to manage their migraines effectively.

Figure 1 represents the view Headache Impact Test (HIT-6) activity diagram. Firstly, the user will navigate to the HIT-6 screen by clicking on the "View HIT-6" icon. The page will prompt the user to answer all of the HIT-6 questions. After the user clicks on the “Submit ” button, the score and the chance of migraine exacerbation will be shown to the user. Lastly, the score is stored in the system.

Figure 2 represents the view HIT-6 records activity diagram. The user can select the “HIT-6 Records” icon to view the previously performed HIT-6. The system will then display a list of HIT-6 records to the user.

Activity Diagrams

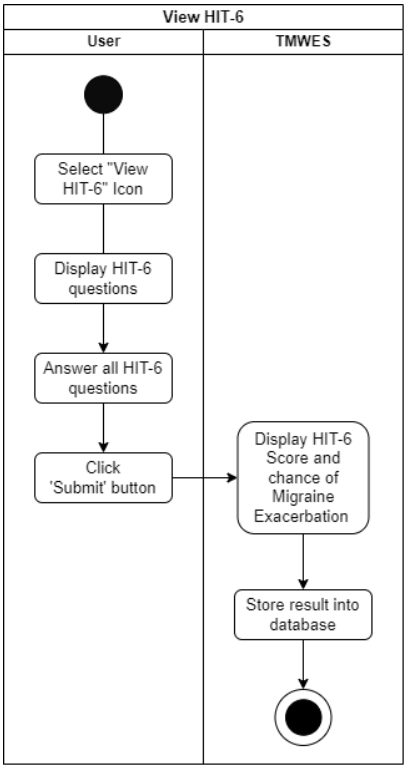

Figure 1. View And Perform Headache Impact Test (HIT-6) Activity Diagram

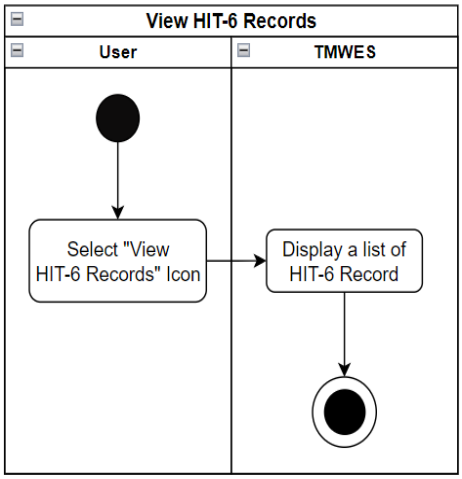

Figure 2. View HIT-6 Records Activity Diagram

Figure 3 represents the update location activity diagram. Firstly, the user will click on the “Update Location” icon. The system will update the current location by retrieving the data from the mobile phone compass. After that, the weather forecast will be retrieved from the weather API based on the updated current location and displayed on the home page. Lastly, the health recommendation based on the current weather will be shown.

Figure 4 below represents the record migraine activity diagram. The user will navigate to the Record Migraine screen by clicking on the "Record Migraine" icon. The page will prompt the user to fill in all of the migraine details. After the user clicks on the “Save” button, the migraine details will be stored into the system.

Figure 5 below represents the view calendar activity diagram. Firstly, the user clicks on the “Calendar” icon to view the calendar. Following that, the user can select a desired date to view their previously recorded migraine details, and the system will provide the particular recorded migraine details to the user.

Figure 6 represents the generate report activity diagram. The user can click on the “Report” icon to view the migraine report. The system will then display a summary migraine report and the user can decide whether to download the report or not.

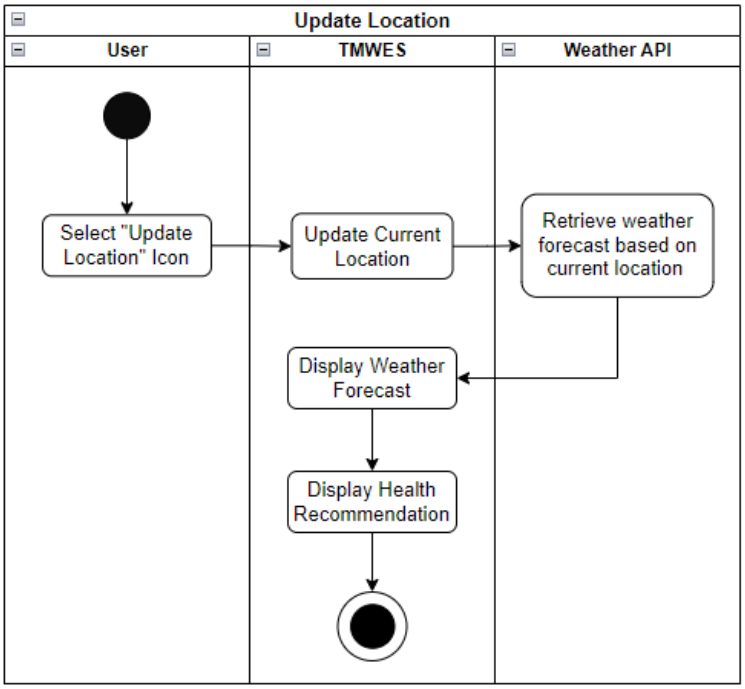

Figure 3. Update Location Activity Diagram

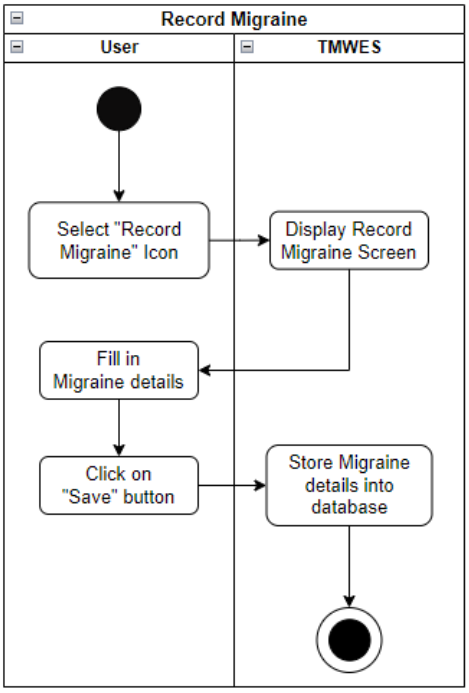

Figure 4. Record Migraine Activity Diagram

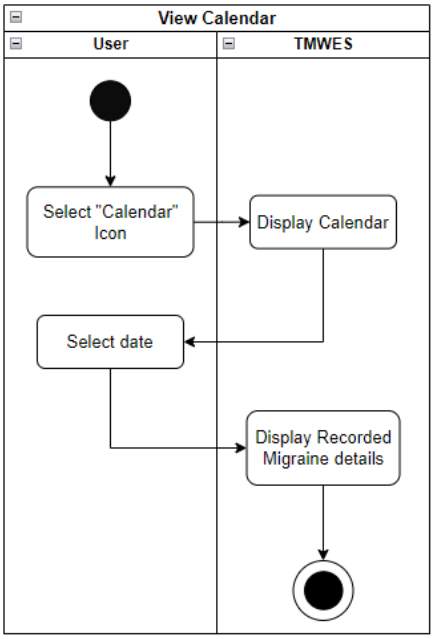

Figure 5. View Calendar Activity Diagram

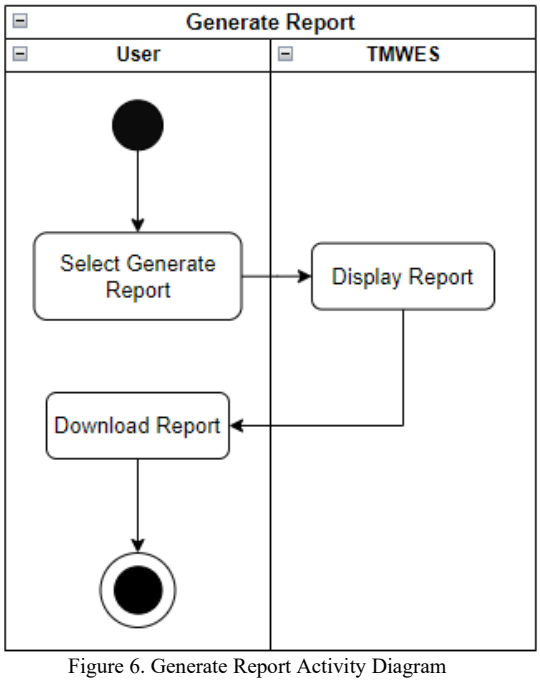

Figure 6. Generate Report Activity Diagram

IV. RESULTS AND DISCUSSIONS

The GetX state management framework was utilized to manage the application's state as well as routing and dependencies efficiently. GetX provides a comprehensive solution by combining route management and dependency management which simplifies the development process. Besides, the Model-View-Controller (MVC) pattern was

implemented in this application's code structure to ensure a clear separation of concerns and to facilitate code organization.

Furthermore, OpenWeather API was integrated into the application as it offers extensive flexibility in retrieving weather data. With this API, we can easily fetch current, hourly, and daily weather data based on the specified city. This capability enables us to provide users with accurate and up-to-date weather information within the app.
TMWES was developed to seamlessly integrate weather data, offering an enhanced user experience specifically designed for migraine patients by leveraging the powerful features of the GetX framework and utilizing the capabilities of the OpenWeather API.

The following section showcases the interface design of the proposed application and provides a discussion on the code implementation.

A. Interface Design

Figure 7 shows the login and signup screen of TMWES. Users are required to enter their email address and password in the designated text fields and click the "Login" button to gain access to their account. Upon providing valid credentials, users will be directed to the home page. If users forget their password, they can click on the "Forgot password" link to initiate the password reset process. For new users, there is a "signup" link located below the login button. Clicking this link will redirect them to the registration screen.

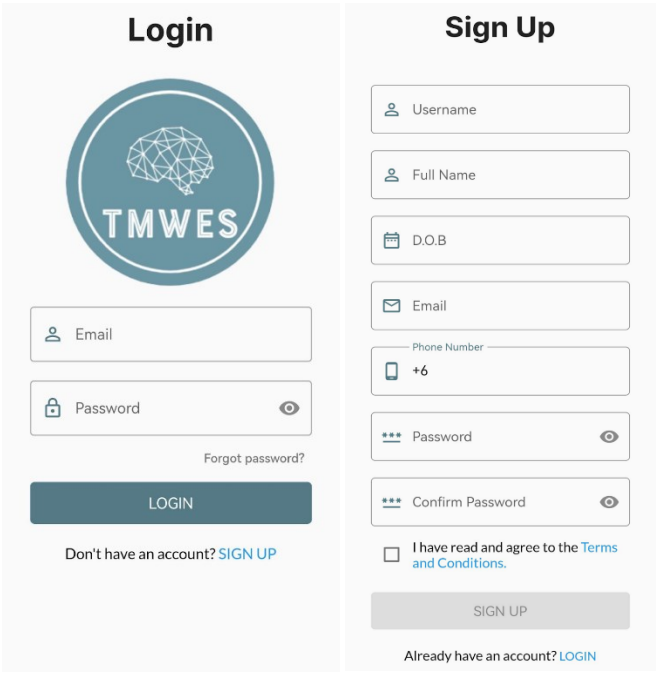

Figure 7. Login And Sign up Screen

To register an account, users are required to enter a username, full name, date of birth, email address, phone number, password, and confirmation password which should match the initially provided password. Additionally, users must agree to the provided terms and conditions. Finally, clicking the "Sign up" button will create their account.

Figure 8 shows the homepage of TMWES. The header section contains icons for location and calendar. The location icon feature enables the system to detect the user's current location. This functionality allows TMWES to provide personalized weather and environment-related information based on the user's geographical location. It enhances the relevance and accuracy of the system's recommendations and forecasts. While the calendar icon provides users with the ability to select a specific date and view their previously recorded migraine details. This feature empowers users to track and monitor their migraine patterns over time.

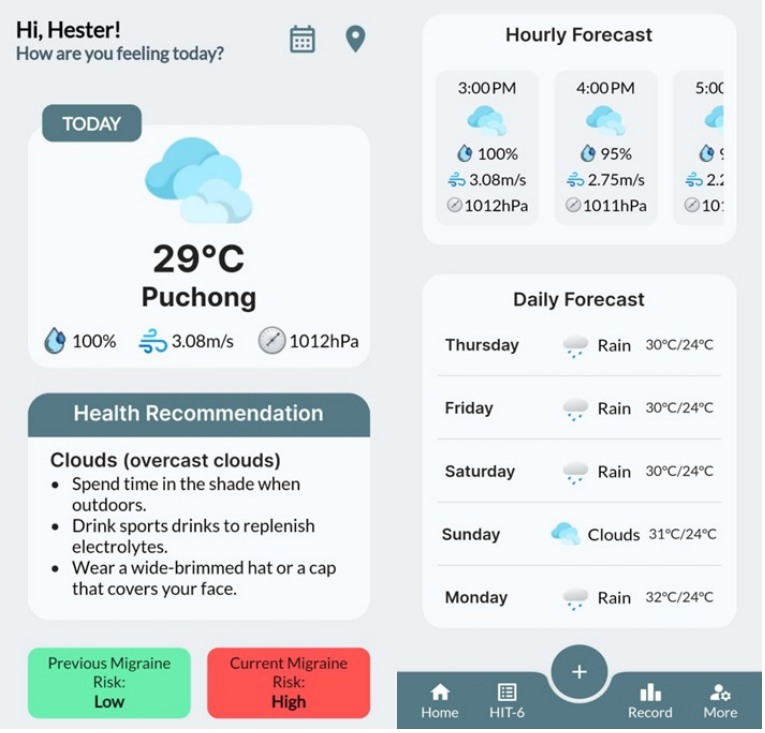

Figure 8. Home Screen

Further down the page, the display of the current weather forecast and the user's location on the homepage is highly informative and useful. It provides users with real-time weather information, ensuring they are aware of the atmospheric conditions that might impact their migraines. In the middle of the main page, weather-based health recommendations for individuals with migraines are displayed. It provides users with proactive strategies and actionable steps to mitigate the impact of weather-related triggers on their migraines.

The page further presents information about the chances of migraine exacerbation, both in the previous and current periods. This feature alerts users to potential triggers or risk factors associated with weather or environmental conditions, enabling them to take preventive measures or adjust their routines accordingly. The page also provides detailed hourly and daily weather forecasts, enabling users to plan and prepare for the upcoming weather conditions. Lastly, a navigation bar at the bottom of the homepage offers convenient access to essential features of TMWES. Icons for home, HIT-6, record migraine, HIT-6 records, and profile ensure seamless navigation through the system, enhancing the overall user experience.

Figure 9 shows the Headache Impact Test Screen of the TMWES. There are listed 6 HIT-6 multiple choice questions for the user to choose from. The user needs to answer all questions and click on the submit button to view the HIT-6 score. By providing a comprehensive assessment of headache impact and generating HIT-6 scores, TMWES empowers users to better understand the severity of their headaches, track changes over time, and support informed decision-making in headache management.

Figure 10 shows the HIT-6 score and records screen of the TMWES. The HIT-6 score screen is presented to the user upon completion of all the questions and clicking the "Submit" button. The HIT-6 score is prominently displayed as the largest number on the page, accompanied by a highlighted rectangle bar that indicates the extent of migraine impact on the user. Additionally, the screen provides information on the predicted migraine risk and offers suggestions for users. The HIT-6 records screen presents a list of the user's previously conducted HIT-6 records. It includes details such as the date, migraine impact, HIT-6 score, and the likelihood of experiencing a migraine exacerbation.

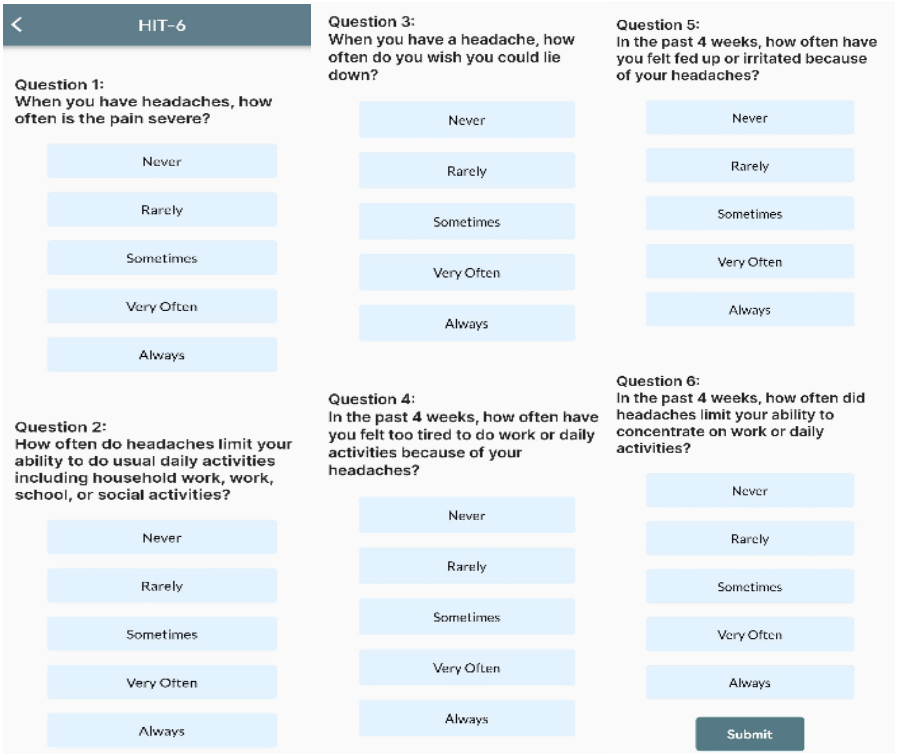

Figure 9. HIT- 6 Screen

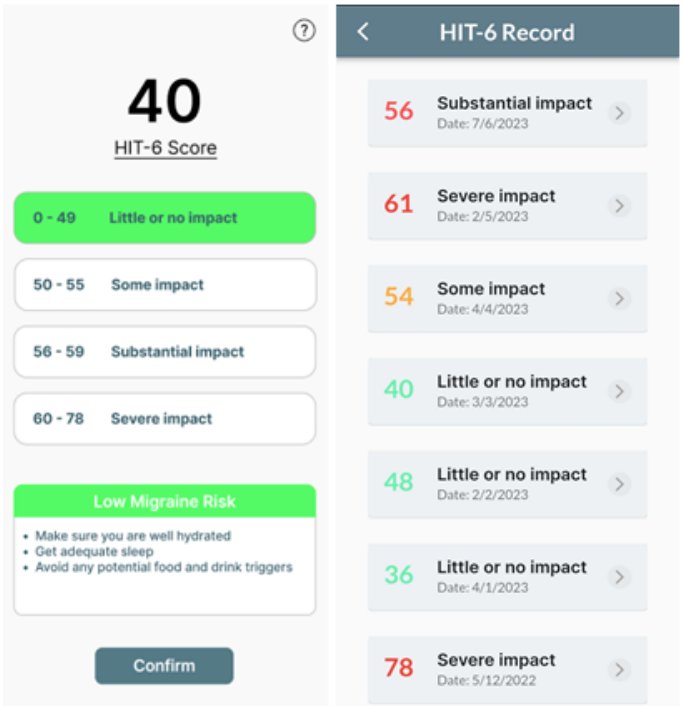

Figure 10. HIT-6 Score And Records Screen

Figure 11 shows the record migraine screen of the TMWES. This screen allows the user to record their migraine by entering the duration, pain severity, migraine location, migraine triggers and medications.

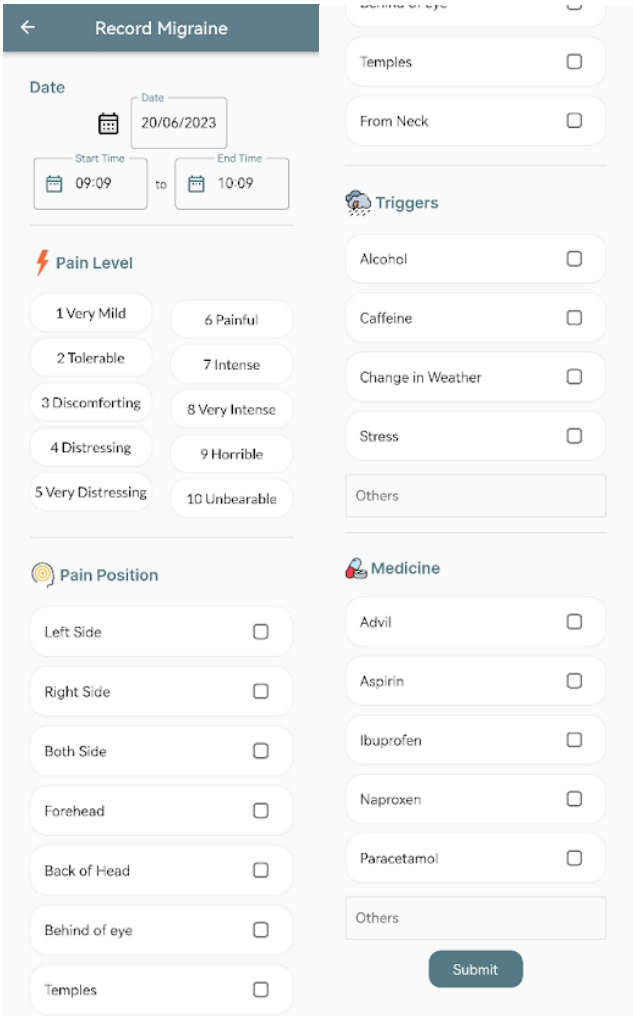

Figure 11. Record Migraine Screen

B. Code Implementation

In Figure 12 below, the app utilizes the built-in methods of Geolocator to retrieve the device's current location. Before accessing the location, users must grant permission as shown in Figure 13. Once the necessary permissions are granted, Geolocator obtains the device's position.

Moving on to Figure 14, the latitude and longitude values are then set to be passed to the FetchWeatherApi() function. This allows the app to retrieve weather data based on the provided coordinates. After that, the location is displayed as shown in Figure 15.

```
getLocation() async {
   bool isServiceEnabled;
   LocationPermission locationPermission;

   isServiceEnabled = await Geolocator.isLocationServiceEnabled();
   //if location service is not enabled
   if (!isServiceEnabled) {
    Get.snackbar("Permission", "Location not enabled",
        snackPosition: SnackPosition.BOTTOM,
        backgroundColor: Colors.redAccent.withOpacity(0.2),
        colorText: Colors.red);
   }
   //status of permission
   locationPermission = await Geolocator.checkPermission();
   if (locationPermission == LocationPermission.deniedForever) {
    return Future.error("Location permission are denied forever.");
   } else if (locationPermission == LocationPermission.denied) {
    //request permission
    locationPermission = await Geolocator.requestPermission();
    //if location denied
    if (locationPermission == LocationPermission.denied) {
     return Future.error("Location permission is denied");
    }
   }
```

Figure 12. Retrieve Current Location Of Device

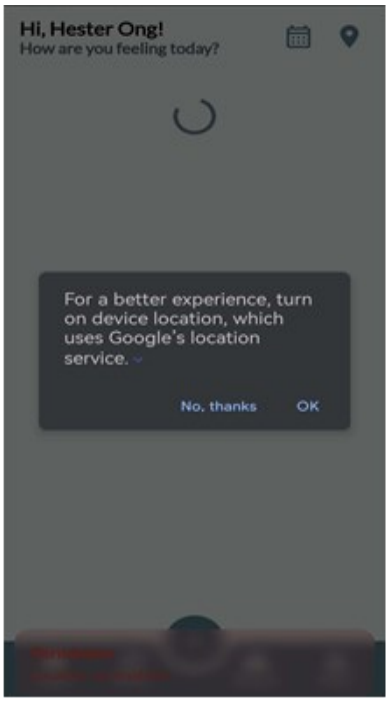

Figure 13. Location Permission

```
//getting the current position
   return await Geolocator.getCurrentPosition(
    desiredAccuracy: LocationAccuracy.high,
   ).then((value) {
    //update latitude and longtitude
    _latitude.value = value.latitude;
    _longtitude.value = value.longitude;
}
//call weather API
    return FetchWeatherApi()
        .processData(value.latitude, value.longitude)
        .then((value) {
      weatherData.value = value;
```

Figure 14. Setting Latitude And Longitude Value

Figure 15. Display Location

Referring to Figure 16, the app initiates a request to the OpenWeather API by utilizing the provided URL link. The API then responds with the weather forecast details. This allows us to retrieve various weather information such as the current weather, as well as hourly and daily weather data. The weather forecast details are shown in Figure 8.

```
class FetchWeatherApi {
  WeatherModel? weatherData;
  //get data from response -> json
  Future<WeatherModel> processData(lat, lon) async {
    var response = await http.get(Uri.parse(apiUrl(lat, lon)));
    var jsonString = jsonDecode(response.body);
    weatherData = WeatherModel(
        CurrentWeatherModel.fromJson(jsonString),
        HourlyWeatherModel.fromJson(jsonString),
        DailyWeatherModel.fromJson(jsonString));
    return weatherData!;
  }
}
String apiUrl(var lat, var lon) {
  String url;
  url =
      "https://api.openweathermap.org/data/2.5/onecall?lat=$lat&lon=$lon&appid=$apiKey&units=metric&exclude
=minutely";
  return url;
}
```

Figure 16. Fetch Weather API

Referring to Figure 17 below, the risk of migraine is determined based on the HIT-6 score. The HIT-6 score is stored in the 'value' variable as shown. If the value is equal to or greater than 60, the risk is categorized as very high. Furthermore, if the value falls between 56 and 59, the risk is considered high. Similarly, if the value ranges from 50 to 55, the risk is categorized as medium. On the other hand, if the value is lower than 50, the risk is classified as low. The migraine risk indicator was shown in Figure 18.

```
//calculate migraine risk based on HIT-6 scores
String calcMigraineRisk(int value) {
  if (value >= 60) {
    return "Very High";
  } else if (value > 55 && value < 60) {
    return "High";
  } else if (value >= 50 && value <= 55) {
    return "Medium";
  } else if (value >= 36 && value <= 49) {
    return "Low";
  } else {
    return "Go Take a HIT-6";
  }
```

Figure 17. Calculate Migraine Risk

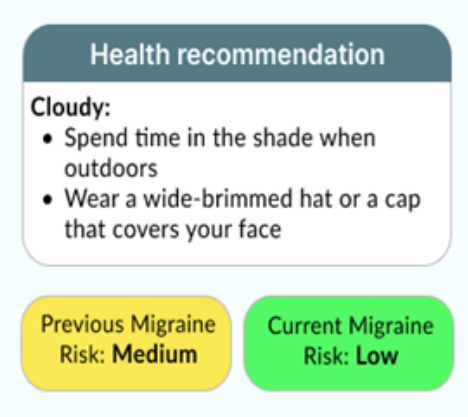

Figure 18. Migraine Risk Indicator

Referring to Figure 19 below, the code first checks if the user is logged in. If the user is logged in, it proceeds to store a HIT6Model record in Firestore. The record is associated with the currently authenticated user and includes the score, date, and selected answers.

```
Future<void> storeHIT6(int score, List<int> selectedAns) async {
  User? currentUser = auth.currentUser;
  final record = HIT6Model(
   userId: currentUser?.uid,
   score: score,
   recordDate: DateTime.now(), //auto added time for record
   selectedAns: selectedAns,
  );
  if (currentUser != null) {
   await firestore
      .collection(usersCollection)
      .doc(currentUser.uid)
      .collection(hit6Collection)
      .add(record.toJson())
      .whenComplete(
       () => Get.snackbar("Success", "Your test has been recorded!",
          snackPosition: SnackPosition.BOTTOM,
          backgroundColor: Colors.white.withOpacity(0.5),
          colorText: Colors.green.shade800),
      )
      .catchError((error, stackTrace) {
    Get.snackbar("Error", error.toString(),
       snackPosition: SnackPosition.BOTTOM,
       backgroundColor: Colors.redAccent.withOpacity(0.2),
       colorText: Colors.red);
    print(error.toString());
   });
  }
 }
```

Figure 19. Store HIT-6 Details Into Firebase Firestore

Referring to Figure 20, the app retrieves all HIT-6 records from the "hit6Collection" in Firebase Firestore. The retrieval is based on the user's unique ID, ensuring that users can only access their own records. The records are arranged in descending order by date, with the latest records appearing first.

Figure 21 shows the code implementation on how HIT-6 Score is being calculated. The function calculates the total score by iterating over a list of “selectedAnswerIndices”, finding the corresponding score for each selected answer from the “answers” list, and accumulating the scores into a “totalScore.value” variable. The function then returns the calculated total score.

```
//Fetch All HIT-6 records
 Future<List<HIT6Model>> getAllHIT6Records() async {
  User? currentUser = auth.currentUser;
  final snapshot = await firestore
      .collection(usersCollection)
      .doc(currentUser?.uid)
      .collection(hit6Collection)
      .orderBy("record_date", descending: true)
      .get();
  //store snapshot in usersData as a list
  final records =
      snapshot.docs.map((e) => HIT6Model.fromSnapshot(e)).toList();
  return records;
 }
```

Figure 20. Retrieve HIT-6 Records From Firebase Firestore

```
int calculateScore(List<Map<String, dynamic>> answers) {
  int score = 0;
  for (int i = 0; i < selectedAnswerIndices.length; i++) {
   final answerIndex = selectedAnswerIndices[i];
   score = 0;
   for (int j = 0; j < answers.length; j++) {
    if (answerIndex != -1 && answers[j]['ansIndex'] == answerIndex) {
     score = answers[j]['score'] as int;
    }
   }
   // Add the score of the selected answer to the total score
   totalScore.value += score;
  }
  return totalScore.value;
 }
```

Figure 21. Calculate HIT-6 Score

V. CONCLUSION

In conclusion, the development of the Treat Migraine Weather Experience System (TMWES) successfully achieved its goals and objectives, providing a weather-based interface for the mobile app companion for migraine patients to improve their management of migraines. The research involved overcoming challenges such as limited research papers, lack of references and existing systems, and acquiring knowledge of the Flutter framework. However, through research, consultation, and problem-solving, these challenges were addressed, resulting in the successful development of TMWES.

TMWES has made a significant contribution by providing valuable information and recommendations based on weather forecasts to assist migraine patients in taking necessary precautions. It has the potential to improve the overall migraine management experience for users. Additionally, the research has identified several areas for future

work, including expanding the system to other platforms, integrating additional data sources, implementing user feedback, and tracking features, exploring wearable device integration, and collaborating with healthcare providers. These future directions would enhance the system's functionality and effectiveness, further supporting migraine patients in their management and prevention efforts.

Overall, this research has demonstrated the feasibility and potential benefits of a weather-based approach in supporting migraine patients. By addressing the identified areas for future work, the system can continue to evolve and make a positive impact on the lives of individuals affected by migraines.

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