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Weather-Based Arthritis Tracking: A Mobile Mechanism for Preventive Strategies

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Abstract -Arthritis is a common joint disorder characterised by symptoms such as swelling, pain, stiffness, and limited joint movement. It primarily affects older individuals, women, and athletes. The advent of information technology has created opportunities for patients to manage their health conditions more effectively. Research indicates that weather can affect arthritis symptoms, with many patients experiencing severe discomfort during rainy weather due to the expansion of already inflamed tissues. However, there is currently no mobile application mechanism available that combines weather forecasting with health recommendations for arthritis patients, which means that patients may not have access to important information that could help them manage their symptoms. Furthermore, few research workflows have focused on weather conditions in online arthritis treatment systems. This research aims to develop a weather-based mobile system for arthritis tracking that provides health advice and alerts based on current and forecast weather conditions, as well as features to help patients track how weather affects their arthritis. This system utilises several tools for its development. The Flutter Framework is used for creating mobile apps, while Firebase is chosen as the cloud-hosted database. Visual Studio Code and Android Studio are utilised as the code editor and Android emulator, respectively. Information about weather forecasts is retrieved via the OpenWeather API. The application mechanism will feature a user-friendly interface to help users stay updated on weather forecasts, and it will collect data in a reliable and user-centric manner for generating robust evidence on health outcomes.

Keywords— Arthritis Inflammation, Joint Disorder, Weather Tracking Mechanism, Mobile Health Recommendation.

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I. INTRODUCTION

Arthritis is one of the common disorders that affect one's joints. Common arthritis symptoms include swelling, pain, stiffness, and diminished range of motion in joints. It's most common among older people, women, and athletes. In this era of advanced information technology, opportunities arise to assist patients in managing their health conditions. Research has shown that weather does have an impact on arthritis symptoms. Many arthritis patients experience exacerbated symptoms before and during rainy days. A drop in atmospheric pressure often precedes cold, rainy weather. This decrease in pressure can cause already inflamed tissues to expand, leading to increased pain. By incorporating weather forecasts into an arthritis tracking solution, patients can receive improved treatment and adopt preventive strategies. The introduction of a practical mobile application aims to assist patients in managing their arthritis disorder.

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The current problem lies in the lack of research workflows for online arthritis treatment systems that incorporate weather conditions. Moreover, there are currently no available mobile applications in the market capable of tracking weather changes and providing health recommendations based on the weather for arthritis patients. To address the problems stated, two main objectives need to be achieved. The first objective is to conduct research on the workflow of an online arthritis treatment system that considers weather conditions. The second objective is to design a mobile application that tracks weather changes and offers health recommendations to arthritis patients based on the weather. This approach will enable patients to implement preventive strategies in response to any weather changes that may impact their condition.

II. LITERATURE REVIEW

A. Arthritis

Arthritis means inflammation or swelling of one or more joints. It is a common disorder that affects a patient's joints (areas where bones meet and move). It causes pain and inflammation and makes it difficult to move or stay active. There are many types of arthritis. Each form causes different symptoms and may need different treatments. Arthritis symptoms affect several body areas, with the feet, hands, hips, knees, and lower back seeing the highest rates of occurrence. Each patient's level of severity of arthritis may differ significantly, and different types of arthritis have varied symptoms. common signs of arthritis include pain, redness, heat, and swelling in the afflicted joints. Arthritis symptoms affect several body areas, with the feet, hands, hips, knees, and lower back seeing the highest rates of occurrence. Each patient's level of severity of arthritis may differ significantly, and different types of arthritis have varied symptoms. common signs of arthritis include pain, redness, heat, and swelling in the afflicted joints. Joint stiffness may make it difficult for a patient to move, which may occasionally produce discomfort, intermittent rashes, or itching. Depending on the individual and the specific type of arthritis they are experiencing, these symptoms may occur sometimes or consistently. While arthritis usually affects older adults, it can develop in men, women, and children of any age. The type of treatment is different depending on different types of arthritis. Treatments for arthritis primarily aim to lessen symptoms and enhance the quality of life. [1], [2].

B. Weather Forecasting and Impact of Weather on Arthritis Condition

Weather forecasting is the result of the process of predicting (forecasting) the state of the atmosphere at a specific location and time using science (meteorology) and technology. Given how linked everything is in nature, meteorologists also investigate the numerous processes that take place on land and in the sea [3]. Weather forecasts consider variations in weather factors like temperature, pressure, wind, humidity, snowfall, and storm tides. With the help of these forecasts, people with illnesses like arthritis may modify their daily routines or be prepared when bad weather strikes.

In 2019, a research study with 2,600 participants investigated the correlation between weather and arthritis pain. The participants utilized their smartphones as research tools, accessing meteorological data for their location through the smartphone's GPS service. The gadget streamlined the data entry process during the 15-month research period, eliminating the need for recalling symptoms or dealing with paper diaries. Even after accounting for mood and physical activity, the analysis of the data revealed a "significant yet modest" association between pain and three environmental factors: relative humidity, air pressure, and wind speed [4].

Humidity measures the amount of water vapor in the air, while relative humidity quantifies the amount of water in the air relative to the maximum amount of water vapor [5]. Wind speed refers to the velocity of air traveling past a specific location. It can be recorded as a peak wind speed, wind gust, or average speed over a period of time, such as miles per hour [6]. Barometric pressure measures the air pressure in the atmosphere, specifically the force exerted by air molecules at a particular location on Earth. Barometric pressure readings differ at each location due to constant fluctuations [7]. Warmer weather generally leads to higher barometric pressure, while colder weather, including storms and strong winds, decreases barometric pressure [8].

The data analysis indicated that increases in atmospheric pressure were associated with a lower probability of experiencing pain events, while increases in humidity or wind speed were specifically linked to higher risks. However,

there was little correlation between temperature and discomfort. [4]. Arthritis patients with joint discomfort may be sensitive to fluctuations in barometric pressure. This sensitivity could be due to nerves in exposed bones sensing changes in air pressure when the protective cartilage inside the joint wears away. Another theory suggests that changes in barometric pressure can cause muscles, tendons, and scar tissue to tighten and expand, resulting in discomfort in arthritis-affected joints. Low temperatures have the potential to thicken the synovial fluid in joints, which normally lubricates them, leading to stiffness and increased sensitivity to pain during movement [9]. In winter or colder days, increased humidity can exacerbate arthritis pain, while warmer, brighter days generally alleviate pain even in the presence of some humidity [8].

Alternatively, prolonged periods of cloudy or wet weather may contribute to poor mood, which can amplify people's awareness of their suffering. Additionally, patients may be less likely to engage in physical activity on chilly, rainy days, known to worsen joint pain and stiffness [10].

C. Comparison of Applications

Table 1 shows the comparison between existing applications that are related to arthritis treatment in the Google Play Store, together with the proposed mobile application, TreatArthritis Meteorological Experience System (TAMes). Arthritis Tracker [11], MyArthritis [12], and RA Monitor [13] are compared in this section. Based on the comparison, none of the mobile applications provide weather forecast information to users. The proposed mobile application will have all the functions and materials that are shown in the first column of Table 1.

Table 1. Comparison Between Existing Applications and the Proposed Application

Functions / Materials	Mobile Application			
	Arthritis tracker	MyArthritis	RA Monitor	Proposed Mobile Application (TAMes)
Health Recommendation	Yes	Yes	Yes	Yes
Geo Location	Yes	No	Yes	Yes
Weather Forecast	No	No	No	Yes
Symptoms	Yes	Yes	Yes	Yes
Tracking	Yes	Yes	Yes	Yes
Questionnaire	Yes	Yes	Yes	Yes
Symptoms tracking questionnaire overview	Yes	Yes	Yes	Yes
Arthritis Diary	No	No	Yes	Yes
Diary Overview	No	No	Yes	Yes
Temperature	No	No	No	Yes
Humidity	No	No	Yes	Yes
Wind Speed	Yes	Yes	Yes	Yes
Barometric Pressure	Yes	No	Yes	Yes

III. RESEARCH METHODOLOGY

A. Conceptual Representations

Figure 1 illustrates the use case diagram for the TreatArthritis Meteorological Experience System (TAMes). Firstly, arthritis patients are the actors in this system, and they are referred to as users. Users are required to register an account to access the functionality of the system. New users who have just registered an account need to complete a medical history form and a health assessment form after logging into the system. For users who already have an account, they can log in using the email address and password associated with their registered account. Upon successful login, users are directed to the homepage (weather view) activity screen, which provides functionality to view weather conditions

and health recommendations. Users can access current weather and forecast details, including temperature, humidity, wind speed, and barometric pressure. Health recommendations are generated based on the current weather conditions and forecast.

Furthermore, the system allows users to answer health assessments and view their assessment records. Users receive a score and category for each health assessment they submit and can view the record of their completed assessments. Additionally, users can create new diaries to record their pain events and associated weather conditions. They can also view the diary records of the diaries they have created. Moreover, users can view their medical history, which they provided during registration and login. Lastly, users have the option to log out of the system.

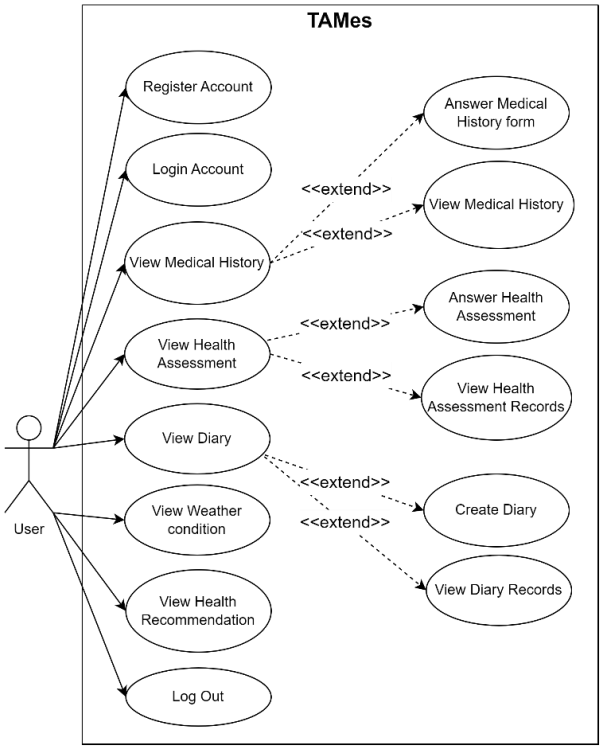


Figure 1. Use Case Diagram

B. Development tools used.

For the development of the application, a list of development tools has been compiled and is displayed in Figure 2. For the development of mobile applications, Flutter Framework which uses Dart as a programming language is used. Additionally, Firebase has been chosen as the cloud-hosted database for this application. Open Weather API is used to retrieve current and forecast weather information. Visual Studio Code serves as the code editor, and Android Studio Code is used as an Android emulator.

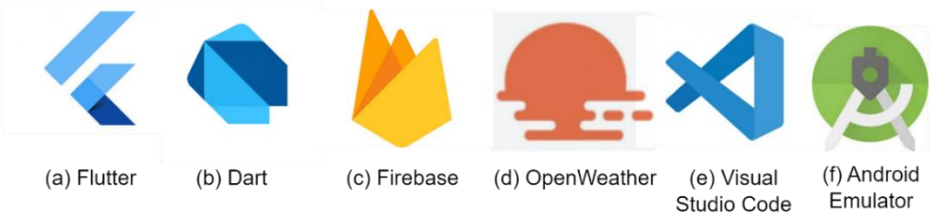


Figure 2. Development Tools Used (a) Flutter Framework. (b) Dart Programming Language. (c) Firebase Firestore. (d) OpenWeather API. (e) Visual Studio Code. (f) Android Emulator

C. Health Assessment Questionnaire

Table 2 shows the questionnaire questions of the Health Assessment form. Each answer option in this questionnaire has its own marks which contribute to the evaluation of the user's arthritis health. There are three categories of arthritis health, namely well-controlled, partly controlled, and uncontrolled arthritis. This health assessment form questionnaire is used to assess the user's arthritis health condition and provide a score and category for the user to refer to.

Table 2. Health Assessment Form Questionnaire

	Question	Type of input	Option available
1.	How often do your symptoms of arthritis occur during the day?	Drop down box	• Always (4) • Very Often (3) • Sometimes (2) • Rarely (1) • Never (0)
2.	Any night waking due to arthritis?	Radio box	• Yes (2) • No (0)
3.	How often?	Drop down box	• Always (4) • Very Often (3) • Sometimes (2) • Rarely (1)
4.	(This question is referring to the previous question, and would not be choosable if the user chosen "No" for the previous question)	Radio box	• Yes (2) • No (0)
Category by marks Well-controlled arthritis = 0-1 marks Partly controlled arthritis = 2-4 marks Uncontrolled arthritis = 5-12 marks			

D. Diary Form Questionnaire

Table 3 shows the questionnaire questions for the diary form, where the pain level option is adapted from [14]. A diary form is used to help users to record their pain events that are associated with weather conditions.

Table 3. Diary Form Questionnaire

	Question	Type of input	Option available
1.	When?	Date time	Eg: 20/1/2023 10.00a.m or now
2.	Weather Condition	Drop down box	• Sunny • Cloudy • Rainy
3.	How are you feeling?	Drop down box	• No pain • Mild pain • Moderate pain • Intense pain • Extremely intense pain
4.	Did your arthritis symptoms disrupt your activity?	Radio box	• Yes • No
5.	Description	Text box	Eg: Saw the clouds outside the windows and stronger wind. My joints feel numb and starting to have some pain.

E. User Acceptance Test

The User Acceptance Test is an integral part of the software testing process, aiming to ensure error-free software systems. Based on the literature review by [15], the principal factors for mobile health application user acceptance include ease of use of the application, trust, and perceived value of service. Therefore, the user acceptance test of

TAMes' would focus on usability, data privacy, and effectiveness of the service provided by TAMes. Table 4 shows the questionnaire questions for the user acceptance test of TAMes.

Table 4. User Acceptance Test Questionnaire

	Aspect	Questions
1.	Usability	Is the user interface intuitive and easy to navigate?
2.		Are there any difficulties in accessing and using the app's features?
3.	Data privacy	To what extent do you feel confident about the security and privacy of your personal health data within the TAMes application?
4.		Did you encounter any concerns or issues related to data privacy while using the app?
5.	Effectiveness of Service	Did the TAMes app provide valuable and relevant health information or services?
6.		Were you satisfied with the overall effectiveness and usefulness of the services offered by TAMes?
7.	General Feedback	Overall, how satisfied are you with TAMes mobile application?
8.		What improvements or additional features would you suggest improving the overall user experience with TAMes mobile application?

IV. RESULTS AND DISCUSSIONS

A. System Overview

Figure 3 shows the system overview diagram of the proposed system. The user's smartphone, Firebase Firestore, and OpenWeather API are all connected via the internet in this application.

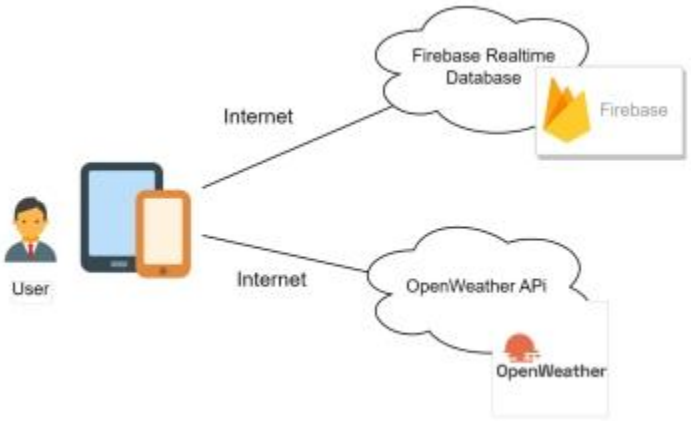


Figure 3. System Overview Diagram

Firebase real-time database will be used as a cloud database to store all the user account details and user-related data. This proposed system utilised OpenWeather API to retrieve current and forecast weather details to provide health recommendations to the user.

B. Generation of Health Recommendations

Figure 4 illustrates the process of generating health recommendations for a user. Firstly, the application TAMes will get current weather information and weather forecast information from OpenWeather API and go through a "generate health recommendation" process.

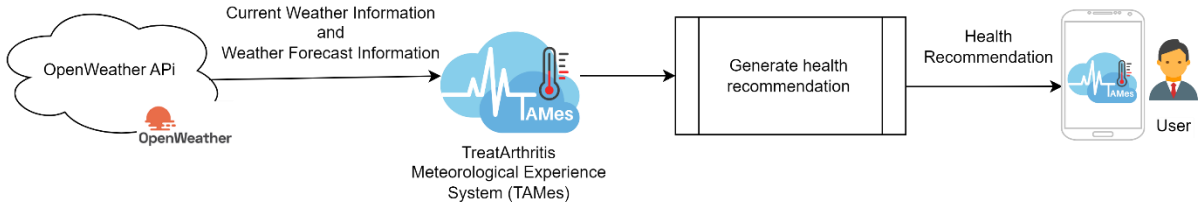


Figure 4. Process of Generating Health Recommendations

Steps in generating health recommendations include:
1. Identify Thresholds:
Establish specific thresholds or ranges of humidity and barometric pressure that correlate with pain events. For instance, define a threshold for high humidity based on a certain percentage of humidity, and consider significant barometric pressure changes when they exceed or fall below a specific threshold.

2. Analyse Weather Data:
Evaluate whether the current or forecast weather conditions fall within the predefined ranges by comparing the weather data with the established thresholds.

3. Generate Health Recommendations:
a. High Humidity:
If the humidity exceeds the defined threshold, display a warning to arthritis patients that says,
"High humidity levels are associated with increased pain. To reduce discomfort, consider using a dehumidifier at home and wearing breathable clothing."

b. Barometric Pressure Changes:
If there is a significant increase in barometric pressure, display a health recommendation that says,
"A rise in barometric pressure is associated with a lower probability of pain events. Use this weather trend to your advantage by doing light exercises or other activities that increase joint flexibility.
If there is a significant decrease in barometric pressure, provide a health recommendation like:
"A drop in barometric pressure may result in increased pain. Consider doing moderate stretching exercises or using pain relief medications as prescribed by your healthcare provider."
After the health recommendation is generated, it will be displayed to the user through TAMes' user interface.

C. Result

Figure 5 shows the weather view screen of the TreatArthritis Meteorological Experience System (TAMes). Users will have to have an account and log in to the system to access the weather view screen. On the weather view screen, users can click the "location" icon button at the right top to update the current location. The current location is shown at the top of the weather view screen. After updating the current location, the weather information of the current time and forecast information that is retrieved from OpenWeather API will be updated. Both current weather and forecast weather will include details of weather information like temperature, humidity, wind speed, and barometric pressure. The weather forecast information is shown in an hourly and daily manner. The health recommendation section is in the middle of the screen and will update based on the current weather and weather forecast information. The bottom of the screen is a bottom navigation bar that users use to navigate through the screens of the application.

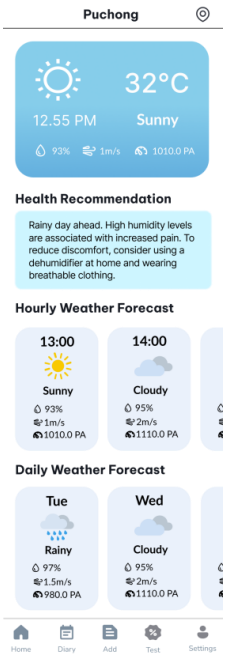
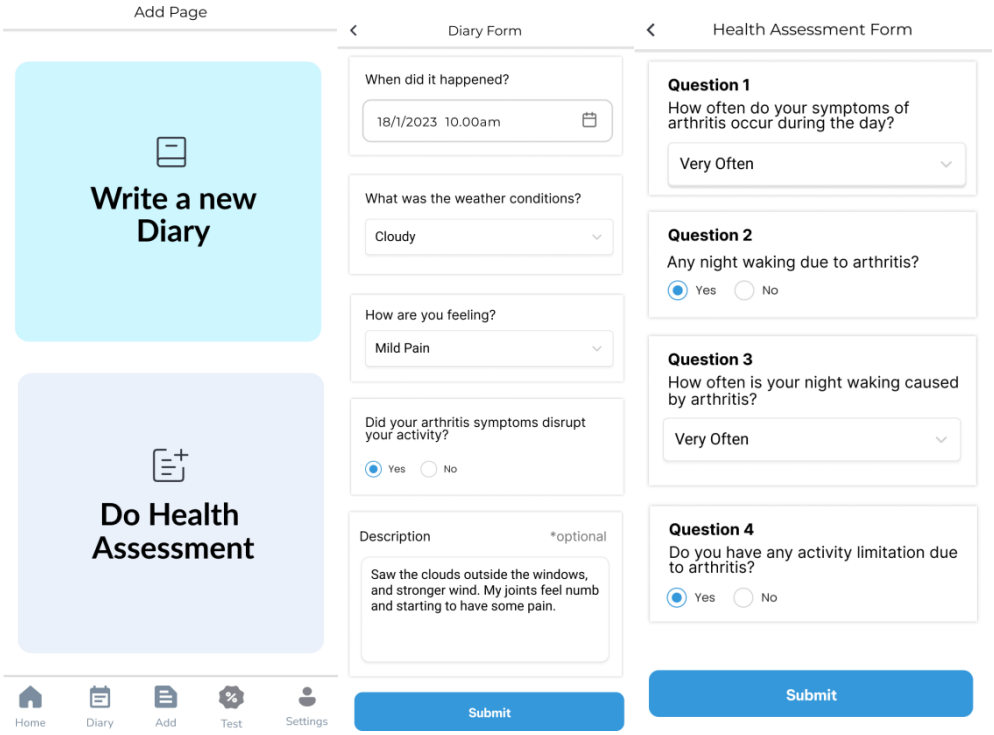


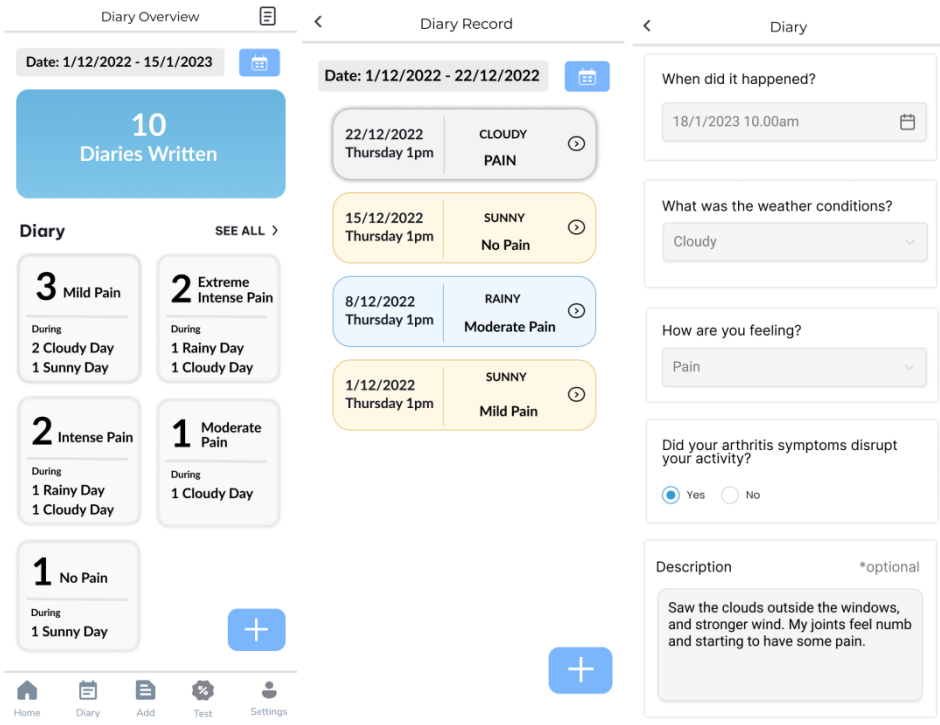
Figure 5. Weather View Screen of TAMes

Figure 6 shows the add screen and questionnaire screens that enable users to create new diaries and do health assessments. A diary is for a user to document pain events they have experienced. Health assessment is for users to know what the category of their arthritis condition is. Figure 6 (a) displays intuitive icons and clear labels for the user to choose between creating a new diary or doing a health assessment.



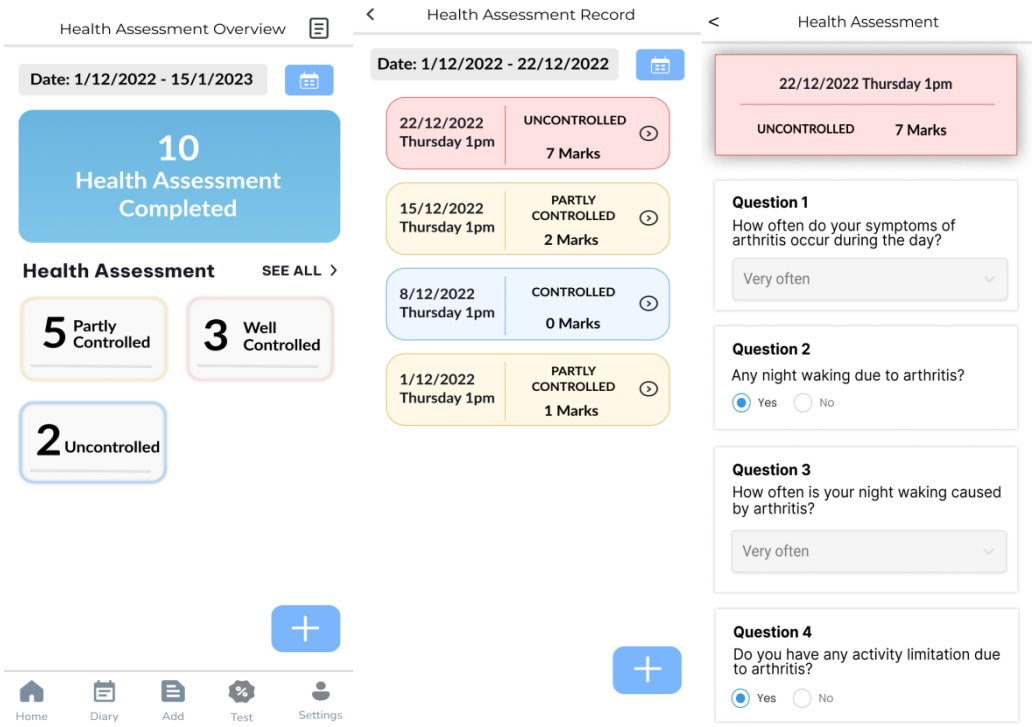
(a) Add screen (b) Diary Form (c) Health Assessment Form

Figure 6. Add Screen and Questionnaire Screens. (a) Add Screen That Provides Users the Option to Write a New Diary or Do a Health Assessment. (b) Diary Form Screen. (c) Health Assessment Form Screen



(a)Diary Overview Screen (b) Diary Record Screen (c) Diary Detail Screen

Figure 7. Diary Screens of TAMes. (a) Diary Overview Screen That Shows an Overview of Diaries. (b) Diary Record Screen. (c) Diary Detail Screen



(a)Health Assessment Overview Screen (b) Health Assessment Records (c) Health Assessment Detail

Figure 8. Health Assessment Screens of TAMes. (a)Health Assessment Overview Screen (b) Health Assessment Records Screen. (c) Health Assessment Detail Screen

Figure 7(a) shows the number of diaries he/she completed, and it categorizes the diaries based on the pain level and weather conditions. This categorization allows users to get an overview of their pain event during a specific time span. Users can filter the date of the diaries in this overview screen by clicking the "calendar" icon button that is located at the top right of the screen. Users can view the diary record by clicking the "list" icon at the right top of the screen or by clicking the "see all >" text button that is in the middle of the screen. Figure 7 (b) shows the diaries that the user created in a list view. Users can filter the date of the diary on this diary record screen by clicking the "calendar" icon button that is located at the top right of the screen. Figure 7 (c) shows the diary form that the user wrote in detail.

Figure 8 (a) displays an overview of the user's response to health assessments showing the health assessment categories. Figure 8 (b) shows a list view of health assessment in a specific time span. The user can filter the results by clicking the top right "calendar" icon button. Figure 8 (c) displays a health assessment that the user did in detail.

Figure 9 shows the email verification screen that will show to new users who just logged in to the system without completing the email verification process. The user can resend email verification or click the 'Restart' text button that will redirect the user to the login page view of TAMes. Firebase's email authentication service is implemented in this system to ensure the email that the user used to register belongs to the user and that a specific action is performed by the rightful owner of the associated email address.

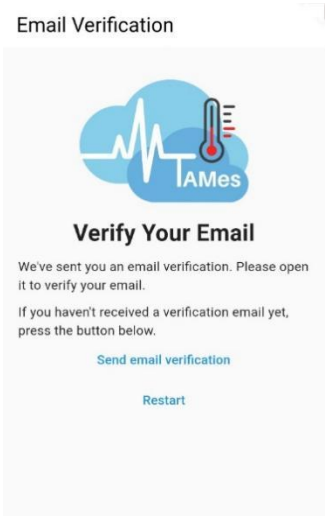


Figure 9. Email Verification Screen of TAMes

D. User Acceptance test result

To conduct a user acceptance test, the TreatArthritis Meteorological Experience System (TAMes) has been released to a group of 30. This testing phase aims to evaluate the application's usability, data privacy, effectiveness of service, and gathering user feedback. A Google Form consisting of 8 questions has been prepared as a medium for this user acceptance test. The first part of the questionnaire (questions 1-2) focuses on testing the application's usability and ease of use. Subsequently, questions 3-4 evaluate data privacy and questions 5-6 evaluate the effectiveness of service. Lastly, questions 7 and 8 are designed to collect feedback from users regarding their satisfaction with the application and suggestions for future enhancements.

Figure 10 displays the responses from Google form which include the first 2 questions. Based on a scale of 1 (Not intuitive) to 5 (Very Intuitive) for question 1, 56.7% of respondents rate 5 out of 5 (very intuitive) marks for the user interface. 40% of respondents rated 4 out of 5 (very intuitive) marks for the user interface while only 3.3% of respondents rate 3 out of 5 (very intuitive) marks for the user interface. For question 2, on a scale of 1 (Major Difficulties) to 5 (No Difficulties), 60% of the respondents rate 5 out of 5 (No difficulties) marks on accessing and using the app's features while 30% of respondents rate 4 out of 5 marks on accessing and using the app's features. 6.7% of respondents rate 3 out of 5 marks and only 3.3% of users rate 2 out of 5 marks on accessing and using the

app's features. The 1 user that rated 2 out of 5 marks didn't mention any additional comment or write general feedback in his /her response.

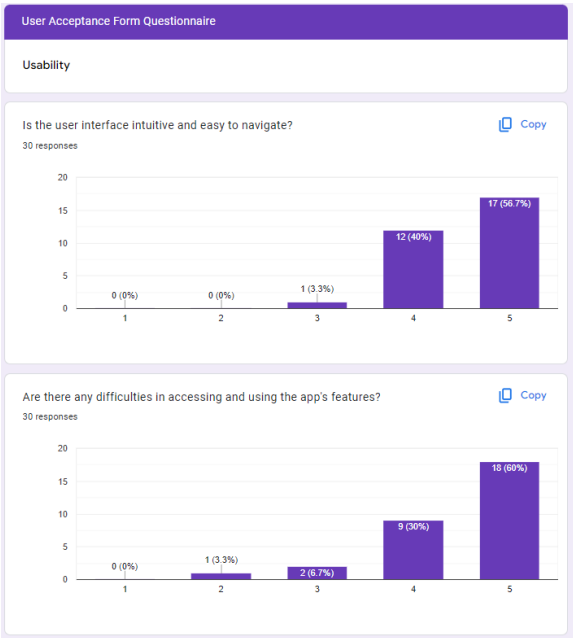


Figure 10. Questions and Responses for the Usability Section

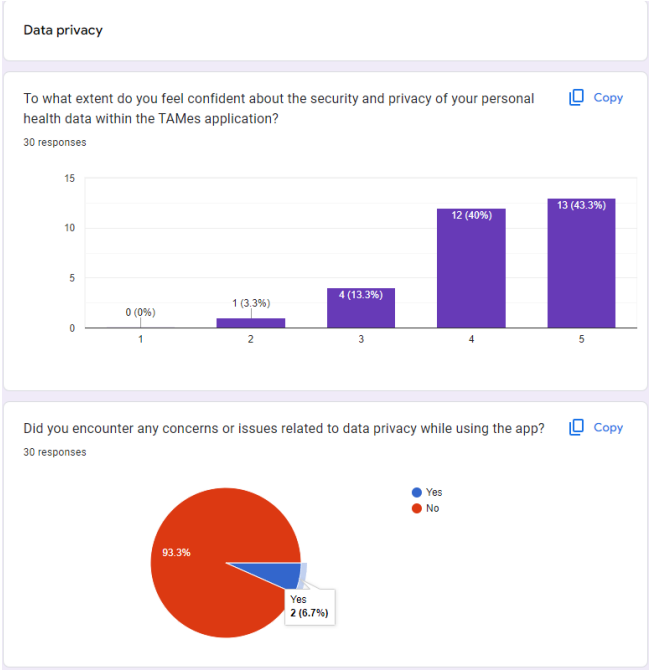


Figure 11. Questions and Responses for Data Privacy Section

Figure 11 shows the first and second questions in the data privacy section, for the first question, on a scale of 1 (Not Confident) to 5 (Very Confident), 43.3% of the respondents rate 5 out of 5 (Very Confident) and 40% of the respondent rate 4 out of 5 marks on the extent that they feel confident about the security and privacy of their personal health data within the TAMes application. 13.3% of respondents rated 3 out of 5 and only 3.3% of the respondents rated 1 out of 5 marks on the extent they feel confident about the security and privacy of your personal health data within the TAMes application. For the second question of the data privacy section, 93.3% of respondents have not encountered any concerns or issues related to data privacy while using the app and only 6.7% of respondents encountered any concerns or issues related to data privacy while using the app.

Figure 12 shows the first and second questions on the effectiveness of service section, for the first question, on a scale of 1 (Not Valuable) to 5 (Extremely Valuable), 53.3% of the respondent rate 5 out of 5 (Extremely Valuable) and 40% of the respondent rate 4 out of 5 marks on the extent to which the TAMes app provided valuable and relevant health information or services. Only 6.7% of respondents rated 3 out of 5 on the extent to which the TAMes app provided valuable and relevant health information or services.

For the second question, on a scale of 1 (Not Satisfied) to 5 (Very Satisfied), 46.7% of the respondents rated 5 out of 5 (Very Satisfied) and 43.3% of the respondents rated 4 out of 5 marks on their satisfaction with the overall effectiveness and usefulness of the services offered by TAMes. 6.7% of the respondents rated 3 out of 5 marks and 3.3% of the respondents rated 2 out of 5 marks on their satisfaction with the overall effectiveness and usefulness of the services offered by TAMes.

The continuous improvement upon Figure 12 feedback includes gathering user feedback and conducting regular updates to improve the application functionality and user experience. We have also considered incorporating additional features based on user suggestions, such as medication reminders, appointment scheduling, or integration with wearable devices for more accurate symptom tracking.

Figure 12. Questions and Responses for Effectiveness of Service Section

Figure 13 shows the first question in the general feedback section, for the first question, on a scale of 1 (Not Satisfied) to 5 (Very Satisfied), 50% of the respondents rated 5 out of 5(Very Satisfied), and 40% of the respondent rate 4 out of 5 marks on their satisfaction with the TAMes mobile application. Only 10% of respondents rated 3 out of 5 marks on their satisfaction with the TAMes mobile application.

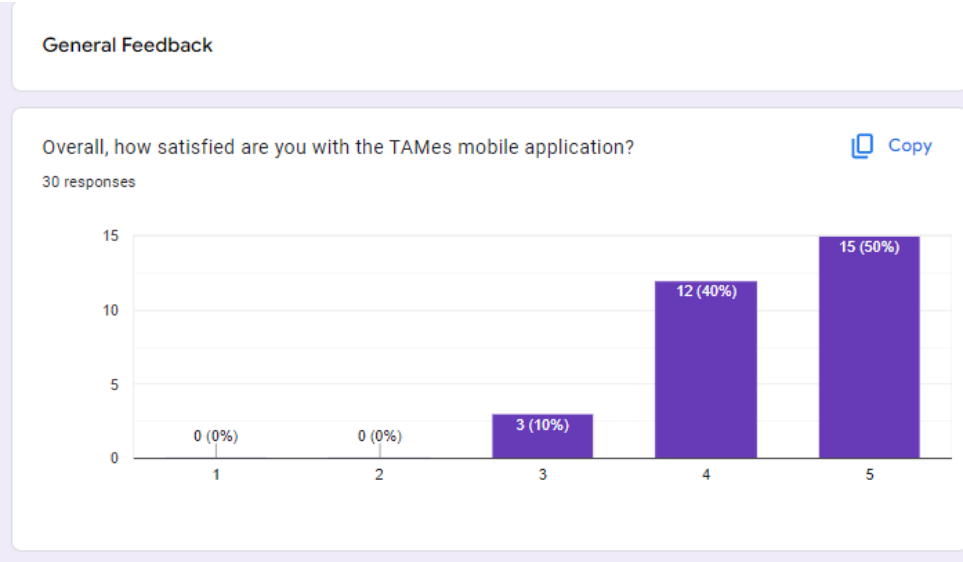
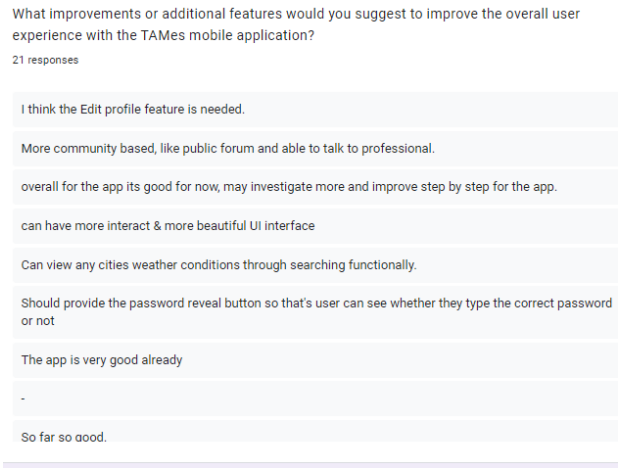
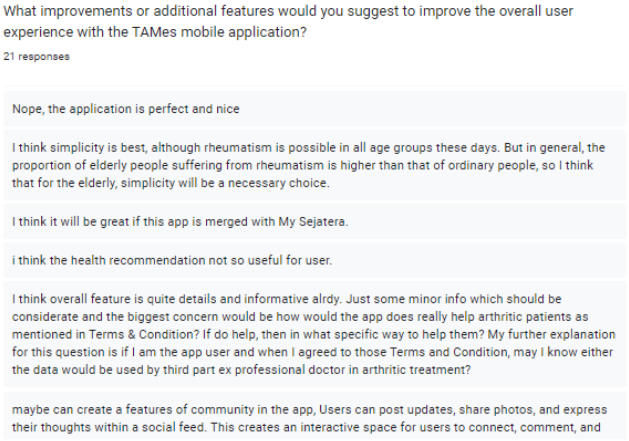


Figure 13. First Question of General Feedback Section

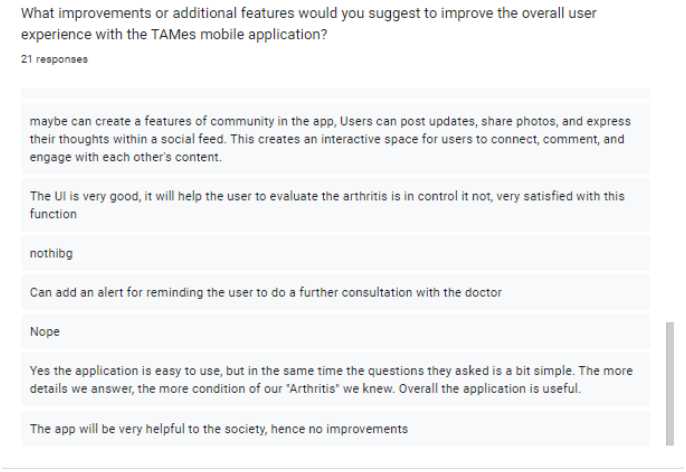
Figure 14 shows the second question in the general feedback section, question 2 of the general feedback section collects the general feedback from respondents and 21 responses are received. Some of the suggestions are included in the newest version of the application and some will be included in the future work of this system.



(a) Second Question of General Feedback (part 1)



(b) Second Question of General Feedback (part 2)



(b) Second Question of General Feedback (part 3)
(c)

Figure 14. Second Question of General Feedback. (a) Second Question of General Feedback (part 1) (b) Second Question of General Feedback (part 2). (c) Second Question of General Feedback (part 3)

V. FUTURE WORK

This Weather-Based Arthritis Tracking Mobile Mechanism can be further improved in several aspects to help users manage their arthritis symptoms. The improvements such as creating personalized health recommendations, data analysis, creating a notifications system, ensuring accessibility, and collaboration with healthcare professionals.

A. Health recommendations generation with machine learning

The generation of Health recommendations can be improved by incorporating machine learning. With more data and the ability to learn from user feedback, health recommendations can be more useful and tailored to arthritis patients. The use of health recommendation systems is found in other parts of the e-health domain as well. E-health domains like dietary, activity assistance [16], and cardiovascular disease [17] are incorporating recommendation systems aiming to aid healthcare professionals in making quick and accurate medical judgments [18]

One of the categories of recommendation systems is the collaborative filtering recommendation system. It employs implicit or explicit user ratings from prior data and can examine products [19]. Users can give feedback on the effectiveness of the health recommendations and this dataset can help improve the generation of recommendations.

Collaborative filtering recommendations can be enhanced by demographic correlation [20]. By categorizing users based on demographic attributes like age, and gender [21], this recommendation system can learn how to give more accurate health recommendations to different age group users [22], making the health recommendations less generic.

Figure 15 demonstrates the system overview of an improved health recommendation system where users provide feedback and demographic attributes to enhance the recommendation system. For the data analysis and insights, one can utilize the Firebase database to securely store and analyze user-generated data. This would identify correlations between weather conditions and symptom severity to generate meaningful insights and visualizations that can be shared with users to help them better understand their condition.

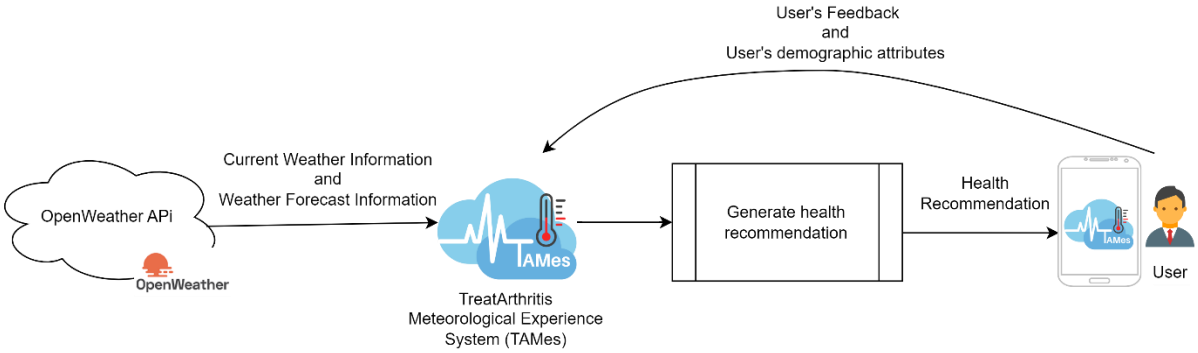


Figure 15. System Overview of Improved Health Recommendation System

B. Data Analysis

By incorporating data analysis techniques, it is possible to provide users with more meaningful insights and data visualizations regarding the correlations between their symptom severity and weather conditions. The existing "Create a new diary" function has already gathered user data on symptom severity and weather conditions. With the application of appropriate data analysis techniques, user-generated data can be effectively applied to enable users to gain a deeper understanding and make informed decisions regarding the management of their symptoms and the planning of their activities.

C. Collaboration with Healthcare professionals

Collaboration with healthcare professionals such as rheumatologists and physical therapists can ensure that the health recommendations are in line with recognized medical guidelines. With healthcare professionals' expertise and regular feedback throughout the development stage of the app, in-depth and accurate suggestions on lifestyle adjustments can be provided to users and can assist the user to alleviate or manage symptoms during some weather conditions.

VI. CONCLUSION

In conclusion, the TreatArthritis Meteorological Experience System (TAMes) represents a significant advancement in the field of arthritis management, addressing several key issues identified in the paper's contributions. TAMes acknowledges the influence of weather on arthritis symptoms, aligning with existing research and providing practical solutions for weather-related challenges faced by patients. Furthermore, TAMes identifies a critical gap in the current landscape of arthritis management: the absence of a mobile application that combines weather forecasting with health recommendations. By setting out to develop this novel weather-based mobile mechanism for arthritis tracking, TAMes offers an innovative and comprehensive approach to improving patients' lives. Moreover, TAMes places a strong emphasis on user-centric design, ensuring a user-friendly interface and reliable data collection methods. This focus on usability and data collection for health assessment adds substantial value to the proposed research, making it accessible and beneficial for arthritis patients.

In summary, TAMes is not just a mobile application but a holistic solution designed to empower arthritis patients. TAMes equips users with the tools to proactively manage their condition, make informed decisions based on weather

forecasts such as temperature, humidity, and atmospheric pressure, as these can influence arthritis symptoms, receive health recommendations, and accurately track their pain events. Furthermore, TAMes sheds light on the intricate relationship between arthritis symptoms and weather conditions, enhancing users' understanding of their condition. Ultimately, TAMes enables individuals to regain control over their arthritis, leading to improved overall well-being and quality of life. Future work includes the ability to provide suggestions on activities, exercises, or lifestyle adjustments that can help alleviate or manage symptoms during specific weather conditions.

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