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Integrated Mobile Healthcare Application for Binary Eczema Screening and Real-Time Environmental Tracking using MobileNetV2 and Open-Meteo API

Elya Sufiyah Iskandar[1], Jumanah Maryam Madina Mohamed[1], Nuraisyaa Czarina Mohd Zamani[1], Mazniha Berahim[1]*

1 Department of Information Technology, Centre for Diploma Studies
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author: mazniha@uthm.edu.my
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Abstract

Eczema management requires continuous monitoring of skin lesions and environmental factors to prevent severe flare-ups. However, patients lack accessible, automated tools to easily distinguish eczema from other skin conditions, and existing platforms fail to centralise basic educational support alongside localised atmospheric awareness. To solve these issues, this project designed and developed a mobile application named Smart AI-Based Eczema Scanner Application to provide binary skin classification, real-time climate tracking and interactive skincare guidance. The system incorporates a MobileNetV2 architecture via TensorFlow Lite for on-device image analysis, utilizes the Open-Meteo API and Maps.co Reverse Geocoding API for localised weather monitoring and uses a remote MySQL database via a PHP API for user data storage. System evaluations demonstrated that the deep learning model successfully outputs percentage probabilities for Eczema or Normal Skin/Not Eczema categories, while System Usability Scale (SUS) testing with 30 participants yielded an exceptional mean score of 91.58. The original value of this project lies in its novel consolidation of a binary skin screening engine, localised weather tracking and an educational chatbot with strict medical disclaimers within a single, integrated user interface. Ultimately, this application provides a robust foundation for digital dermatological screening and significantly improves proactive skin health management for the eczema community.

1. Introduction

Several previous studies and mobile apps have attempted to support individuals with skin problems through digital platforms. Several local studies have shown interest in developing mobile tools for dermatological assessment; however, many existing systems are still limited in functionality. For example, the Skin Analyser app was developed to determine skin type and recommend skin care ingredients, but the app is primarily focused on beauty care and does not provide medical-grade eczema analysis, such as automated eczema detection or generalised educational guidance [1]. Similarly, the Mobile Eczema Support System allows users to record symptoms and monitor weather conditions; however, the system lacks automation and AI-based analysis, relying

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heavily on manual user input [2]. Another app, EczyCode, allows users to scan the barcode of skin care products to assess the safety of ingredients for eczema-prone skin, but it does not include skin condition analysis or environmental data integration [3].

International studies have suggested more advanced approaches, including photography-based monitoring and AI-driven severity assessment. Mobile applications focused on continuous monitoring of hand and foot eczema have been introduced; however, user engagement remains a challenge due to limited interactive features [4]. Other studies have examined AI-powered eczema image analysis, but limitations such as small datasets result in inconsistent accuracy and reduce the reliability of AI predictions [5]. Additional applications emphasise symptom documentation and image upload but still rely on manual tracking and lack AI-driven analysis or environmental integration [6, 7]. AI-based eczema management applications designed for children have demonstrated the feasibility of AI severity scoring, but continue to face challenges related to lighting inconsistency, image angle sensitivity and low user compliance [8, 9]. Furthermore, recent studies have highlighted that existing AI-based eczema detection systems suffer from limited dataset diversity, limiting model generalisation across different users and conditions [10].

When reviewed collectively, a clear research gap emerges. Existing solutions tend to focus on individual aspects such as image scanning, symptom logging, weather monitoring or material inspection. However, none of the systems reviewed combines AI-based skin detection, real-time environmental data obtained via the Weather API and interactive guidance via an AI chatbot in a single integrated platform. This fragmentation may reduce the system's effectiveness and long-term user engagement. Therefore, there is a strong need for a comprehensive, automated mobile solution that integrates these distinct components to support more accessible preliminary screening and safe digital educational guidance.

1.1 Problem Statement

Eczema patients lack an accessible, automated method to quickly screen their skin surface and determine whether a sudden inflammation represents an eczematous flare-up or a non-eczematous condition. Because patients cannot immediately run a reliable preliminary evaluation, they continue to rely on dangerous guesswork or trial-and-error treatments. This lack of immediate screening tools directly contributes to eczema mistreatment, delayed professional clinical attention and worsening dermatological symptoms.

Second, existing digital platforms fail to centralise basic educational support alongside localised atmospheric awareness. Current tools do not display real-time environmental data alongside localised skin-scanning interfaces, which limits a user's access to environmental information while monitoring skin conditions. Without a unified dashboard that displays general atmospheric metrics next to baseline screening features, patients struggle to stay easily informed about the localised environmental conditions that naturally affect their general skin wellness.

Third, traditional eczema management platforms rely heavily on complex, manual user inputs that result in low long-term engagement and poor utility integration. Many existing applications require users to manually type long symptom logs, track multi-class disease subtypes, or navigate overwhelming e-commerce interfaces for skincare products. This demanding manual approach increases the likelihood of incomplete monitoring and frustrates users who simply need basic guidance. Furthermore, conversational health interfaces often lack strict, prominent medical disclaimers, and this omission inadvertently encourages users to treat software recommendations as definitive prescriptions.

1.2 Objectives

The project objectives are:

(i) To design and develop an AI-based Mobile Application named Smart AI-Based Eczema Scanner Application that can scan skin lesions and perform classification into Eczema or Normal Skin/Not Eczema categories.

(ii) To develop a localised environmental dashboard module that fetches and displays real-time general weather metrics (temperature) via the Open-Meteo API and Maps.co Reverse Geocoding API to provide users with basic environmental situational awareness.

(iii) To integrate an AI-powered conversational chatbot within the mobile application capable of answering general educational inquiries regarding eczema management, providing simple skincare product recommendations and systematically enforcing medical disclaimers.

1.3 Related Works

Many existing mobile applications focus either on heavy manual symptom journaling or complex multi-class diagnostic models. A comparison of existing eczema-related digital systems is summarised in Table 1 to highlight

the functional gaps that remain unaddressed. To highlight the functional gaps remaining in existing systems, a detailed evaluation of several market applications was conducted. The capabilities and distinct limitations of these eczema-related digital tools are comprehensively summarised in Table 1.

Table 1 *Comparison of existing eczema-related digital systems*

System/Application	Capabilities	Limitations
Skin Analyser App [11]	Offers skin type analysis and cosmetic ingredient analysis.	Not clinical, no eczema detection, no integration with environment.
Mobile Eczema Support System [12, 13]	Links symptoms with environmental factors; supports daily journaling.	Requires manual entry; does not involve automation or AI identification.
General Dermatology AI Apps [14, 15]	Utilises AI Technology for melanoma classification; has shown efficient performance for controlled datasets.	Poor performance on actual images, biased data sets, not optimised for binary classification.
Symptom Journaling Apps [16, 18]	Enables users to record their symptoms, triggers and routines.	Low engagement, no automation, no predictive analytics, no diagnostic capabilities.
Ingredient Checker Apps [19, 20]	Assists in understanding product composition and allergens.	Non-invasive, does not analyse skin, no prediction of flare-ups, no significance in monitoring.

As shown in Table 1, current solutions are fragmented because they often lack essential features such as dedicated binary image scanning, basic environmental viewing and simple product advice within a single application platform, further strengthening the need for the proposed Smart AI-Based Eczema Scanner App.

Although great strides have been taken in attempting to apply AI in dermatology, most of these models are designed for multi-class classification or melanoma detection, as opposed to straightforward binary classification for inflammatory conditions such as eczema [21-25]. Although those multi-class models are successful for dermoscopic datasets, their application on standard smartphone images often proves to be substandard due to noise, uncontrolled illumination and differences in skin tones [26, 27].

Furthermore, complex multi-class networks are frequently seen as unvalidated systems because they try to classify too many skin categories at once, leading to confusion during user self-assessments [28, 30]. Therefore, this project simplifies the classification task by focusing entirely on a system that separates Eczema from Normal Skin or Not Eczema. This approach uses transfer learning with MobileNetV2 and displays a clear percentage probability using a sigmoid function.

Environmental components also contribute to the comfort of individuals managing eczema, but this aspect has limited integration with contemporary mobile health tools. Findings support that environmental factors like ambient local temperature directly affect skin barrier conditions [31-38]. Contrary to expectations, many mobile apps do not include weather viewing features alongside product recommendations, which creates a technology gap for users who want a centralised view of their current surroundings.

Another important limitation found in existing systems is that they rely heavily on manual data entry or static data inputs rather than interactive information tools [39-40]. While some applications include generic chatbots, they rarely function alongside automated utilities like a binary skin scanner or real-time weather information components [26]. Additionally, poor user interface design in past applications often reduces overall engagement because the layouts are inflexible [41].

In conclusion, it can be said that present-day technology-based eczema tools are fragmented because they do not combine image scanning with everyday environmental context. This project addresses this development gap by developing an application that integrates a MobileNetV2 scanner, a generalised AI chatbot with explicit medical disclaimers, a general weather display using the Open-Meteo API together with the Maps.co Reverse Geocoding API and simple skincare product recommendations connected to a central MySQL database using a PHP API.

2. Methodology

The project utilises the Agile Development methodology to emphasise incremental progress and flexibility through regular, adaptive cycles. The Agile model used in this project is characterised by a repetitive cycle of stages designed to systematically improve software quality with every loop. Instead of running multiple separate project cycles, the entire development lifecycle was executed through one single comprehensive sprint that

progressed sequentially across seven distinct stages, which are Analyse, Plan, Design, Built, Test, Review and Launch, as illustrated in Fig. 1.

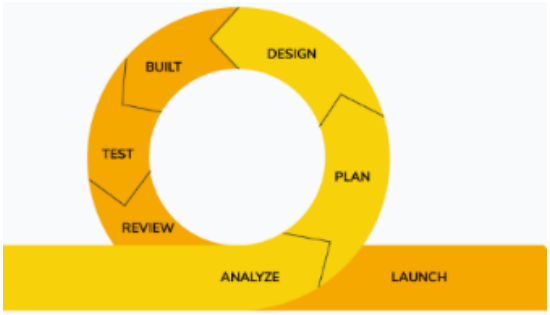

Fig. 1 *Agile development methodology adopted in this project*

The Agile Development Methodology initiated with the Analyse and Plan stages, where user needs and technical requirements were gathered to establish the baseline functional specifications for the system. This moved directly into the Design stage, where system interactions and architectural frameworks were mapped out to guide development. During the Built stage, the core features, including the deep learning scanner, environmental API integration and the conversational chatbot, were fully coded and combined into a single system environment. After development, the Test and Review stages were conducted to run unit and functional tests across all completed components while gathering targeted interface and usability feedback. Finally, during the Launch stage, minor database connectivity issues discovered during the testing loop were resolved, allowing the fully integrated mobile application to be successfully deployed for its final release. This continuous loop ensures that the final product is highly polished, functionally verified and meets the exact operational requirements for skin condition scanning.

2.1 Analyse Phase

The analysis phase focused on gathering and examining the requirements for the eczema scanner by evaluating the practical needs of eczema patients and their caregivers to identify the most critical features for the application. The team reviewed the current limitations of manual skin monitoring and determined how AI can provide a more efficient solution, while studying the technical constraints of the MobileNetV2 model and the Open-Meteo API alongside the Maps.co Reverse Geocoding API to ensure seamless integration within the Android environment. To justify development, a Google Form survey was distributed to 40 respondents in Malaysia (patients and caregivers), revealing that 60.0% find it hard to identify if a skin change is eczema or a temporary rash, 90.0% feel frustrated or stressed by trial-and-error treatments, 87.5% experience worsened symptoms in hot or humid weather, 80.0% demand a mobile application that displays weather conditions for skin awareness and 92.5% maintain a moderate-to-high trust rating (Scales 3–5) for AI-driven skincare advice.

Table 2 *Refined summary of survey findings and explicit data mapping (40 respondents)*

Problem Area	Key Finding	Target Response Options	Result	Justification
Section B: Eczema Challenges	Users struggle to know if a skin change is actually eczema or a normal, temporary rash.	Yes, it is very confusing.	60.0%	AI-Powered Binary Scanner: A direct solution to reduce manual tracking confusion and provide immediate preliminary probabilities.
		Sometimes	27.5%	
		No, I know exactly what type it is	12.5%	
	Users feel frustrated or stressed when they cannot find the right treatment.	Yes	90.0%	
		Maybe	10.0%	
	Eczema symptoms get worse when the	Yes	87.5%	Open-Meteo API Dashboard: Direct integration of real-

Section C: Weather & Environment	weather is very hot or very humid.	Maybe	12.5%	time environmental data to display temperature levels for daily trigger avoidance.
	Users find it helpful to have a mobile application that displays general weather conditions.	Yes, very helpful	80.0%	
		Maybe	20.0%	
Section D: Technology & Features	User trust level in Artificial Intelligence (AI) to provide skincare advice (Scale 1 to 5).	Score 3 (Moderate)	45.0%	AI Chatbot & History Log: High digital acceptance and requests for dietary, dust and pet trigger data validate an automated recommendation assistant.
		Score 4 (High)	30.0%	
		Score 5 (Very High)	17.5%	
		Scores 1 & 2 (Low)	7.5%	

As mapped out in Table 2, these precise metrics directly eliminate ambiguous data and justify the implementation of an AI-powered binary scanner to reduce skin identification uncertainty, a localised real-time weather dashboard for climate-trigger awareness and an interactive chatbot for personalised product recommendations.

The preliminary analysis demonstrates a clear justification for developing the application based on the identified user feedback. The data shows that a vast majority of respondents struggle with eczema identification and face significant frustration regarding stress management when looking for the right treatment. Furthermore, the high percentages in climate impact and proactive needs confirm that hot weather is a major trigger for skin flare-ups, driving a strong user demand for general weather viewing capabilities. Coupled with a high trust level for artificial intelligence acceptance, these findings validate that the integration of an image scanner, weather metrics and an educational chatbot is highly necessary to meet the actual needs of the target users.

2.2 Plan Phase

The planning phase involved establishing the project scope, defining core system requirements and organising all development activities into a single, comprehensive Agile Development. Instead of running multiple separate cycles, the entire development lifecycle was executed through one single sprint that progressed sequentially across seven distinct stages which are Analyse, Plan, Design, Built, Test, Review and Launch as illustrated in Fig. 1. The Agile Development Methodology initiated with the Analyse and Plan stages, where user needs were analysed through a preliminary Google Form survey distributed to 40 respondents to establish the baseline functional requirements for the system. This moved directly into the Design stage, where system interactions were modelled using Use Case, Class and Activity diagrams and high-fidelity user interface storyboards were generated in Figma. During the Built stage, the application was fully coded in Android Studio using Java, which involved training and integrating the MobileNetV2 architecture via TensorFlow Lite for the binary scanner, connecting the Open-Meteo and Maps.co APIs for weather data, embedding the conversational chatbot and setting up the MySQL database via phpMyAdmin using custom PHP API scripts. Following development, the Test and Review stages were conducted to perform unit and functional testing on the machine learning classification, API requests and database connectivity, which was followed by a usability evaluation where 30 participants tested the interface using the System Usability Scale framework. Finally, during the Launch stage, minor database connectivity errors were resolved, and the fully integrated mobile application combining the binary skin scanner, localised weather dashboard and interactive chatbot was deployed for its final release.

2.3 Design Phase

During the design stage, the structural plan and main setup of the application were mapped out to guide the development process. To give a clear overview of the whole project layout and show how the core AI features work with the standard parts of the app, a basic functional framework was created. This complete breakdown of user interactions, system boundaries and different pathways for both the image scanner and the chatbot is shown in Fig. 2.

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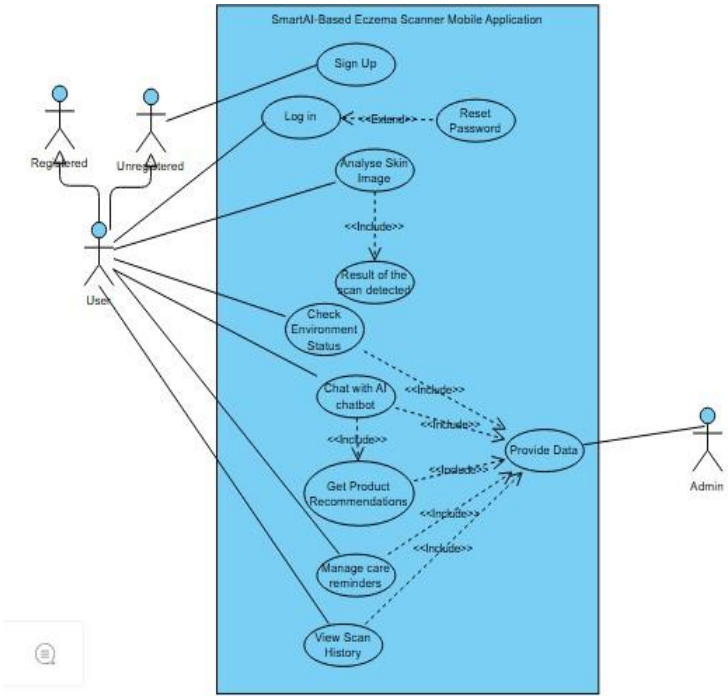


Fig.2 *Use Case Diagram of the Smart AI-Based Eczema Scanner Mobile Application*

Based on the layout shown in Fig.2, the system separates tasks between the primary user and the administrator. The user can interact directly with the main AI tools by uploading photos for skin analysis and talking to the chatbot for recommendations. At the same time, standard features like checking the weather or viewing past scan history run smoothly alongside these AI components. On the backend, the administrator manages and provides the necessary data to keep the application updated, making sure all the features work together as a complete system.

2.4 Build Phase

During this phase, Android Studio was used as the main platform to build the application using the Java programming language [42]. A big focus of this stage was training and putting in the automated skin scanner, which uses a lightweight neural network model called MobileNetV2 [44]. MobileNetV2 is designed for mobile phones because it uses inverted residuals and linear bottlenecks to keep the app running fast without using too much phone memory or battery [43]. This machine learning model was trained outside using skin datasets and then converted into a TensorFlow Lite (.tflite) file so it can run directly inside the Android app [43]. This setup lets the system do fast binary classification to scan skin photos and check for eczema right away without needing an external server, so the app does not lag, and user data stays private [43].

Besides the image scanner, the development also involved connecting the app to the Open-Meteo API [45] and the Maps.co Reverse Geocoding API [44] to make the weather tracker work. When a user opens the feature, the app gets the live GPS location coordinates from the phone [45]. These coordinates are passed straight to the Maps.co Reverse Geocoding API to change the raw numbers into a normal location name like a city or a district [44]. Right after that, the location name is sent to the Open-Meteo API to get real-time weather information like the local temperature and humidity levels so users can see it on their dashboard and stay aware of hot weather triggers [45].

To store all the app data, a MySQL database managed with phpMyAdmin was linked to the front-end using custom PHP API scripts. These scripts work as a bridge to handle backend tasks like user registration, login checking and saving the history of past scans [45]. When a user runs a scan, the MobileNetV2 engine checks the image locally [43] while the app concurrently calls the Maps.co [44] and Open-Meteo APIs [45] to get the current weather. The final results, which include the eczema percentage score [43], the city name [44] and the weather data [45], are then automatically saved into the MySQL database tables. By using a single sprint approach, the team managed to connect the local deep learning model [43], the online weather APIs [44, 45] and the database together smoothly, as shown in the integration diagram in Fig. 3.

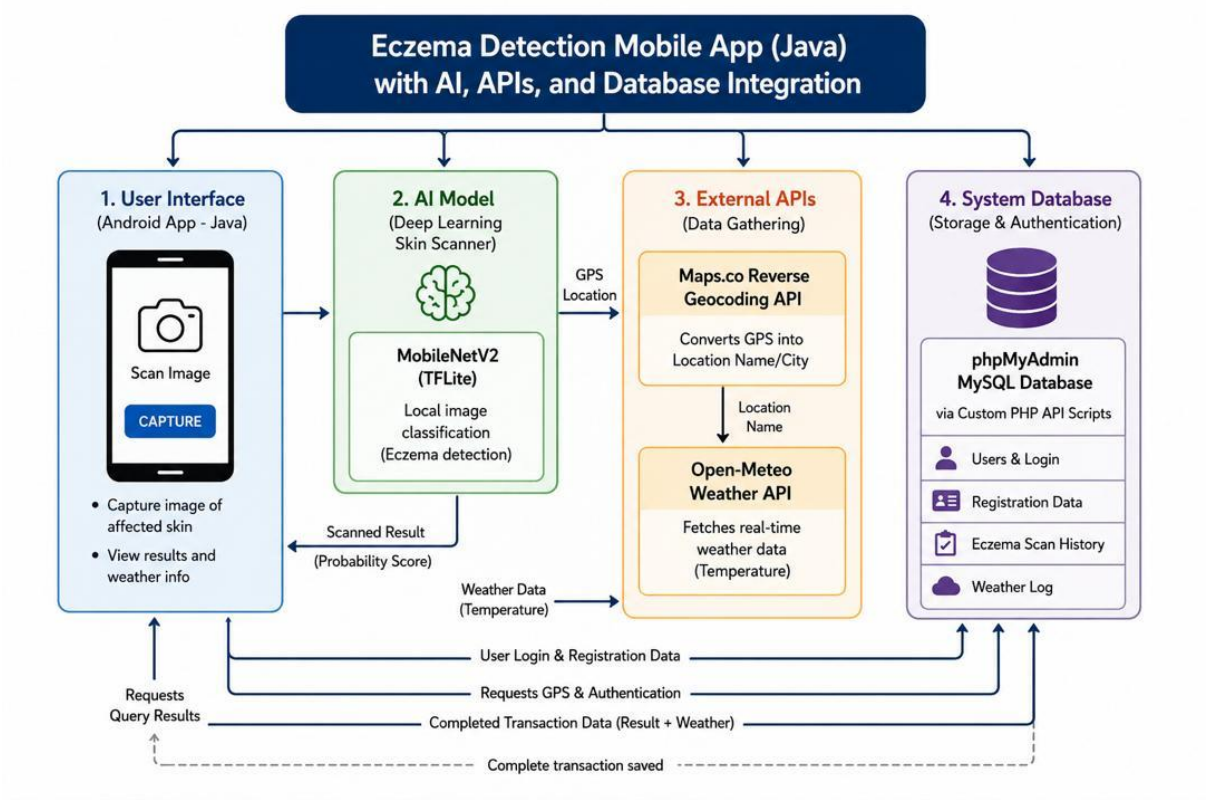


Fig 3 *Component architecture and technical data flow integration (AI Model, APIs and Database)*

2.5 Test Phase

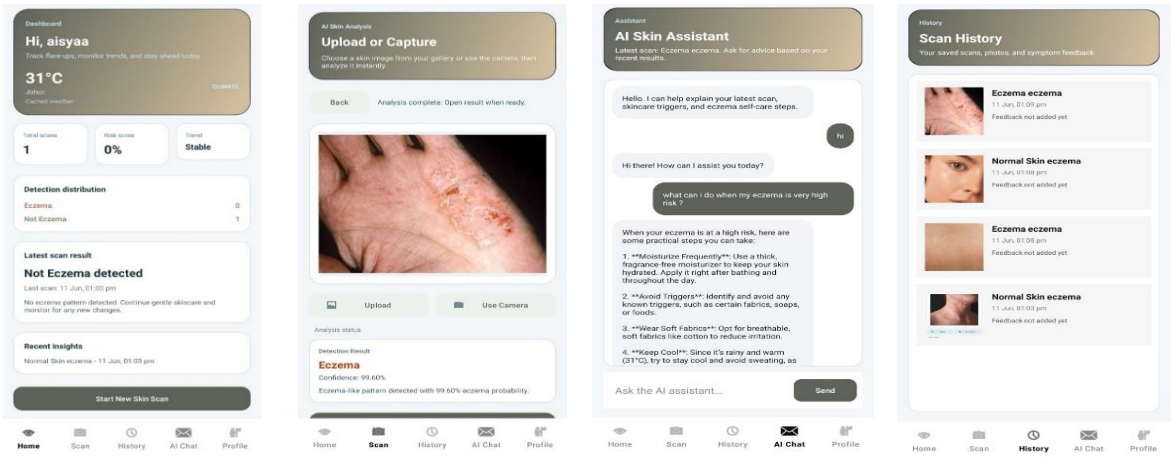
The verification process for module operation against functional requirements **before** deployment. Unit and functional testing protocols for the evaluation of skin image processing via the classification engine, percentage probability generation accuracy and clear weather data display alongside product recommendations without system crashes. Additional validation procedures for proper chatbot inquiry responses and the inclusion of explicit medical disclaimers**.** Compilation of an operational test case summary for tracking pass or fail metrics across user registration, login operations, image scanning and weather loading routines that send data to the MySQL database. Identification of minor database connectivity errors during initial testing, with subsequent code refinement for long-term stability and system reliability.

2.6 Review Phase

The final phase of the methodology involves a comprehensive review of the project outcomes against the initial research objectives. During this stage, feedback should be gathered from a pilot group consisting of individuals seeking skin health screening, including potential eczema patients and caregivers in Malaysia, to evaluate the usability of the mobile application interface, the accessibility of the automated deep learning scanner and the clarity of the generalised AI chatbot advice. This review process is essential for identifying any remaining bugs or areas for improvement. By evaluating the system performance and user satisfaction, it could be ensured that the Smart AI-Based Eczema Scanner is a robust and valuable tool for the eczema community in Malaysia.

3. Results and Discussion

The application offers a user-friendly interface designed to be accessible to users of all ages, enhanced by intuitive colour coding and responsive layouts that engage and assist in navigation. The system development resulted in a responsive and user-friendly Android mobile application interface. Fig.4 (a)-(d) present the visual layout of the primary application interfaces application Smart AI-Based Eczema Scanner screen.



(a) **(b)** **(c)** **(d)**

Fig.4 *(a)-(d) The visual layout of each application Smart AI-Based Eczema Skin Scanner Screen*

The system workflow consists of the following key interfaces:

(i) Localised Climate Dashboard: Fig. 4 (a) showcases the main dashboard featuring a personalised greeting and a live climate monitoring widget powered by the Open-Meteo and Maps.co APIs to give users immediate environmental awareness.

(ii) AI Skin Scanner Output: Fig. 4 (b) displays the binary skin classification results screen demonstrating the on-device MobileNetV2 engine processing performance by outputting clear percentage probabilities for eczema detection.

(iii) OpenAI Educational Chatbot: Fig. 4 (c) illustrates the interactive conversational assistant interface customised to answer general inquiries about eczema management alongside strict medical disclaimers.

(iv) Tracking and History Log: Fig. 4 (d) presents the chronological scan history ledger linked directly to the remote MySQL database to show how long-term dermatological data is securely stored and monitored over time.

3.1 Overall Usability Satisfaction

To find out the final usability level of the developed mobile application, the survey answers from all 30 participants were compiled and calculated. The calculations follow the standard System Usability Scale framework. This system uses ten questions with alternating positive and negative statements. Furthermore, a specific formula must be used to normalise the raw 1 to 5 scale answers into a standard score out of 100. For the positive statements, the score is calculated by subtracting 1 from the raw answer. For the negative statements, the score is calculated by subtracting the raw answer from 5. After that, the total points from all ten questions are added together and multiplied by 2.5. For complete data transparency, the exact response counts from the user charts and the calculated point contributions for each evaluation item are specified in Table 3 located in Appendix A.

$$\text{Total Scaled} = \text{Total Group Points} \times 2.5 = 1099 \times 2.5 = 2747.50 \quad (1)$$

$$\text{Final Mean SUS Score} = \frac{\text{Total Scaled Score}}{\text{Total Number of Respondents}} = \frac{2747.50}{30} = 91.58 \quad (2)$$

Consequently, the final total SUS score is calculated by taking the total group point score and dividing it by the total number of respondents (refer equation (1) and equation (2)).

Therefore, the final calculated usability score for the mobile application is 91.58. Based on the standard grading scale for the System Usability Scale, any score above 85 falls directly into the Grade A or Excellent category. Eventually, this high grade proves that the mobile application is easy to understand and comfortable to use. The result also shows that combining the automated deep learning scanner with simple interface pages creates a smooth mobile experience for the users.

4. Conclusion

This study successfully designed, developed, and evaluated the Smart AI-Based Eczema Scanner Application, addressing critical functional gaps in existing digital dermatological tools. By combining binary image classification, localised environmental monitoring, and interactive conversational guidance within a unified architecture, the application effectively mitigates the fragmentation present in current mobile health platforms. The integration of the MobileNetV2 architecture via TensorFlow Lite enables rapid, privacy-preserving, on-device preliminary skin classification into Eczema or Normal Skin/Not Eczema categories. Concurrently, the localized

weather module powered by the Open-Meteo API and Maps.co Reverse Geocoding API provides users with actionable real-time atmospheric data (temperature) to assist in identifying environmental flare-up triggers. Furthermore, the embedded AI chatbot delivers safe, personalised educational guidance while systematically enforcing medical disclaimers to prevent diagnostic misuse. For future work, the database tracking system handled by the MySQL backend can be optimised, while the underlying AI scanning model will be fine-tuned with a broader dataset to stabilise classification accuracy for both Eczema and Normal Skin outputs against real-world lighting variations.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm their contributions to the paper as follows: ***study conception and design:*** *Mazniha Berahim, Elya Sufiyah Iskandar, Nuraisyaa Czarina Mohd Zamani;* ***data collection****: Elya Sufiyah Iskandar, Nuraisyaa Czarina Mohd Zamani;* ***analysis and interpretation of results:*** *Mazniha Berahim, Elya Sufiyah Iskandar, Nuraisyaa Czarina Mohd Zamani;* ***draft manuscript preparation:*** *Mazniha Berahim, Elya Sufiyah Iskandar, Nuraisyaa Czarina Mohd Zamani. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A

Table 3 *Answer Distribution and SUS Point Contribution*

Question Item	Score 1	Score 2	Score 3	Score 4	Score 5	Calculation	Points
Q1: Want to use app frequently	0	2	2	3	23	(2x1) + (2x2) + (3x3) + (23x4)	107
Q2: Found app unnecessarily complex	23	3	2	2	0	(23x4) + (3x3) + (2x2) + (2x1)	107
Q3: Thought the app was easy to use	0	0	2	4	24	(2x2) + (4x3) + (24x4)	112
Q4: Need support of a technical person	22	4	3	1	0	(22x4) + (4x3) + (3x2) + (1x1)	107
Q5: Functions were well integrated	0	0	1	6	23	(1x2) + (6x3) + (23x4)	112
Q6: Thought there was an inconsistency	24	4	0	2	0	(24x4) + (4x3) + (0x2) + (2x1)	110
Q7: Imagine people learn it quickly	0	0	1	6	23	(1x2) + (6x3) + (23x4)	112
Q8: Found the app very cumbersome	24	2	3	1	0	(24x4) + (2x3) + (3x2) + (1x1)	109
Q9: Felt very confident using the app	0	0	2	4	24	(2x2) + (4x3) + (24x4)	112
Q10: Needed to learn many things first	23	4	2	1	0	(23x4) + (4x3) + (2x2) + (1x1)	111
Total Sum Score							**1 099**

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