Journal of Information Technology and Computer Science
Volume 11, Number 2, August 2026, pp. 185-199
Journal Homepage: www.jitecs.ub.ac.id

Development of the "Pulih" User Interface: A Smartwatch-Integrated Digital Counseling Application for Survivors of Post-Traumatic Stress Disorder due to Violence and Sexual Abuse

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Received 19 April 2026; accepted 14 June 2026

Abstract. The high prevalence of mental health disorders resulting from trauma caused by violence and sexual abuse has not been matched by adequate access to recovery services due to psychological barriers in the form of social stigma. This situation motivated the design of the "Pulih" interface, a smartwatch-based mental health support application developed using Research and Development (R&D) methods with a Design Thinking approach. This application integrates a Bidirectional Long Short-Term Memory (Bi-LSTM) deep learning architecture to analyze users' Heart Rate Variability (HRV) and Resting Heart Rate (RHR) biometric data in real-time. AI testing results on the WESAD physiological dataset showed stable learning curve convergence without overfitting, achieving a training accuracy of 92.0%, validation accuracy of 90.5%, precision of 90.0%, recall of 91.0%, and an F1-Score of 90.5%. Meanwhile, an evaluation of the interface's usability via the System Usability Scale (SUS) test with 27 respondents yielded an average score of 86.79 (falling into the 'Excellent' and 'Acceptable' categories with an A+ grade). The encrypted anonymous community feature further strengthens privacy aspects. In conclusion, Pulih has proven to possess trauma-sensitive technical reliability as well as high usability as an inclusive digital solution for the mental recovery of PTSD survivors.

Keywords: pulih, PTSD, smartwatch, digital counseling application

1 Introduction

Mental health is a state of emotional and psychological well-being that enables individuals to recognize their potential, cope with life's stresses, work productively, and contribute to society [1]. As such, mental health plays a crucial role in determining an individual's quality of life and ability to maintain balance in daily activities. However, this ideal state has not yet been fully achieved, even on a global scale. A report by the World Health Organization [1] indicates that nearly 1 billion people worldwide suffer from mental disorders. This high figure underscores that mental health has become a global crisis requiring serious attention from various stakeholders, including governments, healthcare institutions, and the broader public [2].

Various factors contribute to the rise in mental health disorders, such as social pressure, loss, and profound traumatic experiences. The World Health Organization (2022) [1] notes that violence, abuse, and traumatic experiences are among the greatest risk factors for the development of psychological disorders, including Post-Traumatic Stress Disorder (PTSD) [3]. Specifically, sexual violence and abuse hold a significant position because they directly impact an individual's sense of safety. Global reports indicate that sexual violence is one of the most prevalent forms of gender-based violence [4]. Data from the World Health Organization [5] reinforces these findings, indicating

that approximately 736 million people worldwide have experienced violence by a partner or another person at some point in their lives, with 26% of these cases involving physical or sexual violence by an intimate partner [6]. This figure underscores the high risk of long-term psychological trauma that can disrupt survivors' emotional stability.

This phenomenon is not only occurring on a global scale but has also become a serious issue in Indonesia. The National Commission on Violence Against Women [7] recorded 289,111 cases of violence in 2023, indicating that acts of violence remain widespread and have not yet been adequately addressed. Of this total, 41% involved psychological violence, followed by physical and sexual violence, each accounting for 25%. The psychological impact of these traumatic events is long-term and can impair the mental well-being of victims [8]. Specifically, a study on the psychological well-being of survivors of violence and sexual abuse by Salmany and Hartini [9] revealed that this group is at high risk of experiencing anxiety, sleep disorders, and depression, which can develop into Post-Traumatic Stress Disorder (PTSD). This indicates that sexual violence and abuse are not only human rights violations but also a serious threat to the mental health of the Indonesian population [10].

Most survivors face barriers to psychological recovery due to shame, fear of social judgment, and stigma surrounding mental health issues. McCleary [11] found that shame and internalized stigma are major barriers preventing victims of violence from seeking help, often delaying the recovery process. Digital technology innovations can serve as an alternative for providing safe and empathetic psychological support. Linardon [12] found that smartphone-based mental health apps effectively reduce levels of depression and anxiety. This is supported by a study by Chen [13] and Araib [14], which demonstrates the effectiveness of mobile apps in reducing stress and anxiety and improving users' well-being. However, previous studies still have limitations in providing a comprehensive approach to trauma recovery for survivors. Most mental health apps focus solely on self-report-based interventions without real-time biometric data support, making them less capable of objectively representing users' emotional states. Furthermore, the integration of artificial intelligence, biometric analysis, and a safe community support system has rarely been developed in a unified manner. This situation highlights a research gap in the development of adaptive, personalized, and physiologically based digital support systems to aid in the recovery of PTSD survivors.

This study is framed within the fields of Design Science and Human-Computer Interaction (HCI), with a focus on designing a conceptual prototype of the user interface for an integrated digital support application for smartwatches called Pulih. This application is designed to monitor users' emotional states in real-time through biometric analysis based on HRV and RHR and to provide adaptive and personalized psychological intervention recommendations. The research focuses on trauma-sensitive interface engineering and usability evaluation to support the mental recovery of PTSD survivors, while contributing to the achievement of SDG 3 (Good Health and Well-being) through improved mental health and well-being, as well as SDG 4 (Quality Education) using digital technology to enhance mental health literacy and education.

2 Method

This study employs a Research and Development (R&D) approach aimed at developing the Pulih digital support application, which integrates smartwatch technology and Artificial Intelligence (AI) to support the recovery of Post-Traumatic Stress Disorder (PTSD) survivors. This approach was chosen because it enables the creation of innovative, user-centered products through an iterative and systematic process [15].

In its development process, this study adopts the Design Thinking method as the primary user-centered design approach. The concept of Design Thinking was first introduced by John E. Arnold as a systematic problem-solving approach that emphasizes creativity, innovation, and a deep understanding of human needs. This approach has since evolved and is widely used in digital product development. The Design Thinking method used consists of five main stages: empathize, define, ideate, prototype, and test.

The research stages include Empathize to understand the conditions of PTSD survivors through a needs assessment, Define to formulate problems and service gaps, Ideate to develop the application's core features and design an AI framework for user biometric analysis, Prototype to design the interface and integration workflow for the smartwatch, and Test through Maze simulations

and System Usability Scale (SUS) calculations to assess usability. This method produced an innovative conceptual model oriented toward digital solutions for survivors of sexual violence.

Given that this study involves interactions with vulnerable populations (specifically interviews with survivors of PTSD resulting from sexual violence), all research procedures have received official ethical approval from the University's Research Ethics Committee. Before the primary data collection process began, all participants were provided with a comprehensive explanation of the research objectives, data confidentiality guarantees, and the voluntary nature of participation. All participants reviewed and signed an Informed Consent form. This document guarantees that identities are disguised (full anonymity), data records are protected, and participants have the absolute right to withdraw from the study at any time without penalty to safeguard their emotional well-being.

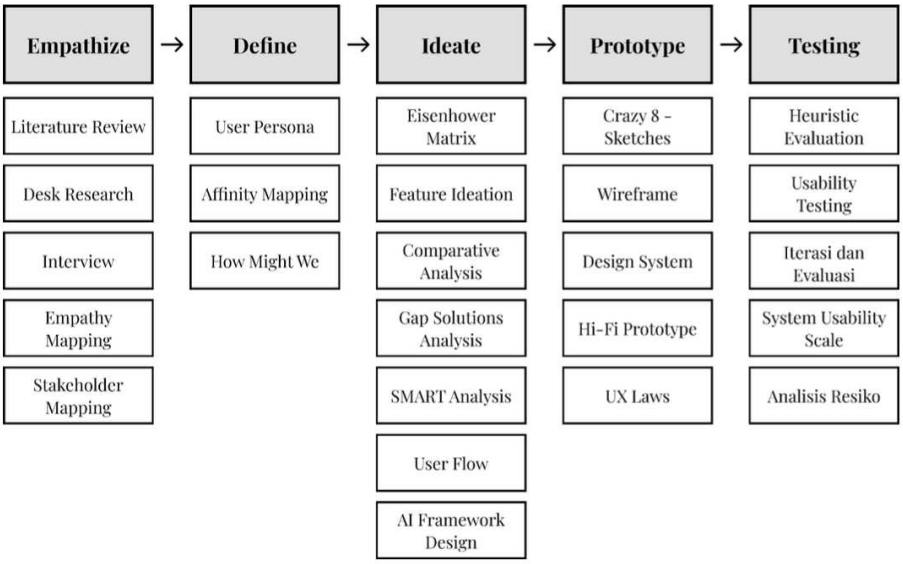

Figure 1. Stages of The Design Thinking Model

This study utilizes two types of data: secondary data obtained through a literature review on PTSD, psychological recovery approaches, and the use of digital technology in mental health. This data is used to strengthen the theoretical foundation of the study, as well as primary data obtained through interviews with clinical psychologists, neurologists, and PTSD survivors. These interviews aim to understand emotional needs, traumatic experiences, and the relationship between psychological conditions and biometric indicators such as HRV and RHR.

3 Results and Discussion

3.1 Results of the Empathize phase

A. Secondary Data

Based on a review of the literature, survivors generally exhibit psychological symptoms (anxiety, sleep disturbances, depression) that have a serious impact on their social functioning [9]. Additionally, McCleary [11] highlight that feelings of shame and the stigma surrounding mental health issues act as barriers preventing victims from seeking help. Several studies also indicate that mobile apps can aid in the emotional recovery process [12].

B. Primary Data

1. Interview with a Clinical Psychologist

An interview with a clinical psychologist with eight years of experience, conducted via HaloDoc, revealed that survivors of PTSD resulting from physical and sexual violence often experience flashbacks and have difficulty expressing their emotions. The psychologist also emphasized the importance of a private space so that survivors can recover in a safe environment, free from pressure.

Figure 2. Clinical Psychologist Interview Documentation (HaloDoc)

2. Interview with a Neurologist

An interview with a neurologist at Sebelas Maret University Hospital (UNS) explains that psychological stress affects the autonomic nervous system, which regulates heart rate and stress responses. Changes in Heart Rate Variability (HRV) and Resting Heart Rate (RHR) can serve as indicators of stress or anxiety levels, with HRV decreasing and RHR increasing during periods of high stress.

Figure 3. Documentation of an Interview with a Neurologist (Google Meet)
Source: Researcher's Documentation (2025)

3. Interview with a Survivor of Post-Traumatic Stress Disorder

The interview was conducted with a survivor of Post-Traumatic Stress Disorder (PTSD) who, over the course of four years, experienced physical and verbal sexual abuse. She often finds it difficult to control her emotions, especially when dealing with the perpetrator, who is still a relative. She is also reluctant to seek counseling and feels more comfortable sharing her story through ChatGPT. The survivor also hopes for easily accessible psychological support that can help her calm down when stress arises.

Figure 4. Documentation of Interviews with PTSD Survivors (WhatsApp Video Call)
Source: Researcher's Documentation (2025)

C. Emphaty Maps

The primary research data is presented in Empathy Maps (Figure 3.4) to gain a deeper understanding of users' desires and needs.

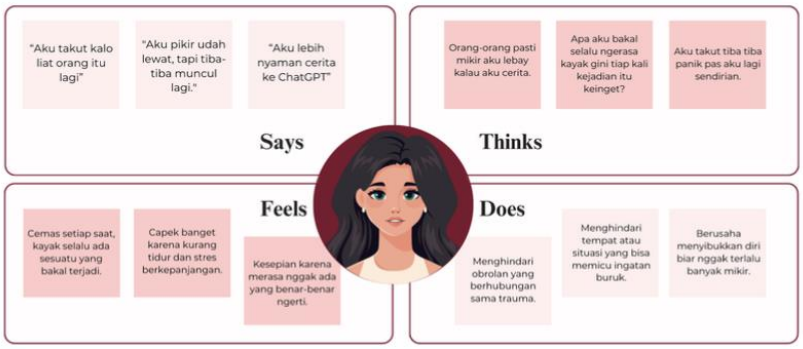

Figure 5. Emphaty Maps

D. Stakeholder Mapping

The researchers created a stakeholder map of the entities involved in the Pulih ecosystem, as shown in Figure 3.5

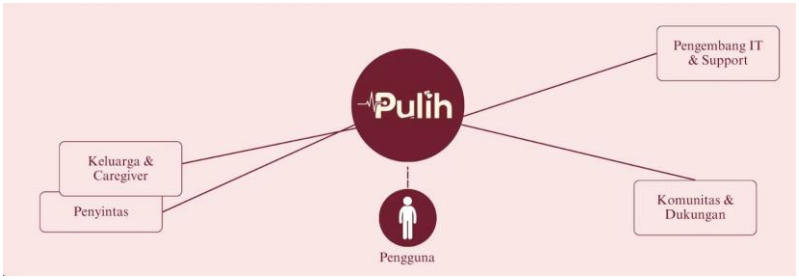

Figure 6. Stakeholder Mapping

3.2 Result of the Define Phase

A. User Persona

User personas were developed to describe the key needs and challenges of survivors, as shown in Figure 3.6

Figure 7. User Persona

B. Affinity Mapping

Based on these User Personas, the researchers then grouped the issues into the following Affinity Map.

Figure 8 Affinity Mapping

C. How Might We

Based on the results of Affinity Mapping, several How Might We (HMW) questions were formulated to guide the Ideate phase.

a. How can we help users start their day with positive emotions through biometric analysis and personalized therapy?
b. How can we provide a safe and creative outlet for self-expression to channel negative emotions constructively?
c. How can we create a supportive and empathetic community space for survivors where they feel safe?

3.3 Result of the Ideate Phase

A. Eisenhower Matrix

The researchers then developed the Eisenhower Matrix to map features based on impact and effort, as shown in Figure 9.

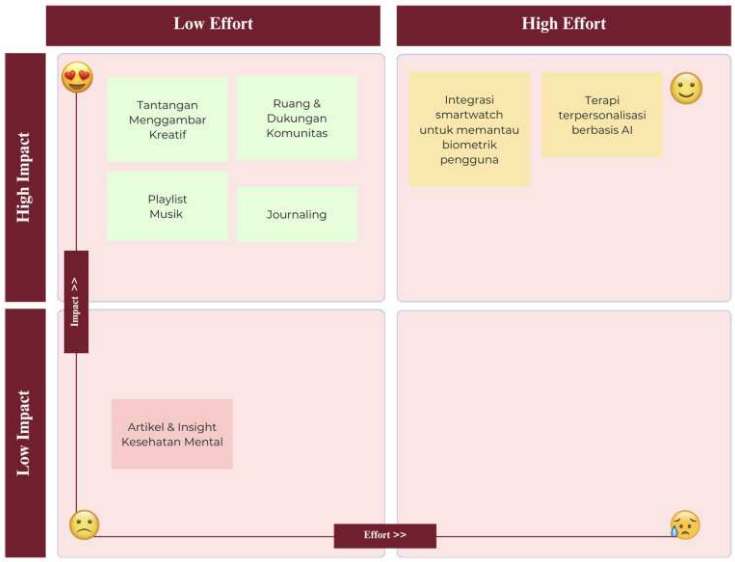

Figure 9. Eisenhower Matrix

B. Feature Ideation

Based on the Eisenhower Matrix, the following four features were identified.

a. Personalized Morning Therapy, this feature helps users start their day with a positive mindset through affirmations and personalized therapy recommendations [16].
b. Relax Space, this feature helps users' channel negative emotions into creative expression, such as painting and listening to music [17].
c. Daily Biometric Analysis, this feature utilizes the integration of biometric data (HRV

and RHR) from a smartwatch to tailor therapy recommendations [18].

d. SafeSpace Community, this feature provides a safe digital community space for survivors [19].

C. Comparative Analysis

	Pemantauan HRV/RHR	Terapi Relaksasi	Terapi Terpersonalisasi	Support Community	Integrasi Smartwatch
HeartMath (Inner Balance)	✓	✓	✗	✗	✓
Samsung Health (Galaxy Watch)	✓	✓	✗	✗	✓
Sanvello	✗	✓	✗	✓	✗
Pulih	✓	✓	✓	✓	✓

Figure 10. Comparative Analysis

D. Gap Solutions Analysis

GAP SOLUTIONS ANALYSIS

No	Aspek Analisis	Kondisi pada Kompetitor	Kesenjangan (Gap)	Solusi oleh Pulih
1	**Pemantauan Biometrik (HRV/RHR)**	- HeartMath & Samsung Health menampilkan data HRV/RHR tanpa interpretasi emosional. - Sanvello tidak menggunakan data biometrik.	Tidak ada sistem yang mengaitkan data fisiologis dengan kondisi emosional pengguna.	Pulih **menganalisis data HRV, RHR,** dan kualitas tidur untuk **menyesuaikan terapi yang dibutuhkan.**
2	**Terapi Relaksasi**	Umum dan tidak disesuaikan dengan kondisi pengguna.	Terapi masih generik dan tidak kontekstual.	Pulih memberikan **panduan relaksasi sesuai hasil** analisis biometrik.
3	**Terapi Terpersonalisasi**	Tidak berbasis kondisi real-time; hanya preferensi pengguna.	Terapi belum benar-benar personal.	Pulih menggunakan AI untuk menyesuaikan terapi berdasarkan kondisi harian pengguna.
4	**Support Group & Community**	Sanvello punya komunitas terbuka tanpa moderasi trauma-informed, sedangkan lainnya tidak punya.	Tidak ada ruang aman bagi penyintas untuk berbagi.	Pulih menyediakan **SafeSpace Community yang aman** dan empatik.
5	**Integrasi Smartwatch**	Fokus pada aspek fisik dan aktivitas olahraga.	Belum dimanfaatkan untuk mendeteksi kondisi psikologis.	Pulih memanfaatkan ***smartwatch*** untuk membaca biometrik dan memicu terapi adaptif.

Figure 11. Gap Solution Analysis

E. SMART Analysis

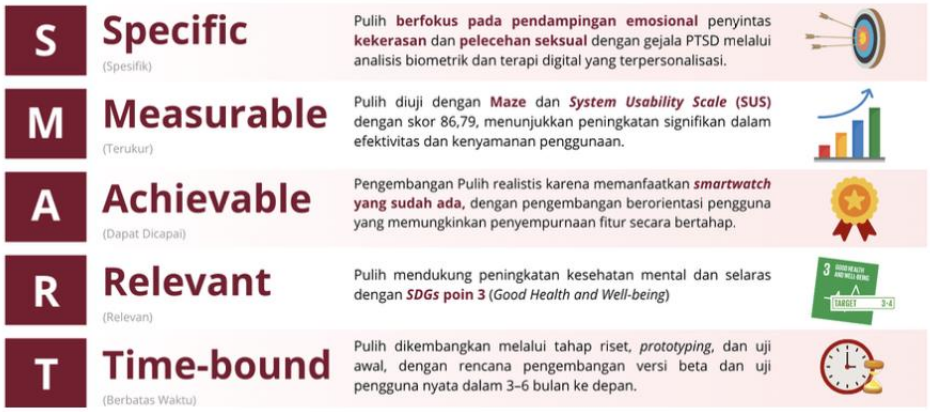

Figure 12. Smart Analysis

F. User Flow

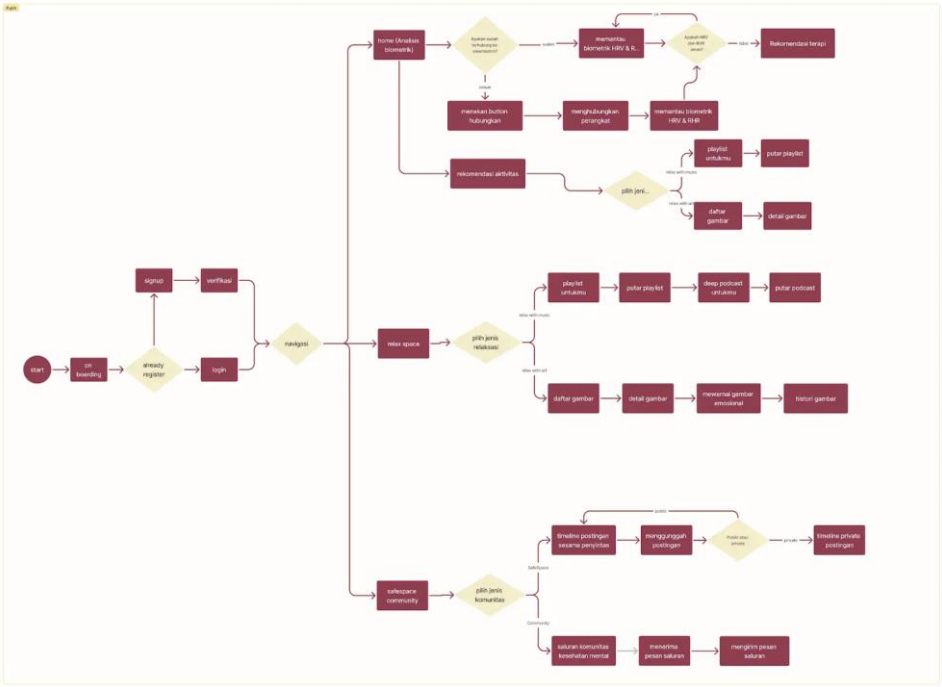

Figure 13. User Flow

G. AI Framework Design

Figure 14. shows the AI Framework Design, which analyzes biometric data (HRV and RHR) to provide personalized therapy recommendations. Heart Rate Variability (HRV) is likened to human breathing, the more regularly it follows the body's rhythm, the more it indicates a stable emotional state.

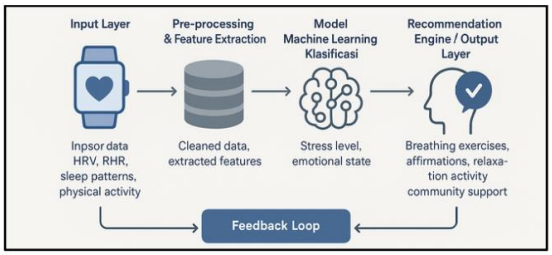

Figure 14. AI Framework Design

To provide valid empirical evidence supporting the feasibility of this AI integration, a Bidirectional Long Short-Term Memory (Bi-LSTM) deep learning model was simulated and validated using the internationally recognized public physiological dataset, WESAD (Wearable Stress and Affect Detection). This dataset contains multimodal biometric data (including heart rate and wearable sensor data) from subjects in both stressed and normal baseline conditions.

a. Data Collection

HRV and RHR data were collected using a smartwatch sensor [20]. The following is the formula for calculating the SDNN parameter:

$$SDNN = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(RR_i - \overline{RR}\right)^2} \quad (1)$$

Description:

RR_i = The time interval between the i-th heartbeat

$\overline{RR}$ = Average RR interval

N = Total number of intervals

b. Preprocessing & Feature Extraction

The raw data is filtered and normalized, and then features such as SDNN, RMSSD, and pNN50 are extracted to represent heart rate variability and stress levels.

c. Deep Learning Model

The Bidirectional Long Short-Term Memory (Bi-LSTM) model was used to classify emotions based on Heart Rate Variability (HRV) data [21][22][23]. Two LSTM networks operate in parallel in forward and backward directions to capture bidirectional temporal patterns.

$$\begin{aligned} &\overrightarrow{h_t^{forward}} \\ &= LSTM_{forward}\left(x_t, \overrightarrow{h_{t-1}^{forward}}, \overrightarrow{c_{t-1}^{forward}}\right) \\ &\overrightarrow{h_t^{backward}} \\ &= LSTM_{backward}\left(x_t, \overrightarrow{h_{t+1}^{backward}}, \overrightarrow{c_{t+1}^{backward}}\right) \\ &h_t = \left[\overrightarrow{h_t^{forward}}; \overrightarrow{h_t^{backward}}\right] \end{aligned} \quad (2)$$

d. Recommendation Engine

The system then generates relaxation and affirmation recommendations based on the stress classification results.

e. AI Model Performance Evaluation Metrics (WESAD Dataset Validation Results)

A comprehensive evaluation of the Bidirectional LSTM (Bi-LSTM) model's performance is detailed in the learning curves and matrices below. Based on the Loss Curve, the training and validation loss values show a smooth exponential decline and converge stably toward zero, proving that the network architecture is free from overfitting and underfitting. In line with this decrease in loss values, the Accuracy Curve shows a consistent increase in accuracy, reaching an optimal training accuracy of 92.0% and a validation accuracy of 90.5%. The tight convergence characteristics of these two curves confirm the model's technical reliability during the training phase. The accuracy of the actual classification details from these training results is further confirmed by the Confusion Matrix. The model recorded a Precision of 90.0%, Recall of 91.0%, and an F1-Score of 90.5% by successfully and correctly predicting 637 normal samples (True Negatives) and 455 stress samples (True Positives). The most crucial point for trauma-sensitive applications like Pulih is the low rate of detection failure (False Negative = 45 samples), which results in a high Recall value. This proves that the Bi-LSTM model is highly sensitive and reliable in capturing indicators of stress relapse in PTSD survivors in real-time before being integrated into the application's interface architecture

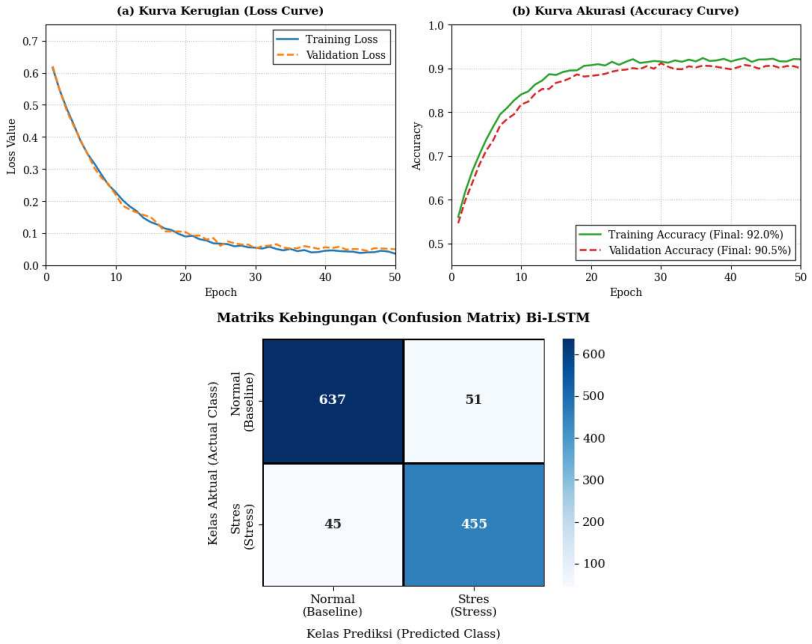

Figure 15. AI Model Performance Evaluation Metrics

f. Feedback Loop

User feedback is saved to update the model so that future recommendations are even more accurate.

Table 3.1 Component and Function AI Framework Design

Stages	Components	Function	Outputs
Data Collection	Smartwatch (HRV & RHR sensor)	Collecting biometric data	HRV data, RHR
Preprocessing & Feature Extraction	Data pipeline	Cleaning and extracting HRV features [24]	Clean feature data
Machine Learning Model	Bi-LSTM	Classifying users' emotional states	Stress prediction
Recommendation Engine	Therapy module	Provide personalized recommendations	Adaptive recommendations
Feedback Loop	Adaptive learning system	Updating the model based on feedback	The latest model

3.4 Result of the Prototype Phase

A. Crazy 8 – Sketches

Before designing the wireframe, the researcher created preliminary sketches using the Crazy 8 method to streamline the app design process.

Figure 16. Crazy 8 - Sketches

B. Wireframe

Based on that sketch, the researchers then designed the wireframe shown in Figure 17.

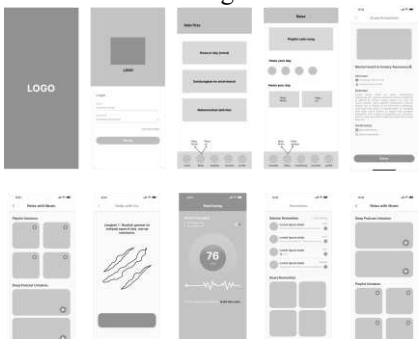

Figure 17. Wireframe

C. Design System

Next, to maintain design consistency, the researchers developed a design system, as shown in Figure 18.

Figure 18. Design System

D. Hi-Fi Prototype

Next, the researchers designed the Hi-Fi Prototype, which can be accessed at the following link: https://clips.id/Prototype.

Figure 19. Mockup High Fidelity

H. UX Laws

Researchers apply the UX Laws to ensure that designs adhere to sound principles, as shown in Figure 19.

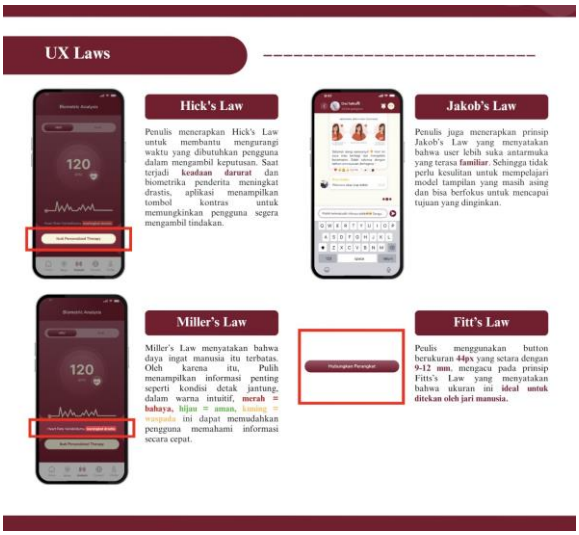

Figure 19. UX Laws

3.5 Result of the Testing Phase

A. Usability Testing

Based on the test results (Maze), a score of 74 was obtained, corresponding to the Grade B (Good) category, as shown in Figure 20.

>80	A	Excellent
68 – 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
< 51	F	Awful

Sumber: El Majjodi, dkk. (2019)

Figure 20. Result Usability Testing

B. System Usability Scale (SUS)

An evaluation of the usability of the Pulih interface using the System Usability Scale (SUS) method, involving 27 participants comprising PTSD survivors, clinical psychologists, and mental health professionals, yielded an average score of 86.79. According to SUS metric standards, this result falls into the 'Excellent' and 'Acceptable' categories with a Grade A+. These empirical results demonstrate that the designed trauma-sensitive navigation flow and visual layout are highly intuitive, easy to use, and possess a robust structural foundation to support PTSD survivors' emotional regulation without imposing a high cognitive load [25].

C. Evaluasi dan Iterasi

Based on the results of the testing, the researchers conducted an evaluation and design iterations, which can be viewed at the following link: https://clips.id/IterasiPulih.

D. Analisis Resiko

Researchers have designed a risk analysis to identify threats and their mitigation strategies; it can be viewed at the following link: https://clips.id/AnalisisResiko.

3.6 Discussion

Most commercial mental health apps available today (such as Calm or Headspace) are generic and rely on manual user input to determine their mood. In contrast, Pulih's conceptual design offers the advantage of an automated feedback loop based on physiological data from a

smartwatch. This interface proactively detects drops in HRV and spikes in RHR which indicate panic attacks or trauma flashbacks and instantly presents an intervention shortcut button without requiring users to type on their phone screens. On the other hand, given that this app is intended for a highly vulnerable population (survivors of sexual violence), design ethics serve as a fundamental pillar of this design research. First, the community feature (SafeSpace Community) employs a strict pseudonym system and end-to-end data encryption to protect survivors' absolute privacy. Second, the interface is designed with automatic content filtering to prevent users from sharing explicit details of their sexual violence experiences, aiming to mitigate the risk of secondary trauma or triggering for other community members. Third, the AI recommendation system is positioned purely as a self-regulation tool, not as a substitute for medical diagnosis or professional clinical therapy sessions.

4 Conclusion

The development of a conceptual model and prototype for the "Pulih" app has successfully resulted in a smartwatch-based digital support platform specifically designed to facilitate the psychological recovery of survivors of Post-Traumatic Stress Disorder (PTSD) caused by sexual violence. Using a Design Thinking approach, the app integrates four key features: Personalized Morning Therapy, Relax Space, Daily Biometric Analysis, and SafeSpace Community. Technical evaluation of the app's intelligent functionality was demonstrated through validation of the Bi-LSTM deep learning architecture on the WESAD dataset, where the model was able to objectively detect stress based on the physiological indicators HRV and RHR with stable learning curve convergence without overfitting. The model's performance recorded a training accuracy of 92.0%, a validation accuracy of 90.5%, a precision of 90.0%, a recall of 91.0%, and an F1-Score of 90.5%, with an extremely low false negative rate of only 45 samples, confirming high sensitivity in capturing real-time indicators of trauma relapse. This technical reliability is reinforced by user evaluation results using the System Usability Scale (SUS) method with 27 respondents, yielding a very satisfactory average score of 86.79, which falls into the 'Excellent' and 'Acceptable' categories with a Grade A+ rating. These empirical results confirm that the trauma-sensitive navigation flow and visual layout designed for the Pulih app have been proven to be highly intuitive, easy to use, and capable of minimizing users' cognitive load under stressful conditions. Although currently still in the conceptual prototype phase, the Pulih app has a solid structural foundation for further development toward the clinical implementation stage, where the combination of adaptive physiological analysis and an encrypted anonymous community space within it has great potential to create a mental recovery ecosystem that is safe, inclusive, and easily accessible to survivors.

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