Evaluating the Role of Gamification on AI Technology tools for addressing Post-Traumatic Stress Disorders

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ABSTRACT

The VERA AI platform offers an innovative, AI-driven neuro-engineering approach to delivering scalable, trauma-informed interventions for Post-Traumatic Stress Disorder (PTSD) among ex- combatants and internally displaced persons (IDPs) in post-conflict Sri Lanka. By combining CBT, DBT, mindfulness, and gamification within a secure, GDPR-compliant ecosystem, it aligns with Disarmament, Demobilisation, and Reintegration (DDR) objectives, supporting both individual recovery and community reintegration.Integrating neuro-sensing technologies such as EEG and HRV with machine-learning models enables personalised, real-time therapy, while policy applications include strengthening DDR programme evaluation and informing national mental health strategies. Ethical deployment emphasising privacy, informed consent, and cultural sensitivity remains central. VERA AI demonstrates how gamified, AI-enabled neuro-engineering can provide effective, cost- efficient, and user-centred psychosocial rehabilitation, empowering individuals in Sri Lanka and other post-conflict settings to rebuild their lives and contribute to sustainable peace.

KEYWORDS: *PTSD, Artificial Intelligence, Neuro Sensing, Gamification, Veterans, Virtual Reality, resilience, CBT, DBT,*

INTRODUCTION

The emergence of Artificial Intelligence (AI) is progressively redefining development praxis by proposing innovative mechanisms for long-standing structural challenges. There is an increased use of geospatial AI in climate-resilience planning, as well as the application of Natural Language Processing (NLP) to support diversity-sensitive communication, the use of chatbots in delivering public services, and the application of Machine Learning (ML) models to model policies and optimise humanitarian logistics. These technologies can be used to further a data-driven, equitable, and participatory approach to enhancing governance, empowering marginalised groups, simplifying the delivery of aid, and making society more resilient to socio-political changes. AI can become a game changer in conceptualising and implementing development, especially in the critical frameworks of post-development theory that emphasise local agents, autonomy, and the rejection of universal theories on development.

This paper interrogates the application of AI and Gamification concepts to address Post- Traumatic Stress Disorder (PTSD) in post-conflict development contexts. It examines the gamified deployment of AI-powered mental health tools, namely virtual counsellors, trauma-informed care chatbots, predictive risk-screening models, and culturally localised Virtual Reality (VR) based therapies, to support the psychosocial reintegration of ex-combatants and Internally Displaced Persons (IDPs). The paper critically evaluates the degree to which such instruments enhance psychological well-being, restore agency, and dignity in post-war societies.

Disarmament, Demobilisation, and Reintegration activities are essential to post-conflict reconstruction. The effective reintegration into civil society depends on successful rehabilitation programmes for ex-combatants. The IOM report suggests that over thirty-five DDR programmes have been established in different parts of the world, and Sri Lanka was also one of the major case studies carried out during the last two decades (IOM, 2017). The conflict between the armed group Liberation Tigers of Tamil Eelam and the Government of Sri Lanka displaced over 3 million civilians and identified more than 10,000 as ex-combatants (WHO, 2022; Kirmayer & Pedersen, 2014).

Considering the challenges of this large group of ex-combatants and IDPs, the Government of Sri Lanka developed a policy framework called the National Framework for Reintegration (MDMHR, 2009). The

https://doi.org/10.54389/IFTF9467

policy aimed to respect the human rights of ex-combatants and IDPs, promote sustainable peace and reconciliation, and provide economic opportunities for their reintegration. The Armed Forces of Sri Lanka pursued this programme, and it went beyond military measures to involve psychological reintegration activities (Ratnayake, 2012). The available interventions for psychosocial rehabilitation in Sri Lanka were counselling, vocational training, group therapy and community-based reintegration programs. These were only partially effective, burdened by limited resources and shortages of mental health professionals (Somasundaram, 2007).

Neuro-engineering and Brain Computer Interfaces (BCI) now present cutting-edge biomedical solutions that provide real-time monitoring, adaptive feedback, and personalised intervention within smart-health systems, thereby transforming mental-health delivery in post-conflict settings (Lange, 2012). Psychotherapeutic interventions for post-traumatic stress disorder, including face-to-face Cognitive Behavioural Therapy (CBT) and group counselling, require substantial resources, highly skilled personnel, and stable environmental conditions, which are unavailable in post-conflict settings (Gillespie, 2021). Under these conditions, it is important that scalable, technology-centred interventions be developed and implemented.

Even though there are several AI applications available for mental health care support, based on the available literature, medically/clinically tested Gamified AI Platform backed by neuro sensing data for mental health care which is conceptualised within post-development theory and the Capability Approach (Sen, 1999; Nussbaum, 2011; Escobar, 1995), to deliver personalised, scalable post-traumatic stress disorder care is not to be found. To strengthen methodological validity and address concerns about the lack of results, an in-depth comparative analysis with numerical data extracted from published evaluations of similar systems provides a clear justification for the chosen study design. The paper, therefore, presents the Virtual Emotional Resilience Advisor (VERA), a unique Gamified AI Platform, as a potentially effective and efficient mechanism for addressing post-traumatic stress disorder among ex-combatants, veterans and IDPs in post-conflict development settings.

COMPARATIVE ANALYSIS

System	Symptom Reduction	Engagement Rate	Target Population	Limitations Compared to Vera AI
Woebot (Fitzpatrick et al., 2017)	22% decrease in PHQ-9 scores after 2 weeks	85% daily check-in rate	Depression/anxiety (general population)	No neuro-sensing; no DDR, gamification limited to mood tracking
Wysa (Inkster et al., 2018)	31% reduction in GAD-7 scores over 8 weeks	72% weekly active use	General anxiety/stress	Limited biofeedback integration; not trauma-specific, no DDR,
Mindstrong Health (Dagum, 2018)	Improved cognitive decline ($p<0.05$)	Passive usage rates not disclosed	Severe mental illness	No direct therapy; no gamification and cultural context, no DDR
BioBeats (Schaefer et al., 2020)	HRV improvement ($p<0.01$)	68% app retention at 6 weeks	Workplace stress	No trauma protocols; no DDR integration, no gamification
Ellie – USC ICT (DeVault et al., 2014)	Increased disclosure rate by 25% vs humans	Session completion 90%	PTSD in veterans	Diagnostic only; no ongoing therapy, no DDR integration,
Bravemind – USC ICT (Rizzo et al., 2019)	Reductions in PTSD (CAPS-5, PCL-M) $d=0.78–1.12$	Session adherence ~80%	Combat veterans with PTSD	VR exposure therapy only; lacks integration with neuro-sensing, no DDR integration

CONTRIBUTIONS

The VERA AI platform integrates neuro-sensing devices, such as Electroencephalogram (EEG) headbands and Heart Rate Variability (HRV) monitors. This is to capture real-time physiological signals relevant to stress regulation and emotional imbalances (Brynjolfsson & McAfee, 2017). Such data are utilised to modulate the delivery of evidence-based interventions within the application, including cognitive behavioural therapy, Dialectical Behaviour Therapy (DBT), and mindfulness-based cognitive techniques, thereby offering context-specific, precise therapeutic support to end-users (Rizzo & Shilling, 2017; WHO, 2022).

The integration of brain-computer interface and neuro-engineering technologies provides precision psychotherapeutic treatments, allowing them to be calibrated according to individual neurophysiological states (Gillespie & Hall, 2021). Also, the incorporation of Trauma-Informed Care (TIC) principles, which prioritise safety, trust, and empowerment for users presenting substantial post- traumatic stress disorder symptoms (Kirmayer & Pedersen, 2014; WHO, 2022). By embedding these principles into Gamified AI chatbot dialogues and Gamified mindfulness modules, the VERA AI platform creates a personalised user environment that supports healing and emotional regulation (Molnar & Gill, 2018).

From a policy perspective, the VERA AI platform aligns with the objectives and frameworks of disarmament, demobilisation, and reintegration programs, which is the globally accepted mechanism developed by the United Nations for post-conflict peacebuilding and stabilisation (Gleichmann et al., 2004; UNDP, 2021). Psychosocial rehabilitation is a key component of disarmament, demobilisation, and reintegration, facilitating the reintegration of ex-combatants into civilian life and reducing the risk of recidivism and social marginalisation (Banholzer, 2013; Ager & Strang, 2008). The platform supports disarmament, demobilisation, and reintegration efforts by offering mental health services at affordable prices and with a scalability that encourages long-term community cohesion and resilience.

METHODOLOGY

The technical architecture of the VERA AI platform is organised as a layered, integrative framework that combines neuro-engineering, brain-computer interface, and advanced AI pipelines to deliver scalable, culturally relevant interventions for post-traumatic stress disorder among ex- combatants, veterans, and IDPs (Brynjolfsson & McAfee, 2017; WHO, 2022). The hardware layer comprises electroencephalogram and heart rate variability sensors, capable of capturing real-time neural and physiological signals, such as stress responses and hyperarousal markers prevalent in patients with post-traumatic stress disorder (Rizzo & Shilling, 2017). Signal preprocessing algorithms are implemented for artefact removal and noise reduction, thereby assuring data integrity prior to processing by the adaptive intervention system (Gillespie & Hall, 2021). Personalised calibration protocols adjust sensor thresholds to individual baselines, supporting the trauma-informed, culturally sensitive objectives of the system (Kirmayer & Pedersen, 2014).

The software architecture level of the VERA AI platform utilises a transformer-based natural language processing pipeline fine-tuned for local languages, enabling culturally contextual chatbot interactions that resonate with user experiences (Molnar & Gill, 2018). Generative Pre- Trained Transformers (GPT) layers trained on local counselling dialogue ensure responsive, empathetic, non-triggering, and consistent dialogue with cognitive behavioural therapy and dialectical behaviour therapy (WHO, 2022). The gamified chatbots facilitate real-time dialogues while continuously monitoring sentiments and intent. Additionally, this enables predictive models to identify escalation points that alert to potential escalations or abnormalities, thereby ensuring safety and responsiveness (Kuhfuß et al., 2021).

The gamification module further incorporates Virtual Reality (VR) and Augmented Reality (AR) enabled cognitive behavioural therapy and dialectical behaviour therapy learning loops, providing scenario-based emotional regulation exercises and mindfulness micro-interventions (Rizzo & Shilling, 2017). Reward structures incentivise repeated engagement, mitigating stigma associated with mental health support and reinforcing user adherence (Gillespie & Hall, 2021). These modules are optimised for low-bandwidth contexts, utilising offline-first architectures with local data caching and synchronisation; such capabilities are essential for deployment in post-conflict, infrastructure- constrained settings (UNDP, 2021).

With adequate data governance, the data pipeline enables the real-time ingestion and processing of data on neurophysiological and interaction data. Machine-learning models perform sentiment and behavioural risk stratification, providing clinicians and reintegration program managers with data for decision making (Brynjolfsson & McAfee, 2017). The use of AI tools considering the Ethical explainability layers offers transparency, security, and compliance with GDPR-aligned protocols, incorporating multi-layer encryption, privacy preservation, and explicit user consent to safeguard sensitive health data (Molnar & Gill, 2018).

Seamless integration with disarmament, demobilisation, and reintegration frameworks, as well as existing healthcare infrastructures in Sri Lanka, enables synchronisation with case management systems used in reintegration programs. This facilitates real-time updates to user progress and intervention outcomes, which are crucial for program monitoring and evaluation (Gleichmann et al., 2004; Banholzer, 2013). Customisable analytics dashboards allow disarmament, demobilisation, and reintegration managers to assess community-level trends, informing policy adjustments and intervention targeting, thereby aligning VERA AI platform deployment with broader peacebuilding and reintegration objectives (Ager & Strang, 2008; UNDP, 2021).

Evaluating PTSD interventions requires careful selection of research methodologies that balance feasibility and contextual relevance. A range of alternative designs has been used in prior studies, each with distinct strengths and limitations. Single-case experimental designs are valuable for early-stage pilot testing of intervention feasibility but are limited in their generalisability (Kazdin, 2019). Pre and post-single-group studies provide rapid insight into short-term effectiveness but lack a control group, making it difficult to attribute changes directly to the intervention (Creswell & Plano, 2018). Quasi-experimental matched designs avoid the need for randomisation yet are susceptible to residual confounding (Shadish et al., 2002). Finally, qualitative and mixed-methods approaches provide rich contextual data on user acceptability, cultural fit, and lived experience, which is especially critical in post-conflict DDR contexts (Patton, 2015).

Despite the merits of these alternatives, a randomised controlled trial (RCT) remains the optimal design for evaluating Vera AI's effectiveness. They hold high policy-grade credibility, which is essential for DDR and health authorities considering large-scale adoption (WHO, 2021). RCTs can accommodate pre-specified subgroup analyses to address heterogeneity across gender, age, severity, and language, ensuring findings are generalisable within target populations (Moher et al., 2010). It also allows for cost- effectiveness analyses to be embedded alongside clinical outcomes (Drummond et al., 2015), providing a robust evidence base for decision-making in resource-constrained post-conflict settings.

THERAPEUTIC FRAMEWORK

The VERA AI platform employs an integrated therapeutic framework that merges cognitive behavioural therapy, dialectical behavioural therapy, mindfulness practices, and Trauma Informed Care (TIC) principles to deliver culturally sensitive and scalable interventions for ex-combatants, veterans and internally displaced persons with post-traumatic stress disorder in post-conflict Sri Lanka (WHO 2022; Kirmayer & Pedersen 2014). Neuro-engineering sensors such as Electroencephalography (EEG) and Heart Rate Variability (HRV) are embedded to monitor physiological signals in real time, to monitor the user's emotional and cognitive state (Rizzo & Shilling 2017). Predictive modelling, employing sentiment analysis and behaviour tracking, tailors cognitive behavioural therapy, dialectical behavioural therapy modules according to emotional regulation needs while avoiding triggers and adhering to trauma-informed care protocols (Molnar & Gill 2018; Kuhfuß et al. 2021).

Cognitive behavioural therapy modules within the VERA AI platform focus on identifying and reframing maladaptive thought patterns that contribute to hyperarousal and avoidance behaviours typical of post-traumatic stress disorder, using interactive chatbot dialogues and scenario-based microlearning activities to facilitate cognitive restructuring (Gillespie & Hall, 2021; WHO, 2022). Dialectical behaviour therapy modules address emotional dysregulation through skills training in distress tolerance, emotional regulation, interpersonal effectiveness, and mindfulness, operationalised via gamified exercises and VR-enabled role-play to enhance engagement (Rizzo & Shilling 2017). Mindfulness modules will be delivered via guided meditation, breathing exercises, and grounding techniques, and are integrated within session flows to address hypervigilance and dissociation symptoms, allowing users to practice self-regulation techniques contextualised to culturally relevant environments (Kirmayer & Pedersen 2014).

The platform ensures trauma-informed implementation by maintaining a safe, non-judgmental digital environment and prioritising user autonomy, thereby aligning with post-development and Capability Approach frameworks (Sen 1999; Nussbaum 2011; Escobar 1995). Gender and cultural sensitivities are embedded within therapeutic content to ensure that interventions respect social norms and individual identities, which is critical for effective post-conflict reintegration (UNDP, 2021). Gamification elements encourage consistent participation and skill mastery through reward-based progression systems while reducing the stigma associated with mental health treatment (WHO 2022). Initial baseline assessments utilise standardised tools, such as the Generalised Anxiety Disorder Assessment (GAD-7), Patient Health Questionnaire (PHQ-9), and Posttraumatic Stress Disorder Checklist (PCL-5), to inform personalised intervention mapping (Kuhfuß et al., 2021). The user is guided through modular sessions, receiving feedback and reflective nudges, with content continuously updated by data-driven adaptations based on user progress and bio signal data. The feedback loop enables users to track improvement, and backend data informs clinical and reintegration program staff regarding user readiness for community reintegration, aligning therapeutic outcomes with DDR objectives (Ager & Strang, 2008; Gleichmann et al., 2004).

RESEARCH DESIGN AND CLINICAL VALIDATION

The study will be carried out within the framework of the convergent mixed-methods design: qualitative and quantitative data will be simultaneously collected, and subsequently, will be analysed separately, and only during the interpretation process, they will be combined with each other (Ytterstad & Olaisen, 2021). It allows getting an in-depth insight into the research issue through triangulation of results found due to the research design perspective (Creswell & Plano Clark, 2018).

The first phase involves stakeholder engagement and consultations with DDR-program managers, mental health professionals, community leaders, and ex-combatants to align therapeutic modules with local needs and cultural sensitivities, thereby developing the prototype of the VERA AI platform (Ager & Strang, 2008; UNDP, 2021). This participatory approach keeps in view the respect for the cultural norms, gender issues, and lives of ex-combatants and IDPs. The second stage involves developing the platform based on the feedback and conducting pilot testing of the VERA AI platform by ex-combatants and mental health professionals of national hospitals in Sri Lanka. Feedback from this stage guides iterative design improvements. (Kirmayer & Pedersen, 2014).

The clinical validation of the VERA AI platform will be conducted using a well-defined, multi- stage process that includes ethics, effectiveness, cultural fit, scalability, and general acceptability testing in a post-conflict Sri Lanka. The core evaluation will be a 24-week Randomised Controlled Trial (RCT) design using internationally validated psychometric instruments, namely GAD-7 for generalised anxiety, PHQ-9 for depression, and PCL-5 for PTSD symptom measurement (WHO, 2022; Kuhfuß et al., 2021). The participants will be randomly selected from the National Hospital of Sri Lanka and the Military Hospital in Sri Lanka and will be assigned to either the treatment group or the control group. The treatment group receives VERA AI interventions, while the control group receives standard care aligned with ethical standards (Molnar & Gill, 2018). The neuro-sensing components of the VERA AI platform (EEG and HRV) and BCI integration enable continuous monitoring, yielding objective physiological data that complement psychometric assessments and facilitate studies of bio-psycho- social correlations in PTSD treatment within post-conflict contexts (Rizzo & Shilling, 2017). Data management ensures secure, encrypted storage in line with GDPR and local data-protection laws (Brynjolfsson & McAfee, 2017; Cong & Zheng, 2021).

The data analysis involves paired-sample t-tests, ANCOVA, and machine-learning predictive modelling to assess the effects of symptom reduction, user engagement, and adherence, and to match the patterns to policies and practices. Progress during the trial is aligned with DDR monitoring frameworks to correlate psychosocial rehabilitation outcomes with reintegration success, thereby informing DDR planning and peacebuilding objectives (Gleichmann et al., 2004; Ager & Strang, 2008).

ETHICAL AND CULTURAL CONSIDERATIONS

Approvals for the proposed study will be obtained from the relevant ethics committees in Sri Lanka and partner academic institutions. This will also ensure adherence to the principles of informed consent, voluntary participation, psychological support throughout participation, and compliance with the principles of trauma-informed care (Kirmayer & Pedersen, 2014; WHO, 2022).

Data governance protocols conform to General Data Protection Regulation (GDPR) standards and employ encryption, transparent consent, and secure data management to safeguard participant confidentiality (Brynjolfsson & McAfee, 2017; Cong & Zheng, 2021). Gender sensitivity and cultural nuances are embedded through local language interfaces, culturally resonant metaphors, and participatory design that respect local values and social norms, thereby ensuring relevance and dignity (UNDP, 2021). Trauma-informed care principles are integrated throughout the design to promote safety, trust, and user control, while preventing re-traumatisation, an essential safeguard for PTSD interventions in post-conflict environments (Kirmayer & Pedersen, 2014; WHO, 2022). Ongoing algorithmic bias mitigation and fairness auditing utilise explainable AI layers and iterative local stakeholder feedback to adjust interventions in response to evolving needs (Molnar & Gill, 2018).

Community trust is cultivated through sustained stakeholder engagement, collaboration with local actors, and participatory validation studies that feature community voices in shaping deployment (Ager & Strang, 2008). There is great respect for gender and religious identities, and clear precautions are taken to ensure that no one is excluded or hurt in interactions within the systems. The sensitivity to local contexts within scenario-based modules, as well as chatbot conversations that incorporate highly culturally adapted scenarios, ensures the cultural integrity of psychological interventions and mindfulness practices.

Informed consent is implemented beyond mere compliance, ensuring users comprehend the technology, its purpose, and their rights, including the right to withdraw without consequence (Brynjolfsson & McAfee, 2017). Local ethics committees and institutional review boards engage in rigorous oversight, aligning with international best practices for research ethics and digital health interventions (WHO, 2022). Security-by-design and privacy-by-design influence the development process, integrating ethical considerations at all levels of platform design.

CONCLUSION

The VERA AI platform constitutes a notable innovation of neuro-engineering, brain-computer interaction, and smart-health systems, offering scalable, trauma-informed interventions for Post- Traumatic Stress Disorder (PTSD) among ex-combatants and internally displaced persons (IDPs) in post-conflict Sri Lanka. The deployment of cognitive-behavioural therapy (CBT), dialectical- behavioural therapy (DBT), mindfulness practices, and gamification within an AI-regulated ecosystem aligns the platform with Disarmament, Demobilisation, and Reintegration (DDR) frameworks, thereby contributing to reintegration and peace-building initiatives (WHO, 2022; Ager & Strang, 2008).

The platform's integration of neuro-sensing devices, notably electroencephalography (EEG) and heart-rate variability (HRV) monitoring, combined with machine-learning models, facilitates real- time, individualised Gamified therapeutic delivery, addressing the heterogeneous presentation of Post-Traumatic Stress Disorder (PTSD) while adhering to ethical standards through compliance with the General Data Protection Regulation (GDPR) and adoptable explainability features in AI systems (Brynjolfsson & McAfee, 2017; Cong & Zheng, 2021). Policy implications of the VERA AI platform include its potential to enrich monitoring and evaluation frameworks in DDR programmes through data-driven insights that refine psychosocial support strategies and inform national mental health policies (Molnar & Gill, 2018; WHO, 2022). Ethical deployment emphasises user privacy, informed consent, and the prevention of harm to ensure that interventions remain trauma-informed and culturally responsive throughout the user journey (Kirmayer & Pedersen, 2014; Brynjolfsson & McAfee, 2017).

The VERA AI platform is used as an illustrative example of how a Gamified AI-based neuro- engineering solution could help address complex mental health issues during the post-conflict period. It offers an effective, cost-efficient, user-centred, scalable model of psychosocial rehabilitation; rooted in the latest technological innovations, but informed by ethical, cultural and therapeutic best-practices to enable ex-combatants, veterans and IDPs in Sri Lanka and other post-conflict countries around the world to rebuild their own lives and become contributors of a wider reintegration process in Sri Lanka and elsewhere.

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