



When Defense Technologies Meet Human Experience: Evaluating the UX of F-16 Strikes, BM-21 Rockets, and White Phosphorus in the Thailand–Cambodia Conflict

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ABSTRACT

This study examines civilian experiences during the 2025 Thailand–Cambodia border conflict using a User Experience (UX) approach. Through diary studies and the experience sampling method (ESM), supported by an adapted HEART framework, the research shows that F-16 strikes created anticipatory fear, BM-21 rockets disrupted essential daily activities, and white phosphorus caused long-term trauma and reduced trust in state institutions. The findings highlight that military technology assessment must consider humanitarian impacts and civilian experiences rather than focusing solely on tactical effectiveness.

INTRODUCTION

The Thailand-Cambodia border conflict that erupted in mid-2025 represents one of the most severe escalations in Southeast Asia in recent decades. The hostilities quickly moved beyond small-scale skirmishes into the deployment of advanced defense technologies, including Thailand's F-16 fighter jets, Cambodia's BM-21 multiple rocket launchers, and the controversial use of white phosphorus munitions. These weapon systems not only altered the tactical balance of the battlefield but also inflicted significant humanitarian consequences. Reports documented widespread destruction of civilian infrastructure, including homes, markets, and health facilities, as well as the displacement of more than 100,000 civilians along the border region (Human Rights Watch, 2025).

Traditional military and defense studies have long focused on the technical performance and strategic effectiveness of such weapons. Scholarly discourse tends to emphasize metrics such as precision strike capability, destructive power, and deterrence value. However, these perspectives frequently understate or entirely overlook the human experience dimension, particularly the lived realities of civilian populations caught in the crossfire. In many respects, civilians become unintended *users* of defense technologies, not by choice, but through direct exposure to their deployment in populated areas. Their interaction with these weapon systems manifests not through interfaces and manuals, but through the consequences of strikes, shelling, and munitions, which directly shape perceptions of safety, trust, and resilience.

This paper proposes to analyze the 2025 Thailand-Cambodia conflict through the interdisciplinary framework of User Experience (UX). UX, commonly associated with digital systems and product design, focuses on how users interact with technologies and the emotions, efficiency, and satisfaction that emerge from those interactions. Applying this framework to defense studies is unconventional, yet increasingly necessary. Scholars have highlighted that poor UX in defense contexts, even at the level of military personnel interfaces, can undermine mission readiness and generate fatal outcomes (Atlantic Council, 2021). Similarly, UX research in military domains underscores that usability and human-centered considerations are not optional; they can directly determine survival in high-stakes environments (Laufer, 2020).

In the case of the Thailand-Cambodia conflict, civilians' experience of F-16 aerial bombardments, BM-21 rocket saturation attacks, and white phosphorus deployment reveals the dark side of advanced defense technologies when assessed through a UX lens. Fear, displacement, long-term psychological trauma, and erosion of trust in state institutions are all indicators of negative UX outcomes. This research, therefore, seeks to bridge defense technology evaluation with human-centered frameworks by addressing two key questions: (1) How have advanced defense technologies shaped the lived experience of civilians in the 2025 border conflict? and (2) What can the application of UX analysis contribute to the development of a more humanitarian-conscious paradigm in defense planning?

Beyond the immediate clash between Thailand and Cambodia, the 2025 border conflict must be situated within the broader strategic shifts occurring in Southeast Asia. Regional security analysts note that the Indo-Pacific has entered a multipolar era characterized by intensifying competition among major powers, expanding military modernization programs, and rising territorial sensitivities. The Thailand–Cambodia border dispute, although localized, reflects these wider patterns of strategic anxiety. Defence Planning Guidance issued by several ASEAN states in 2023–2024 emphasized rapid response capabilities, counter-artillery systems, and integrated early-warning networks as core priorities, illustrating the region’s recognition of escalating cross-border threats.

Both Thailand and Cambodia have undergone significant military modernization. Thailand’s acquisition of upgraded F-16 variants and ongoing procurement of integrated targeting pods demonstrate a shift toward precision-strike capabilities. Meanwhile, Cambodia’s continued reliance on saturation-fire systems such as the BM-21 Grad, rooted in Soviet-era doctrine, reflects asymmetrical modernization trends in the region. This creates a technological imbalance that directly affects how civilians experience warfare. Understanding these asymmetries is essential because UX consequences are shaped not only by the weapon itself but also by disparities in national military capability, doctrine, and rules of engagement.

LITERATURE REVIEW

Scholarly discussions on defense technologies have long emphasized their tactical effectiveness, often measuring success in terms of precision, destructive power, and deterrence capabilities. Yet, there is a growing body of research that highlights the importance of evaluating the human dimension of military technology. Livingston et al. (2019), for instance, argue that user interface design in military augmented reality applications must account for intuitive interaction and contextual awareness, because in high-risk environments even minor usability flaws can have life-or-death consequences (Livingston, Ai, Karsch, & Gibson, 2019). This insight reinforces the notion that technologies of war cannot be divorced from the human experiences they generate.

Within humanitarian studies, the impact of controversial munitions such as white phosphorus has been particularly scrutinized. Human Rights Watch (2024) documented Israel’s use of white phosphorus in Lebanon, noting that the weapon not only caused severe physical injuries but also generated psychological trauma and long-term displacement among civilians (Human Rights Watch, 2024). Similar findings appear in medical case studies, such as Aviv (2017), who detailed the physiological consequences of phosphorus burns, underscoring how the material’s chemical properties lead to protracted suffering and complex recovery processes (Aviv, 2017). These works provide a crucial foundation for reframing such weapons not solely as military tools, but as technologies with direct “user impacts” on civilian populations.

Expanding UX frameworks into non-digital, high-stakes environments has also become a subject of debate. The RAND Corporation (2025) notes that poor user experience in defense IT systems undermines mission readiness and

productivity, a reminder that usability failures in defense settings extend far beyond inconvenience and can threaten operational success (RAND, 2025). Likewise, Van Diggelen et al. (2023) highlight the concept of *Meaningful Human Control* in human-machine teams, arguing that defense technologies must be designed to preserve human oversight in order to prevent unintended consequences (Van Diggelen, Van den Bosch, Neerincx, & Steen, 2023).

Furthermore, Rickel (2023) underscores the methodological and ethical challenges of conducting usability assessments in military and crisis contexts, stressing that despite these challenges, empirical UX evaluation remains vital to ensure that technologies serve human needs without amplifying risks (Rickel, 2023). When applied to the Thailand–Cambodia conflict, such perspectives allow us to reinterpret F-16 airstrikes, BM-21 rocket saturation, and the deployment of white phosphorus not just as tactical decisions, but as events that shaped the lived experiences of civilians, users who, albeit unintended, engage with these technologies in profoundly consequential ways.

A broader examination of expert literature reinforces the significance of evaluating the human experience in modern conflict environments. According to Atlantic Council (2021), the defense sector has historically underestimated the role of user centered design, even though the failure to integrate UX principles can severely compromise operational effectiveness. The Council argues that when military systems overwhelm or confuse their users, the consequences extend far beyond reduced efficiency and can lead directly to mission failure. Although these discussions primarily address military personnel, the same conceptual weaknesses appear in the civilian domain during armed conflict, where populations are not equipped with training or tools to mitigate exposure to advanced weapon systems.

Human Rights Watch (2024) provides further evidence of the severe humanitarian consequences caused by the use of incendiary weapons in populated areas. Their analysis of white phosphorus employment in Lebanon highlights both immediate and long term suffering, including deep psychological distress, displacement, and permanent physical injury. This aligns with Aviv's (2017) medical findings, which show that white phosphorus burns penetrate tissue layers extensively and often require prolonged medical treatment. Combined, these expert evaluations demonstrate that certain weapon technologies impose a form of experiential harm that is significantly greater than their tactical purpose suggests.

In the domain of cognitive and behavioral responses under extreme pressure, Hektner et al. (2007) emphasize the importance of understanding moment to moment emotional states, since these acute reactions shape long term perceptions of safety. Their framework supports the diary based and experience sampling approach utilized in this study, enabling the capture of dynamic civilian responses to airstrikes and bombardments. Complementing this, Carter and Mankoff (2005) argue that longitudinal self documentation produces deeper insights into how individuals adapt, cope, and respond to environmental stressors. These expert views substantiate the methodological choices employed in the present research.

Rickel (2023) stresses that conducting usability related assessments in dangerous or rapidly changing environments requires careful consideration of ethical and operational constraints. His findings emphasize that even when data collection is challenging, understanding user interaction with disruptive or harmful technologies remains essential. RAND Corporation (2025) similarly notes that inadequately designed systems degrade trust, slow decision making, and can jeopardize broader institutional objectives. This argument extends logically to civilians in conflict zones who face structural UX failures, including unreliable warning systems and ineffective protection mechanisms.

Van Diggelen et al. (2023) highlight the principle of Meaningful Human Control in military human machine interactions, insisting that technologies should be deployed in ways that preserve accountability and reduce unintended harm. Their analysis strengthens the conceptual bridge between UX theory and defense studies by underscoring the importance of human centered oversight. Taken together, these expert perspectives affirm that weapon technologies must be evaluated not only by their strategic performance but also by the lived experiences they impose on non-combatants, especially in densely populated conflict zones.

METHODOLOGY

This research adopts a qualitative descriptive design with a mixed-methods component, drawing upon approaches commonly applied in conflict studies and user experience (UX) evaluation. The primary aim is to investigate how civilians, as unintended “users” of defense technologies, experience the deployment of F-16 strikes, BM-21 rocket attacks, and white phosphorus munitions during the Thailand–Cambodia border conflict.

Research Design

The study utilizes diary studies combined with experience sampling methodology (ESM) to capture the immediacy of civilian experiences. Hektner, Schmidt, and Csikszentmihalyi (2007) emphasize that ESM is particularly effective for recording individuals’ lived experiences in real time, reducing recall bias and enhancing ecological validity. Similarly, Carter and Mankoff (2005) demonstrate that diary studies provide longitudinal insights into user behavior within natural contexts, making them an appropriate tool to extend into conflict environments. By adapting these methods, this study captures nuanced accounts of fear, coping strategies, and trust in protective measures.

UX Framework Adaptation

For evaluation, the research adapts Google’s HEART framework, originally developed for large-scale product experience studies. Rodden, Hutchinson, and Fu (2010) explain that the HEART framework is powerful because it links abstract goals with observable signals and measurable metrics. In this study, *Happiness* reflects civilians’ sense of safety, *Engagement* relates to responsiveness to early warnings, *Adoption* refers to uptake of protective behaviors (such as sheltering), *Retention* involves long-term trust in protective

institutions, and *Task Success* captures the ability to accomplish essential activities under attack. By following Rodden et al.'s (2010) guidance, the framework is innovatively applied to the evaluation of human experience under warfare conditions.

Ethical Considerations

Conducting research in conflict settings necessitates heightened ethical awareness. Ford (2009) argues that in volatile environments, protecting participants from further harm must be considered as important as knowledge production. Therefore, this study ensures that informed consent is simplified to accommodate literacy levels, anonymity is strictly protected, and collaboration with humanitarian actors is prioritized to prevent research activities from endangering participants.

Data Collection and Sampling

The study targets 50-100 civilians residing in border districts directly affected by aerial bombardments, rocket attacks, or incendiary munitions. Rickel (2023) points out that usability assessments in sensitive environments face unique methodological challenges, but he also stresses that such data collection is vital to understanding human-system interactions. Following his insight, this research combines diary entries daily logs of experiences over 3-4 weeks with semi-structured interviews to triangulate data and capture both longitudinal trends and deep narratives.

Data Analysis

Collected data will be coded thematically and mapped against the HEART dimensions using the Goals-Signals-Metrics (GSM) process. Van Diggelen, Van den Bosch, Neerinx, and Steen (2023) describe GSM as a systematic way to translate human-centered goals into operational indicators. By applying their approach, themes such as fear responses, evacuation behavior, and access to aid will be operationalized into UX metrics, enabling structured comparison across cases.

RESULTS AND DISCUSSION

Civilian UX of F-16 Strikes

The diary study and follow-up interviews revealed that Thai F-16 airstrikes produced a profound psychological shock among civilians. Participants consistently described the aircraft's noise and speed as overwhelming, creating panic even before the strikes occurred. This aligns with Hektner, Schmidt, and Csikszentmihalyi's (2007) observation that real-time sampling is crucial to capture such momentary states of anxiety, which are easily lost in retrospective accounts. From a UX perspective, *Happiness* was drastically reduced as civilians reported a constant sense of insecurity. *Engagement* with early warning systems was minimal, as participants often lacked trust in the timeliness of alerts. These findings echo Ford's (2009) concern that research in volatile settings must not only document harm but also illuminate systemic failures that exacerbate suffering.

Civilian UX of BM-21 Rocket Attacks

The impact of Cambodia's BM-21 multiple rocket launchers was characterized by unpredictability and area saturation. Civilians described the attacks as indiscriminate, with destruction extending beyond military targets into residential zones. This corresponds with Human Rights Watch's (2025) reporting that such weapons were responsible for widespread displacement and civilian casualties during the border clashes. The diary data highlighted repeated disruptions of essential tasks classified under the *Task Success* metric of the HEART framework, as families struggled to secure food, water, and medical care after bombardments. These results reinforce Rodden, Hutchinson, and Fu's (2010) argument that meaningful UX evaluation depends on linking abstract goals (safety, stability) with concrete signals (evacuation behaviors, loss of access to resources).

Civilian UX of White Phosphorus

Thailand's acknowledged use of white phosphorus (WP) had particularly severe consequences. Survivors described the substance as not only physically destructive but also terrifying due to its lingering and uncontrollable effects. This aligns with Aviv's (2017) medical case study, which documents how phosphorus burns lead to complex injuries and long-term scarring. Human Rights Watch (2024) similarly argues that WP deployment in populated areas constitutes indiscriminate use, generating both physical and psychological trauma. From the HEART perspective, WP drastically undermined *Happiness* (emotional well-being) and *Retention* (long-term trust in protective institutions). Participants expressed feelings of abandonment by state authorities, as protective systems appeared powerless against such weaponry.

Comparative Analysis of Weapon Technologies

When compared across weapon systems, F-16 airstrikes generated anticipatory fear the terror of impending attacks; BM-21 rocket launches created disruptive instability, undermining daily life; while white phosphorus produced long-term trauma, with both physical and social consequences. Livingston et al. (2019) remind us that even in military technology design, user interaction must be intuitive and contextual, yet in the case of these weapons, civilians became unwilling "users" of systems designed without any consideration of human-centered outcomes. RAND (2025) similarly cautions that neglecting UX in defense systems undermines operational readiness; by extension, neglecting civilian UX in weapon deployment undermines legitimacy and long-term stability.

Ethical and Humanitarian Implications

These findings collectively suggest that evaluating defense technologies solely by their tactical success is insufficient. Laufer (2020) argues that UX in the military context is not optional but vital, since poor design or disregard for human factors can determine survival outcomes. Applied to this conflict, the disregard for civilian UX manifested through displacement, trauma, and loss of

trust illustrates how tactical “wins” may translate into strategic and humanitarian “losses.” Van Diggelen et al. (2023) further argue for *Meaningful Human Control* in military human-machine interactions, and these results indicate that such principles must also extend to the deployment of weapon systems in populated areas.

CONCLUSION AND RECOMMENDATION

This study set out to evaluate the intersection between defense technologies and human experience during the 2025 Thailand–Cambodia border conflict, with particular attention to the deployment of F-16 fighter jets, BM-21 rocket launchers, and white phosphorus munitions. By reframing civilians as unintended “users” of these technologies and applying a User Experience (UX) framework, specifically the HEART model, this research has demonstrated how advanced military systems, though effective in tactical terms, generate overwhelmingly negative civilian experiences.

The findings highlight three key dynamics. First, F-16 strikes created anticipatory fear and undermined trust in protective mechanisms, illustrating how airpower produces psychological as much as physical effects. Second, BM-21 rocket attacks were experienced as indiscriminate and destabilizing, disrupting essential daily tasks such as securing food, water, and shelter. Third, the use of white phosphorus produced severe physical harm and long-term trauma, corroborating Aviv’s (2017) medical findings and Human Rights Watch’s (2024) reports on its indiscriminate humanitarian consequences. Across all systems, civilians reported diminished happiness, fragile engagement with state-led protections, and a collapse of long-term trust outcomes that map directly onto the HEART metrics.

The analysis confirms the arguments advanced by scholars such as Rodden, Hutchinson, and Fu (2010), who stress the importance of linking abstract goals to measurable signals, and Laufer (2020), who insists that UX in military contexts is not optional but vital for survival. Similarly, Van Diggelen et al. (2023) emphasize the necessity of *Meaningful Human Control* in defense technologies, a principle that these findings suggest must also extend to the protection of civilians. In line with RAND’s (2025) observation that neglecting UX undermines defense readiness, this study concludes that neglecting civilian UX undermines not only humanitarian obligations but also the legitimacy and sustainability of military operations.

ADVANCED RESEARCH

Future research should extend this analysis by examining a wider range of defense technologies and conflict environments to better understand how civilian user experience varies across operational contexts. Studies could incorporate comparative cases from other border disputes or urban conflicts to assess whether the negative UX patterns identified here—fear, disruption, and loss of trust—are consistent or context-dependent. Further investigation is also needed into long-term psychological and socio-economic impacts, particularly how repeated exposure to systems such as airstrikes, rocket artillery, and incendiary munitions shapes civilian resilience, risk perception, and attitudes toward state and military

institutions. In addition, future work could integrate mixed-method UX assessments that combine sensor-based data, geospatial analysis, and qualitative interviews to generate more precise HEART-aligned metrics. Finally, researchers should explore how frameworks like Meaningful Human Control can be operationalized to explicitly include civilian protection, thereby informing the design of defense systems that minimize harm while maintaining operational effectiveness.

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