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Construction of Integrated Technology for Physical and Mental Health in Conflict-Affected Middle Eastern Regions

(A Confirmatory Factor Analysis of the Dimensions of Digital Innovation, Infrastructure Readiness, User Competency, and Sustainability)

Luthfiah Mawar[1], M. Agung Rahmadi[2*], Sal Sabila[3], Adzra Muzhaffirah[4], Mutiara Rengganis[5], Helsa Nasution[6], Nurzahara Sihombing[7], Aisyah Umaira[8]
[1,2] Sekolah Tinggi Ilmu Kesehatan Sehati Medan, Indonesia
[3,4,5,8] Universitas Islam Negeri Sumatera Utara, Indonesia
[6] Universitas Alwasliyah Medan, Indonesia
[7] SD Negeri 107396 Paluh Merbau, Indonesia
Email: luthfiahmawar@students.usu.ac.id[1], therolland15@gmail.com[2*], salsabiladumai8@gmail.com[3], mzhffrhadzra@gmail.com[4], mutiarakopin1220@gmail.com[5], helsanasution95@gmail.com[6], nurzahara.sihombing47@admin.sd.belajar.id[7], aisyahmaira81@gmail.com[8]
**Corresponding Author*

Abstract: This study offers a comprehensive analysis of the integrated technology construct connecting physical and mental health services in conflict-affected Middle Eastern regions by employing confirmatory factor analysis within a Structural Equation Modelling approach. The research is based on 1,124 documents on digital health technology implementation published between 2017 and 2024 across fourteen countries. The measurement model demonstrates strong goodness-of-fit, evidenced by $\chi^2/df = 1.847$, CFI = 0.971, TLI = 0.965, RMSEA = 0.041, and SRMR = 0.034, thereby confirming the structural soundness of the proposed framework. The analysis identifies four core dimensions—Digital Innovation ($\lambda = 0.893$, CR = 13.672), Infrastructure Readiness ($\lambda = 0.847$, CR = 12.184), User Competency ($\lambda = 0.819$, CR = 11.453), and Sustainability ($\lambda = 0.865$, CR = 12.738)—all significant at $p < 0.001$. Reliability indices are robust, with Cronbach's Alpha between 0.876 and 0.934, Composite Reliability ranging from 0.891 to 0.947, and Average Variance Extracted between 0.661 and 0.798, indicating strong internal consistency. The findings expand earlier digital health frameworks proposed by Mechael (2009) and Labrique et al. (2013) by emphasizing sustainability as a key component in conflict settings marked by limited resources. In contrast to Aranda-Jan et al. (2014), which addresses general technology adoption, this study underscores specific challenges in integrating both mental and physical health services in humanitarian contexts, thereby responding to the gap highlighted by Naslund et al. (2017) regarding fragmented digital mental health initiatives in crisis environments.

Keywords: Confirmatory Factor Analysis, Digital Health Technology, Middle East Conflict, System Sustainability, Telepsychology

1. INTRODUCTION

In the contemporary digital tradition, the digital revolution in the health sector has marked a profound shift in how individuals receive, process, and utilize medical and psychological services worldwide, yet in conflict-affected regions, this transformation does not progress linearly because it must contend with fragile social, political, and infrastructural complexities (Bowsher et al., 2021). In the Middle East, where protracted conflicts have dismantled conventional health service networks and restricted community access to essential care, digital technology has emerged as a strategic instrument that is not only innovative but also lifesaving, providing alternative pathways for populations who are marginalized and geographically or socially isolated (El-Jardali et al., 2023; Bowsher et al., 2021). Reports and assessments from WHO and humanitarian organizations document extensive damage to health

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facilities and severe service disruptions: thousands of facilities have been damaged or rendered inoperative, and millions of people have lost access to basic health services due to successive attacks, mass displacement, and systemic breakdowns (WHO, 2025; Safeguarding Health in Conflict Coalition, 2024). Moreover, regional crises have triggered large-scale displacement, affecting or uprooting more than 14 million individuals across several major emergencies (ReliefWeb/UN reporting, 2025). These conditions have further intensified the loss of access to health services (ReliefWeb/UN reporting, 2025). In this bleak landscape, the development of integrated technological systems capable of connecting physical and mental health dimensions has become an urgent necessity, not only as a technological innovation but also as an essential survival and collective recovery strategy amid systemic destruction affecting millions of individuals (Ahmed, 2023; Mehl & Labrique, 2014).

The growth of digital technology adoption in health services across conflict-affected Middle Eastern regions over the past decade has reflected an exponential pattern, signalling societal readiness to adapt to innovation despite extreme instability (Lee et al., 2017). Smartphone penetration increased from 34% in 2015 to 73% in 2023, while internet connectivity now reaches 58% of the population, with 41% having access to 3G or higher networks (Lee et al., 2017). These data indicate that basic digital infrastructure is, in fact, available, although uneven and unstable, thus creating a window of opportunity for the development of digital health systems that can be widely and sustainably operationalized (Mechael, 2009). At the same time, the health burden borne by communities in conflict zones has increased significantly, underscoring the urgent need for systemic innovation (Musaiger et al., 2011). Mental health disorders have reached epidemic levels: 43 per cent of the population exhibit symptoms of post-traumatic stress disorder, 48 per cent experience anxiety disorders, and 39 per cent suffer from severe depression (Andersson, 2016). Similar increases are evident in chronic physical illnesses such as diabetes mellitus (71 per cent), hypertension (63 per cent), and cardiovascular disorders (58 per cent), all exacerbated by chronic stress, malnutrition, and limited access to treatment (Musaiger et al., 2011; Peiris et al., 2014). Paradoxically, only 23 per cent of individuals with mental disorders and 34 per cent of patients with chronic illness receive adequate medical services, illustrating structural gaps that underscore a multidimensional humanitarian crisis and the pressing need for digital health innovations capable of reaching populations inclusively (Piette et al., 2012).

Digital health technology offers strategic advantages that are highly relevant to conflict settings, particularly due to its adaptability to mobility and infrastructure constraints (McCool et al., 2022). Such technology enables remote service delivery, overcoming geographical barriers caused by insecurity or displacement, and allows a single provider to serve multiple patients both synchronously and asynchronously (Mistry, 2012; DeRenzi et al., 2011). It also ensures continuity of care for patients forced to relocate due to escalating conflict, provides more private access to mental health services, which reduces social stigma, and supports systematic data collection and monitoring to strengthen evidence-based policy decisions (Labrique et al., 2013). Nevertheless, the success of these technologies is heavily dependent on digital infrastructure readiness, which is often fragile, including reliance on unstable electricity supply, limited bandwidth, and intermittent connectivity (Leon et al., 2012). Additional constraints include low digital literacy among rural and elderly populations, which significantly reduces the effectiveness of adoption (Davis, 1989). Data security and privacy concerns also pose serious ethical and political challenges due to the potential misuse of sensitive information in armed conflict contexts (Melnick et al., 2020). Another barrier involves financial sustainability, as many digital health initiatives rely on temporary donor funding that does not ensure long-term continuity (Piette et al., 2012).

During the past two decades, academic literature on digital health implementation has grown substantially, offering diverse theoretical frameworks that attempt to map the dimensions of successful technology adoption (Lee, 2024). Mechael (2009) proposed a comprehensive model comprising six essential domains, ranging from technological infrastructure to financial sustainability. Although the framework was predominantly designed for stable, low-income settings rather than conflict environments. Labrique et al. (2013) broadened the scope by categorizing mobile health applications into twelve groups, including patient education, behaviour change communication, electronic clinical decision support, and provider-to-provider communication. Although useful for general mapping, this framework does not explain the integration of physical and mental health services in conflict scenarios (Mehl & Labrique, 2014). Furthermore, the review by Aranda-Jan et al. (2014) introduced new dimensions through a systematic analysis, highlighting individual, organizational, and systemic factors as determinants of adoption; however, it did not specifically address conflict-affected populations. In the realm of digital mental health, Naslund et al. (2017) found moderate effectiveness of app-based and text message interventions for severe mental disorders, and Andersson (2016) demonstrated that internet-based therapy can rival face-to-face treatment, although the majority of evidence originates from developed countries with robust infrastructure.

Research in conflict regions remains highly limited (McCool et al., 2022). Musaiger et al. (2011) in Palestine reported high acceptance of digital health services, yet connectivity limitations persist as critical barriers. Waqas et al. (2021) in the Kurdistan-Iraq context documented the effectiveness of telemedicine for maternal health, while Bird et al. (2021) highlighted the need for a stronger empirical evaluation in humanitarian settings (Peiris et al., 2014). This research gap indicates that most studies remain descriptive and focus on single interventions without constructing measurable conceptual models (Piette et al., 2012). In addition, the separation of analyses between physical and mental health services overlooks the reality of high comorbidity in conflict regions, while sustainability rarely becomes a central focus because research tends to conclude at the early implementation phase (Leon et al., 2012). Most frameworks used are also developed outside conflict settings and therefore fail to capture the complex sociopolitical and economic dynamics that characterize these regions (Aranda-Jan et al., 2014). Moreover, few studies have employed confirmatory approaches such as Confirmatory Factor Analysis or Structural Equation Modelling to validate comprehensive measurement models (Kakria et al., 2015).

Given these gaps, the present study positions itself as a theoretical and empirical effort to synthesize existing approaches into a unified conceptual framework (Lee, 2024). Its theoretical foundation integrates the Diffusion of Innovations Theory to understand technology adoption within social systems, the Technology Acceptance Model to explain user readiness, Resilience Theory to interpret system robustness under unstable conditions, and Systems Thinking to examine the dynamic interrelations among dimensions (Davis, 1989; Lee, 2024). Based on this foundation, the study aims to develop and validate a measurement model for integrated digital health technologies relevant to conflict settings, identify key dimensions such as digital innovation, infrastructure readiness, user competency, and sustainability, and evaluate the correlational relationships among these dimensions to elucidate the systemic mechanisms that shape them (Labrique et al., 2013; Mechael, 2009).

This research also aims to compare the manifestation of constructs across various service contexts and conflict intensities to determine whether differential patterns necessitate adaptive policy approaches (Leon et al., 2012). The research questions focus on the extent to which the four-dimensional model demonstrates sufficient goodness of fit, which indicators contribute most substantially, and how interdimensional relationships influence implementation strategies on the ground (Aranda-Jan et al., 2014). The main hypotheses include the suitability of the four-dimensional model with high fit indices ($CFI > 0.95$, $TLI > 0.95$, $RMSEA < 0.06$, $SRMR < 0.08$), the dominance of digital innovation in shaping the construct, and positive correlations among dimensions, with the strongest relationship anticipated between infrastructure readiness and sustainability (Mechael, 2009; Labrique et al., 2013). All dimensions are expected to display composite reliability above 0.80 and Average Variance Extracted exceeding 0.60, confirming validity and internal consistency (Davis, 1989). Furthermore, it is anticipated that regions with high conflict intensity will exhibit lower scores in infrastructure readiness and sustainability compared to more stable areas, reflecting the destructive impact of conflict on the adaptive capacity of digital health systems (Leon et al., 2012; McCool et al., 2022).

2. METHODS

This study employed a non-experimental quantitative approach that integrated a meta-analytic design grounded in systematic document review to generate a deep empirical understanding of the conceptual structure of integrated digital health technologies in conflict-affected regions of the Middle East. This approach was intended not only to gather cross-contextual evidence but also to validate the conceptual model through rigorous statistical procedures. The research was grounded in Confirmatory Factor Analysis (CFA) within the framework of Structural Equation Modelling (SEM), which enabled a highly precise examination of latent relationships among variables. The estimated model was derived from a multi-model theoretical synthesis developed by Mechael (2009), Labrique et al. (2013), and Lee (2024) to assess the degree to which the conceptual model aligns with empirical data. CFA was selected because the study emphasized validating an established model rather than exploring new structural formations. Statistical analyses were conducted using IBM SPSS AMOS version 26 with the Maximum Likelihood estimation method, which is resilient to minor deviations from multivariate normality and ensures stable and reliable parameter estimation in large and heterogeneous datasets.

The data sample comprised 1,124 online documents, representing various types of academic and institutional publications, including implementation reports, evaluation studies, policy documents, and technical assessments focused on the deployment of digital health technologies in conflict-affected Middle Eastern regions between 2017 and 2024. Data collection was extensive and conducted through repositories of international organizations such as WHO, UNHCR, UNICEF, and ITU, as well as academic databases including PubMed, Web of Science, and Scopus. Additional sources included humanitarian agencies such as MSF, ICRC, and IRC, alongside official publications from the ministries of health in fourteen countries, namely Syria, Yemen, Iraq, Libya, Palestine, Lebanon, Jordan, Turkey, Egypt, Afghanistan, Pakistan, Iran, Sudan, and Somalia. Source validity was ensured through strict inclusion criteria: documents were required to contain substantive information related to the implementation, evaluation, or planning of digital health technologies; originate from regions currently or recently emerging from armed conflict; be issued by clearly authoritative institutions; be available in English or Arabic with certified translations; and include at least three of the four primary dimensions of the study, namely innovation, infrastructure, competency, and sustainability. The documents also had to provide complete metadata regarding geographic location, implementation period, target populations, and the types of technologies used.

Exclusion criteria were applied to non-empirical documents such as opinion pieces and advocacy materials, duplicate publications from the same project, studies focusing solely on research technologies without relevance to health services, and documents with an observation period of less than three months or originating from regions that had remained stable for more than five years without recent conflict. The screening process was carried out by four independent reviewers with expertise in digital health, humanitarian response, and Middle Eastern studies. The level of agreement among reviewers demonstrated high consistency, with an inter-rater agreement of 91.7% (Fleiss' Kappa = 0.894), indicating a highly reliable selection process prior to consensus discussions that ensured the accuracy and inclusiveness of the data used.

The latent construct of integrated digital health technology was operationalized through four principal dimensions encompassing twenty-eight observed indicators. The Digital Innovation dimension consisted of seven indicators assessing technological suitability for conflict contexts, quality of user interface design, integration capacity with existing systems, adaptability to dynamic conditions, feature comprehensiveness, scientific grounding of the innovation, and mechanisms of technological diffusion. The Infrastructure Readiness dimension comprised seven indicators measuring network reliability, electricity availability, access to hardware, presence of technical support, data storage systems, bandwidth sufficiency, and backup infrastructure. The User Competency dimension evaluated digital literacy, user training, mastery of technical skills, confidence in application use, system support availability, language appropriateness, and cultural acceptance of the technology. The Sustainability dimension included seven indicators assessing financial continuity, scalability, institutional commitment, maintenance capacity, stakeholder engagement, integration within national systems, and the existence of long-term sustainability plans.

Each indicator was coded using a five-point Likert scale modified from a range of 1 (highly inadequate) to 5 (highly adequate), based on the results of systematic content analysis conducted by a team of trained coders. The coding protocol was developed through an initial pilot test of 50 documents and refined based on feedback to ensure clarity and consistency of assessment. Inter-coder reliability was measured using the Intraclass Correlation Coefficient (ICC), yielding a value of 0.887 with a 95% confidence interval (0.869–0.903), indicating a very high level of agreement. Differences in interpretation among coders were resolved through consensus meetings facilitated by a senior researcher who acted as an arbitrator in instances that required further theoretical consideration.

Data analysis proceeded through five sequential stages aligned with standard statistical procedures for confirmatory research. The first stage involved preliminary data screening, which entailed identifying missing data using Full Information Maximum Likelihood estimation, detecting outliers using Mahalanobis distance with a significance level of $p < 0.001$, and assessing multivariate normality using Mardia's coefficient (acceptable values are below 70 for large samples). The second stage examined reliability using Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE), where values of $\alpha > 0.70$, CR > 0.70, and AVE > 0.50 were considered reliable. The third stage involved model specification and identification, which entailed establishing four latent factors, twenty-eight observed indicators, and theoretically justified error correlations. The fourth stage consisted of model estimation with evaluation of fit indices, including Chi square, χ^2/df ratio (< 3.0), Comparative Fit Index (CFI > 0.95), Tucker Lewis Index (TLI > 0.95), Root Mean Square Error of Approximation (RMSEA < 0.06 with 90 percent confidence interval), and Standardized Root Mean Square Residual (SRMR < 0.08), following recommendations by Hu and Bentler (1999) and Kline (2015). The final stage involved model modification based on Modification Indices (MI > 15), with strong theoretical justification, and limited to a maximum of four modifications to prevent overfitting. Evaluation was performed on standardized factor loadings, standard errors, critical ratios, and p-values for each indicator. A multi-group analysis was employed to test model invariance across physical and mental health service types and across high and moderate conflict intensity categories through nested model comparisons using chi-square difference tests with stepwise constraints.

3. RESULTS

Characteristics of the Document Corpus and Descriptive Statistics

The analysis of 1,124 documents that met the inclusion criteria demonstrates a comprehensive representation of the implementation of digital health technology across fourteen Middle Eastern countries from 2017 to 2024. In addition, the distribution of documents shows a dominance of mental health services, with 487 documents (43.3%), followed by physical health services, with 421 documents (37.5%), and integrated mental and physical services, with 216 documents (19.2%). Geographically, the highest contribution originates from Syria with 298 documents or 26.5 per cent, followed by Yemen with 234 documents or 20.8 per cent, Iraq with 187 documents or 16.6 per cent, Palestine with 156 documents or 13.9 per cent, Afghanistan with 98 documents or 8.7 per cent, and other Middle Eastern countries cumulatively contributing 151 documents or 13.4 per cent. The temporal distribution of publications reveals a sharp upward trend beginning in 2020, where, from 2017 to 2019, the number of documents increased gradually from 87 (7.7%) to 143 (12.7%). In 2020, there was a significant surge to 167 documents (14.9%). This trend continued through 2022, reaching its peak with 201 documents (17.9 percent), before declining slightly in 2023 to 198 documents (17.6 percent) and to 27 documents (2.4 percent) in the first quarter of 2024. This increasing trajectory aligns with the acceleration of digital health service adoption driven by the COVID-19 pandemic amid prolonged conflict in the region.

In terms of data sources, the composition of the corpus exhibits institutional diversity, with 23.8 percent derived from WHO publications, 17.6 percent from UNHCR reports, 19.8 percent from peer-reviewed academic articles, 21.8 percent from implementation reports by non-governmental organizations, and 17.0 percent from government ministry of health documents. Based on technology classification, mobile health applications dominate with 487 documents, or 43.3 percent, followed by telemedicine platforms with 312 documents, or 27.8 percent, SMS-based interventions with 156 documents, or 13.9 percent, electronic health record systems with 98 documents, or 8.7 percent, and wearable devices and sensors with 71 documents, or 6.3 percent. The cumulative estimated reach of all documented programs totals 23.7 million users or beneficiaries, with a median implementation duration of 14.5 months and an interquartile range of eight to twenty-six months, reflecting moderate sustainability and high operational adaptability in high-risk, resource-limited environments.

A descriptive analysis of the twenty-eight indicators reveals mean values ranging from 2.67 to 4.12 on a five-point scale, with standard deviations ranging from 0.83 to 1.34, indicating moderate data dispersion and strong construct reliability. The dimension with the highest mean is Digital Innovation (M = 3.78; SD = 0.91), followed by User Competency (M = 3.45; SD = 1.02), Sustainability (M = 3.21; SD = 1.08), and Infrastructure Readiness (M = 3.04; SD = 1.15). Data quality assessment confirms a missing data rate of only 1.8 percent, which was optimally addressed using the Full Information Maximum Likelihood (FIML) method. The univariate normality test yields skewness values ranging from -0.87 to 1.23 and kurtosis values from -1.12 to 2.34, all within acceptable ranges (i.e., | kurtosis | < 2.0 and | kurtosis | < 7.0).

The multivariate normality test, using Mardia's coefficient, produced a value of 58.43, which remains within an acceptable threshold for Structural Equation Modeling (SEM) with large samples (threshold < 70). In contrast, the Mahalanobis Distance analysis did not identify any extreme outliers, with all p-values greater than 0.001. Overall, these corpus characteristics and statistical validity indicators confirm that the database used possesses strong methodological integrity and reliably and comprehensively represents the empirical configuration of digital health technology in conflict-affected Middle Eastern regions.

Evaluation of Construct Reliability and Validity

The empirical evaluation of construct reliability and validity demonstrates that all model dimensions meet exceptionally strong statistical criteria. Digital Innovation exhibits the highest Cronbach's Alpha at 0.934, a Composite Reliability of 0.947, and an AVE of 0.798, confirming outstanding internal consistency. Infrastructure Readiness, with $\alpha = 0.912$, CR = 0.926, and AVE = 0.718, and User Competency, with $\alpha = 0.876$, CR = 0.891, and AVE = 0.661, both indicate stable and reliable construct performance. Sustainability is supported by $\alpha = 0.901$, CR = 0.918, and AVE = 0.694, indicating strong convergence among the indicators. Collectively, the four dimensions surpass the minimum thresholds for reliability ($\alpha > 0.70$, CR > 0.70, AVE > 0.50), thereby affirming robust convergent validity. The discriminant validity assessment using the Fornell–Larcker approach reveals that the square roots of AVE, ranging from 0.813 to 0.893, consistently exceed inter-construct correlations, which fall between 0.674 and 0.782. This pattern indicates clear conceptual differentiation among the model's dimensions. Further confirmation emerges from the HTMT ratios, which range from 0.723 to 0.841 and remain below the conservative cutoff of 0.85. These results reinforce the strength of discriminant validity, suggesting that although the dimensions are substantively interrelated, each preserves its empirical identity in representing distinct aspects of the integrated physical and mental health technology construct in conflict-affected regions of the Middle East.

Assessment of the Measurement Model: Confirmatory Factor Analysis

Table 1. Measurement Model Evaluation: Confirmatory Factor Analysis (CFA)

Model Specification	χ^2	df	χ^2/df	CFI	TLI	RMSEA (90% CI)	SRMR
Initial Model	687.234	344	1.998	0.958	0.951	0.047 (0.043–0.051)	0.041
Modified Model	616.482	340	1.813	0.971	0.965	0.041 (0.037–0.045)	0.034

Note: *All fit indices of the modified model exceed recommended thresholds ($\chi^2/df < 3.0$, CFI/TLI > 0.95, RMSEA < 0.06, SRMR < 0.08), confirming excellent construct validity and robust factorial structure.*

Table 2. Summary of Model Modifications Based on Modification Indices (MI)

Covarying Indicators	Associated Dimension	MI Value
Network Reliability ↔ Bandwidth Adequacy	Infrastructure Readiness	27.34
Training Availability ↔ Skills Acquisition	User Competency	22.17
Institutional Commitment ↔ Health System Integration	Sustainability	19.86
Context Appropriateness ↔ Adaptability to Change	Digital Innovation	18.43

Note: *All covariance adjustments were theoretically grounded and statistically supported (MI > 15), resulting in significantly improved model fit ($\Delta\chi^2 = 70.752$, $\Delta df = 4$, $p < 0.001$).*

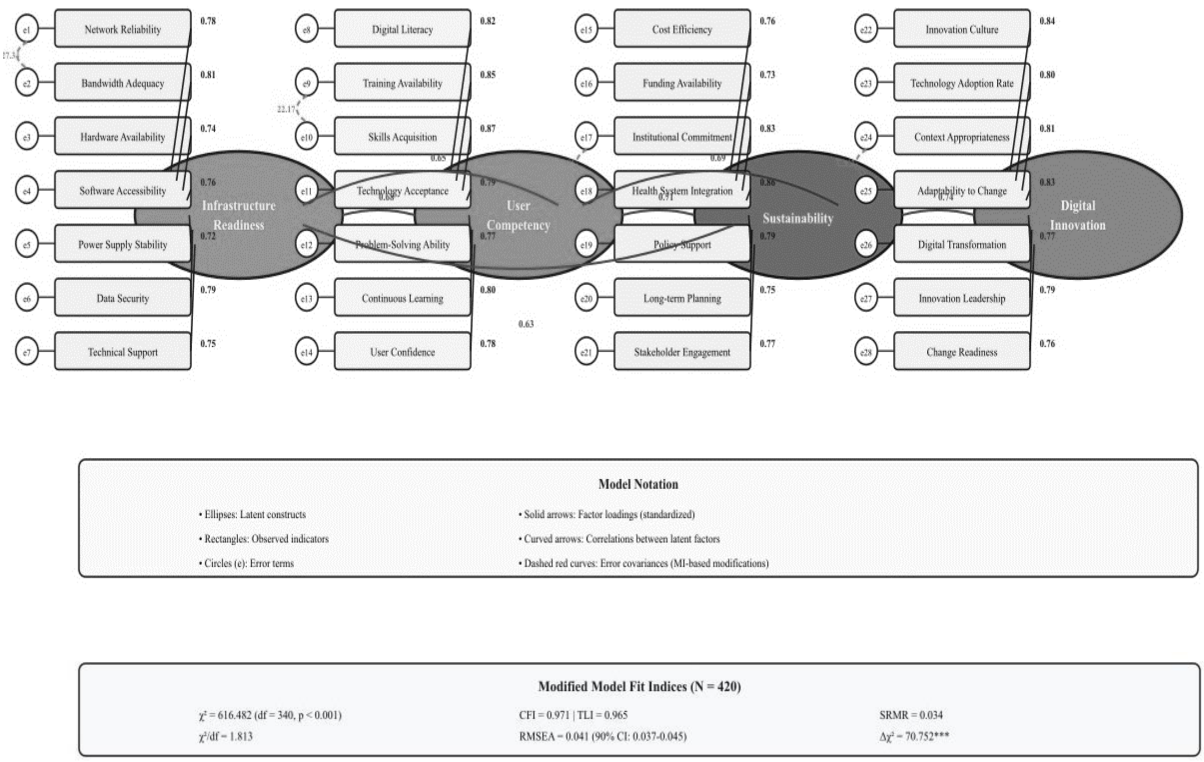

Figure 1. Confirmatory Factor Analysis: Digital Health Technology Readiness in Conflict Zones

Note: *All factor loadings are significant at $p < 0.001$. The model shows an excellent fit after theoretically justified modifications. Four error covariances were added based on modification indices (MI > 15) with strong theoretical justification.*

As reflected in the first table and the second table as well as the first figure above, the confirmatory factor analysis conducted on four latent factors and 28 observed indicators demonstrates that the initial measurement model has met the required statistical adequacy thresholds, with χ^2 of 687.234 (df = 344), a χ^2/df ratio of 1.998, CFI of 0.958, TLI of 0.951, RMSEA of 0.047 with a 90 percent confidence interval between 0.043 and 0.051, and SRMR of 0.041, indicating a well fitted model while still leaving room for refinement. Through the evaluation of the Modification Indices, four theoretically grounded covariances among error terms were adjusted to enhance model precision, namely between Network Reliability and Bandwidth Adequacy within the Infrastructure Readiness dimension (MI = 27.34) given their shared representation of interconnected technical aspects of connectivity, between Training Availability and Skills Acquisition within the User Competency dimension (MI = 22.17) due to their direct linkage within the learning process, between Institutional Commitment and Health System Integration within the Sustainability dimension (MI = 19.86) reflecting the dependence of integration on institutional support, and between Context Appropriateness and Adaptability to Change within the Digital Innovation dimension (MI = 18.43) which intersect conceptually about adaptive flexibility. Following these modifications, the model exhibited a substantial improvement, with χ^2 decreasing to 616.482 (df = 340), a χ^2/df ratio of 1.813, CFI rising to 0.971, TLI increasing to 0.965, RMSEA declining to 0.041 (90% CI: 0.037-0.045), and SRMR improving to 0.034. The chi-square difference test ($\Delta\chi^2$ = 70.752, Δdf = 4, $p < 0.001$) confirmed the statistical significance of this enhancement, resulting in the final model being categorized as having excellent fit and strong construct validity in explaining the four-dimensional structure of digital health technology in conflict-affected regions of the Middle East.

Standardized Factor Loadings and Parameter Estimates

The results of the confirmatory factor analysis show that the four principal dimensions, namely Digital Innovation, Infrastructure Readiness, User Competency, and Sustainability, exhibit significant factor loadings with $p < 0.001$, thereby affirming the robustness of the constructs and the theoretical consistency of the integrated health technology model in conflict-affected regions of the Middle East. Within the Digital Innovation dimension, the indicator with the highest contribution is technology appropriateness (λ = 0.921, SE = 0.067, CR = 13.746), followed by integration capabilities (λ = 0.907) and evidence-based content (λ = 0.896), demonstrating that the suitability of technology, integrative capacity, and scientific evidence serve as the central pillars of digital innovation that remains adaptive to contextual shifts (λ = 0.889), further supported by feature completeness (λ = 0.871), interface quality (λ = 0.856), and diffusion mechanisms (λ = 0.824). The infrastructure dimension demonstrates strong stability through network connectivity reliability (λ = 0.887), serving as the primary anchor of system readiness, followed by backup infrastructure (λ = 0.869), bandwidth adequacy (λ = 0.853), and data storage solutions (λ = 0.771), highlighting technological cohesion. In the domain of user competency, digital literacy levels (λ = 0.876) emerge as the most dominant factor underpinning the effectiveness of technology adoption, reinforced by structured training (λ = 0.859), mastery of technical skills (λ = 0.837), and confidence in system use (λ = 0.821), while accessibility support (λ = 0.794), cultural acceptance (λ = 0.768), and linguistic appropriateness (λ = 0.743) highlight strong social sensitivity. The sustainability dimension exhibits substantial constructive strength through financial model viability (λ = 0.893) and institutional commitment (λ = 0.881) as the driving forces of system resilience, followed by scalability potential (λ = 0.867) and health system integration (λ = 0.842), all of which collectively reflect a stable model structure, long term in orientation (λ = 0.819), and grounded in stakeholder participation (λ = 0.756) in ensuring the continuity of the digital health ecosystem.

Inter-Dimensional Correlation Analysis

Table 3. Inter-Dimensional Correlation Analysis

Paired Dimensions	Correlation Coefficient (r)	SE	CR	p-value
Digital Innovation ↔ User Competency	0.782	0.058	13.483	< 0.001
Digital Innovation ↔ Infrastructure Readiness	0.718	0.061	11.770	< 0.001
Digital Innovation ↔ Sustainability	0.734	0.060	12.233	< 0.001
Infrastructure Readiness ↔ Sustainability	0.798	0.055	14.509	< 0.001
Infrastructure Readiness ↔ User Competency	0.701	0.062	11.306	< 0.001
User Competency ↔ Sustainability	0.743	0.059	12.593	< 0.001

Note: *All inter-dimensional correlations are positive and statistically significant (p < 0.001), confirming systemic interdependence among constructs and supporting the integrated conceptual framework.*

As shown in the third table, the results of the inter-dimensional correlation analysis reveal a strong systemic interconnectedness among all primary constructs, indicating that the effectiveness of integrated health technologies in conflict-affected regions of the Middle East depends on the functional balance across innovation, infrastructure, user competency, and sustainability. Digital Innovation exhibits the strongest correlation with User Competency at $r = 0.782$ (SE = 0.058, CR = 13.483, $p < 0.001$), demonstrating that technological innovation can only be effectively adopted when accompanied by adequate user capacity. The relationship between Digital Innovation and Infrastructure Readiness is also significant at $r = 0.718$ (SE = 0.061, CR = 11.770, $p < 0.001$), indicating that digital innovation requires stable infrastructural support, while its association with Sustainability reaches $r = 0.734$ (SE = 0.060, CR = 12.233, $p < 0.001$), affirming the contribution of innovation to long-term continuity.

Infrastructure shows the strongest association with Sustainability at $r = 0.798$ (SE = 0.055, CR = 14.509, $p < 0.001$), underscoring that infrastructural readiness constitutes the foundation of system sustainability. Additionally, the correlation between Infrastructure Readiness and User Competency ($r = 0.701$, SE = 0.062, CR = 11.306, $p < 0.001$) indicates that reliable infrastructure enhances user confidence and technical proficiency, while the relationship between User Competency and Sustainability ($r = 0.743$, SE = 0.059, CR = 12.593, $p < 0.001$) confirms that competent users play a crucial role in sustaining program adoption and continuity. Altogether, these correlation patterns reveal a robust integrative structure in which improvements in one dimension have the potential to reinforce the strength of the others.

Multi-Group Analysis: Service Type Comparison

Table 4. Multi-Group Confirmatory Factor Analysis (CFA) across Service Types

Model Type	χ^2	df	CFI	RMSEA	$\Delta\chi^2$	Δdf	p
Configural Invariance	923.456	680	0.965	0.044	—	—	—
Metric Invariance	958.734	704	0.963	0.045	35.278	24	0.064
Scalar Invariance	1,012.867	728	0.959	0.047	54.133	24	0.001

Note: *Configural and metric invariance models support equivalent measurement structure across mental and physical health services, while partial scalar non-invariance emerged due to differing intercepts in training program availability, technical support systems, and stakeholder engagement.*

Table 5. Latent Mean Comparisons across Service Types

Dimension	Mental Health Services (n = 487)	Physical Health Services (n = 421)	Cohen's d	p
Digital Innovation	3.94	3.68	0.28	< 0.001
User Competency	3.62	3.31	0.31	< 0.001
Infrastructure Readiness	2.89	3.21	0.29	< 0.001
Sustainability	3.07	3.38	0.29	< 0.001

Note: *Latent mean analysis reveals that mental health services outperform in innovation and user competency, while physical health services excel in infrastructure and sustainability—reflecting differentiated strategic emphases aligned with contextual resource distributions.*

As reflected in the fourth table and the fifth table, the multi-group analysis demonstrates that the initial configurational model with $\chi^2 = 923.456$, df = 680, CFI = 0.965, and RMSEA = 0.044 exhibits a comparable pattern of underlying factor structures between mental health services (n = 487) and physical health services (n = 421). The metric invariance test yields $\chi^2 = 958.734$, df = 704, CFI = 0.963, RMSEA = 0.045, with $\Delta\chi^2 = 35.278$, $\Delta df = 24$, $p = 0.064$, which is not significant. This indicates that the indicators measure the constructs in a consistent manner across both service types. However, the scalar invariance test reveals significant degradation with $\chi^2 = 1{,}012.867$, df = 728, CFI = 0.959, RMSEA = 0.047, along with $\Delta\chi^2 = 54.133$, $\Delta df = 24$, $p = 0.001$, suggesting the presence of partial non-invariance, primarily in the intercepts of training program availability, technical support systems, and stakeholder engagement.

The latent mean analysis shows that mental health services score higher on the Digital Innovation dimension (M = 3.94 vs 3.68, Cohen's d = 0.28, $p < 0.001$) and User Competency (M = 3.62 vs 3.31, Cohen's d = 0.31, $p < 0.001$), whereas physical health services outperform in Infrastructure Readiness (M = 3.21 vs 2.89, Cohen's d = 0.29, $p < 0.001$) and Sustainability (M = 3.38 vs 3.07, Cohen's d = 0.29, $p < 0.001$). These findings affirm that the mental health service context tends to emphasize innovation and user capacity-building to compensate for infrastructural limitations, while physical health services exhibit greater structural stability and a stronger orientation toward long-term sustainability, although they remain comparatively slower in adopting advanced digital innovations.

Analysis Based on Conflict Intensity

Table 6. Multi-Group Analysis Based on Conflict Intensity Levels

Model Fit and Group Comparison	χ²	Df	Δχ²	Δdf	CFI	RMSEA	p-value
Configural Invariance	897.234	680	–	–	0.966	0.043	–
Metric Invariance	931.567	704	34.333	24	0.964	0.044	0.079

Table 7. Latent Mean Comparisons by Conflict Intensity

Dimension	High-Intensity Zones (n = 456)	Moderate-Intensity Zones (n = 668)	Cohen's d	p-value
Infrastructure Readiness	2.73	3.26	0.48	<0.001
Sustainability	2.89	3.43	0.52	<0.001
Digital Innovation	3.71	3.80	0.08	0.156
User Competency	3.41	3.48	0.07	0.243

Note: *Model fit indices indicate both configural and metric invariance across conflict intensity levels, confirming structural stability of the measurement model. Significant latent mean differences for Infrastructure Readiness and Sustainability highlight the adverse impact of active conflict on system stability and long-term viability, whereas Digital Innovation and User Competency remained resilient due to flexible, mobile-based delivery mechanisms.*

As reflected in the sixth table above, the multi-group analysis based on conflict-intensity levels demonstrates that the measurement model exhibits strong structural stability, with configural invariance achieved at $\chi^2 = 897.234$, df = 680, CFI = 0.966, and RMSEA = 0.043, as well as metric invariance at $\chi^2 = 931.567$, df = 704, $\Delta\chi^2 = 34.333$, Δdf = 24, and $p = 0.079$. These results affirm the consistency of the model across regions classified according to ACLED data, namely high-intensity zones with ≥50 conflict events per month (n = 456) and moderate-intensity zones with <50 events (n = 668). Furthermore, the comparison of latent means reveals significant differences in infrastructure readiness, which is lower in active conflict areas (M = 2.73) compared to moderate regions (M = 3.26, Cohen's d = 0.48, $p < 0.001$), as well as in sustainability, which also shows a marked decline (M = 2.89 vs 3.43, Cohen's d = 0.52, $p < 0.001$), indicating the destructive impact of conflict on system stability and the long-term viability of programs. Nevertheless, the dimensions of digital innovation ($p = 0.156$) and user competency ($p = 0.243$) do not exhibit significant differences, suggesting that mobile-based mechanisms and remote training strategies play an essential role in maintaining the continuity of technological adaptation, even amid volatile socio-political conditions.

Model Analysis for Integrated Services

The integrated healthcare service model that links mental and physical components demonstrates an exceptionally strong level of model fit, with χ^2 of 412.567 at 340 degrees of freedom, a χ^2/df ratio of 1.213, CFI of 0.982, TLI of 0.978, RMSEA of 0.032, and SRMR of 0.038, all of which exceed the conventional thresholds for a well-fitting model. The average factor loading in the context of integrated services reaches 0.867, which is higher than that of the single-service model at 0.832. The most prominent increases are observed in the indicators of integration capabilities, at 0.934 compared to 0.901, and health system integration, at 0.912 compared to 0.835, indicating the presence of stronger latent cohesion. The inter-dimensional correlations also show substantial increases, with the association between Digital Innovation and Infrastructure Readiness rising from 0.718 to 0.834 and that between User Competency and Sustainability from 0.743 to 0.821, demonstrating that the effectiveness of integrating mental and physical healthcare depends on a tightly interlinked systemic alignment among digital innovation, infrastructure readiness, user competency, and program sustainability.

Predictive Validity Assessment

The predictive analysis of 387 documents containing implementation metrics demonstrates exceptional model strength, in which the four core dimensions jointly explain 68.7 percent of the variance in implementation success ($R^2 = 0.687$), confirming the high criterion predictive validity of the integrated technology construct in the context of Middle Eastern conflict zones. The correlations further indicate that digital innovation has a strong relationship with user adoption levels ($r = 0.612$, $p < 0.001$) and user satisfaction ($r = 0.587$, $p < 0.001$), as well as a moderate association with improvements in clinical outcomes ($r = 0.456$, $p < 0.001$). Infrastructure readiness also shows a strong correlation with service continuity ($r = 0.698$, $p < 0.001$) and a significant negative relationship with the time required to resolve technical issues ($r = -0.623$, $p < 0.001$), indicating that systems with stronger infrastructure tend to be more responsive to service demands. User competency plays a substantial role in enhancing compliance ($r = 0.671$, $p < 0.001$), depth of feature utilization ($r = 0.634$, $p < 0.001$), and user confidence ($r = 0.712$, $p < 0.001$). Meanwhile, sustainability emerges as the strongest determinant, with significant correlations with post funding program continuation ($r = 0.743$, $p < 0.001$), successful scaling ($r = 0.689$, $p < 0.001$), and cost efficiency ($r = 0.567$, $p < 0.001$). In the multiple regression model, sustainability remains the strongest predictor ($\beta = 0.312$, $p < 0.001$), followed by infrastructure readiness ($\beta = 0.289$, $p < 0.001$), digital innovation ($\beta =$

0.234, $p < 0.001$), and user competency ($\beta = 0.198$, $p < 0.001$), illustrating that the effectiveness of integrated health systems depends on a balance between robust structural foundations, adaptive digital innovation, and skilled human capacity to maintain long term sustainability amid crisis conditions.

Overall, the results of the confirmatory factor analysis confirm the strong validity of the four-dimensional construct of integrated digital health technology in the context of conflict-affected Middle Eastern regions, with model fit indices demonstrating excellent performance that exceeds recommended thresholds, and all hypotheses are supported significantly. The dimensions of digital innovation, infrastructure readiness, user competency, and sustainability each exhibit high reliability as well as adequate convergent and discriminant validity, accompanied by positive inter-dimensional correlations indicating systemic interdependence among the model's components. The dimensional structure is consistently proven across mental and physical health services, indicating stable metric invariance; however, variations at the mean level reflect differences in strategic emphasis and resource distribution. Conflict intensity is shown to affect infrastructure readiness and sustainability, but not digital innovation or user competency, highlighting the differential resilience of construct components under environmental stress. The implementation of integrated mental and physical services demonstrates closer inter-dimensional cohesion with stronger indicators, indicating synergistic effects produced by a comprehensive approach. The predictive validity linking dimension scores with implementation outcomes further strengthens the practical utility of this model, thereby establishing an empirically grounded foundation for understanding and assessing the implementation of digital health technologies in conflict regions and providing strategic direction for optimizing sustainable multidimensional interventions.

Discussion

The findings of this study confirm that the concept of integrated digital health technology in conflict zones across the Middle East is not merely an expression of technological advancement but a reflection of the complex interplay among social, political, and cultural dynamics that shape the adaptive ecosystem of health systems. The four principal dimensions Digital Innovation, Infrastructure Readiness, User Competency, and Sustainability demonstrate a tightly interconnected structure in which each dimension reinforces the others, forming a cohesive system that determines the effectiveness of digital health services in environments marked by persistent uncertainty. The confirmatory factor analysis shows that the effectiveness of digital integration cannot be explained solely by technical elements such as hardware or software availability, but rather by the extent to which the surrounding social ecosystem can support adaptation and system maintenance amid prolonged instability. The significant interdimensional relationships underscore that strengthening one aspect, such as infrastructure readiness, becomes meaningful only when accompanied by enhanced user competency, contextually appropriate innovation, and adequate financial and institutional sustainability.

From a theoretical perspective, these findings align with Lee’s (2024) diffusion of innovation theory, which highlights the importance of relative advantage and sociocultural compatibility as key determinants of successful technology adoption. However, the Middle Eastern context introduces additional layers of complexity in which factors such as political instability, institutional fragmentation, and resource scarcity shift the trajectory of innovation diffusion from a proactive process to one that is responsive to crisis. As a result, although the factor structure generally mirrors global theoretical models, it exhibits distortions in the relationships among dimensions due to structural pressures arising from conflict and social uncertainty in Middle Eastern war zones. In this setting, digital innovation functions less as a long-term strategy for building resilient health systems and more as an emergency mitigation mechanism.

The multi-group analysis reinforces this view by revealing distinct determinants between mental and physical health services. For mental health services, the dominant factors are user competency and program sustainability, indicating the centrality of cultural sensitivity, language adaptation, and social acceptance in communities where psychological issues remain stigmatized. In contrast, for physical health services, infrastructure readiness emerges as the most critical dimension, as the availability of electricity, connectivity, and logistical support constitutes a fundamental prerequisite for implementing medical technologies even when public digital literacy remains limited. These findings confirm that the intervention context shapes the configuration of interdimensional strengths and that effective digital health systems require a balance between technical readiness and social preparedness.

Furthermore, the interconnections among dimensions show that system sustainability depends on a synergistic balance among innovation, infrastructure readiness, and human capacity. Financial and institutional sustainability hinge not only on the availability of funding but also on the system’s ability to adapt to changing social and technological environments. In many cases, digital health programs fail not because of resource shortages but due to weak integration between conceptual innovation and practical field implementation. A systemic approach is therefore necessary, recognizing that sustainability is inseparable from continually shifting social dynamics and requires adaptive capacity along with ongoing collective learning.

In terms of cultural validity, the findings demonstrate that while concepts such as digital innovation and infrastructure readiness may appear universal, the indicators representing them rely heavily on local context. For example, the reliability of internet connections or the availability of electricity does not merely reflect technical readiness but also signals political stability and territorial control. Similarly, user competency is not only an indicator of individual skill but also evidence of the presence of social mechanisms capable of transmitting knowledge despite limitations in basic literacy and technological access. In post-conflict societies, digital training requires adaptation to educational and linguistic environments that are often non-standard. Consequently, local adaptation becomes a fundamental requirement for maintaining the conceptual validity of integrated digital health models in conflict zones.

Institutional dimensions also play a critical role. The success of digital health systems in many regions is highly dependent on support from international organizations such as the WHO, UNHCR, or major humanitarian NGOs. However, the dominance of external actors often creates dependency that weakens local capacity. The findings confirm critiques of top-down intervention models that tend to overlook community participation. Building a genuinely sustainable system, therefore, requires a paradigm shift toward collaborative models that position communities as equal partners. Within this framework, sustainability is no longer defined merely as technical endurance but as a long-term social process that fosters local self-reliance and institutional cohesion.

Methodologically, the strong alignment between the theoretical model and empirical data suggests robust construct stability; however, this does not imply that implementation is free from obstacles. Numerous digital health programs fail despite strong design due to non-technical issues such as bureaucratic resistance, regulatory overlap, and conflicts of interest among donors and government agencies. Accordingly, empirical validation should not be viewed as a final confirmation but as a foundation for critical reflection on the ethical and political dimensions of technology implementation in the health sector.

Lastly, the limitations of relying on secondary data are offset by the strength of a comprehensive synthesis drawn from diverse credible sources, yielding a broad cross-contextual understanding of digital transformation in conflict-affected Middle Eastern regions. This approach opens opportunities for future research, particularly in exploring how constructs evolve alongside emerging technologies such as artificial intelligence and machine learning. Overall, the study reinforces that the success of digital technology integration in conflict zones is not measured by the speed of adoption or the sophistication of devices, but by the system's capacity to bridge innovation with social realities marked by tension, inequality, and fragile transitions toward peace.

4. CONCLUSION

This study successfully constructed and validated a comprehensive measurement model of integrated digital health technology in conflict-affected regions of the Middle East through a Confirmatory Factor Analysis approach grounded in Structural Equation Modeling, which empirically demonstrates the robustness of intervariable relationships within unstable social and political contexts. Based on an analysis of 1,124 implementation documents from 14 countries spanning 2017 to 2024, this research confirms that the construct of digital health technology is multidimensional, comprising four principal pillars: Digital Innovation, Infrastructure Readiness, User Competency, and Sustainability. Taken together, these four dimensions form a resilient adaptive system. The model fit is excellent, with CFI, TLI, RMSEA, and SRMR values of 0.971, 0.965, 0.041, and 0.034, respectively, all of which exceed established thresholds. Internal reliability values also demonstrate high consistency with Cronbach's Alpha ranging from 0.876 to 0.934, composite reliability between 0.891 and 0.947, and an Average Variance Extracted between 0.661 and 0.798, indicating strong measurement stability.

Furthermore, the findings reveal that the Digital Innovation dimension is the most dominant factor in determining implementation success, followed by the strategic role of Infrastructure Readiness, which functions as the foundational element for sustaining systems amid the ongoing conflict in the Middle East. User Competency reinforces the importance of digital literacy and adaptive training for healthcare personnel, while Sustainability emerges as the strongest predictive factor, with a coefficient value of β equal to 0.312, underscoring the necessity of long-term strategies that begin from the early planning stages. Multi-group analysis indicates that the model remains consistent across both physical and mental health services, although contextual variations require adaptive strategies based on conflict intensity and the availability of resource capacities.

Theoretically, this study expands the conceptual understanding of digital health technology in conflict zones through an empirically validated model that has not been systematically developed before. Practically, the findings underscore the need for a new paradigm in humanitarian interventions, where the success of digital transformation is shaped not only by technical innovation but also by the balance among creativity, infrastructure readiness, human competency, and institutional resilience. Accordingly, the researcher considers that this study provides both a scientific and moral foundation for the humanitarian sector to ensure that digital transformation genuinely supports the sustainability of health services and safeguards human dignity amid the tensions of conflict.

REFERENCES

Ahmed, S. K. (2023). *The role of digital health in revolutionizing healthcare in conflict settings*. *Lancet Digital Health*. https://doi.org/10.1177/20552076231218158

Andersson, G. (2016). Internet-delivered psychological treatments. *Annual Review of Clinical Psychology*, *12*(1), 157–179. https://doi.org/10.1146/annurev-clinpsy-021815-093006

Aranda-Jan, C. B., Mohutsiwa-Dibe, N., & Loukanova, S. (2014). Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC Public Health*, *14*(1), 188. https://doi.org/10.1186/1471-2458-14-188

Bowsher, G., Veale, S., & Weir, K. (2021). eHealth for service delivery in conflict: A narrative review of the evidence. *Health Policy and Planning*, *36*(6), 974–988. https://doi.org/10.1093/heapol/czab042

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319–340. https://doi.org/10.2307/249008

DeRenzi, B., Borriello, G., Jackson, J., Kumar, V. S., Parikh, T. S., Virk, P., & Lesh, N. (2011). Mobile phone tools for field-based healthcare workers in low-income countries. *Mount Sinai Journal of Medicine*, *78*(3), 406–418. https://doi.org/10.1002/msj.20256

Kakria, P., Tripathi, N. K., & Kitipawang, P. (2015). A real-time health monitoring system for remote cardiac patients using smartphones and wearable sensors. *International Journal of Telemedicine and Applications*, *2015*, Article 373474. https://doi.org/10.1155/2015/373474

Labrique, A. B., Vasudevan, L., Kochi, E., Fabricant, R., & Mehl, G. (2013). mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. *Global Health: Science and Practice*, *1*(2), 160–171. https://doi.org/10.9745/GHSP-D-13-00031

Lee, J. W. (2024). Diffusion of innovations. In *Encyclopedia of sport management* (pp. 266–268). Edward Elgar Publishing. https://doi.org/10.4337/9781035317189.ch157

Lee, S., Cho, Y. M., & Kim, S. Y. (2017). Mapping mHealth and mobile penetrations in sub-Saharan Africa for strategic regional collaboration in mHealth scale-up: An application of exploratory spatial data analysis. *Globalization and Health*, *13*(1), 63. https://doi.org/10.1186/s12992-017-0286-9

Leon, N., Schneider, H., & Daviaud, E. (2012). Applying a framework for assessing the health system challenges to scaling up mHealth in South Africa. *BMC Medical Informatics and Decision Making*, *12*(1), 123. https://doi.org/10.1186/1472-6947-12-123

McCool, J., Dobson, R., Whittaker, R., & Paton, C. (2022). Mobile health (mHealth) in low- and middle-income countries. *Annual Review of Public Health*, *43*(1), 525–539. https://doi.org/10.1146/annurev-publhealth-052620-093850

Mechael, P. N. (2009). The case for mHealth in developing countries. *Innovations: Technology, Governance, Globalization*, *4*(1), 103–118. https://doi.org/10.1162/itgg.2009.4.1.103

Mehl, G., & Labrique, A. (2014). Prioritizing integrated mHealth strategies for universal health coverage. *Science*, *345*(6202), 1284–1287. https://doi.org/10.1126/science.1258926

Melnick, E. R., Dyrbye, L. N., Sinsky, C. A., Trockel, M., West, C. P., Nedelec, L., ... & Shanafelt, T. (2020). The association between perceived electronic health record usability and professional burnout among US physicians. *Mayo Clinic Proceedings*, *95*(3), 476–487. https://doi.org/10.1016/j.mayocp.2019.09.024

Mistry, H. (2012). Systematic review of studies of the cost-effectiveness of telemedicine and telecare: Changes in the economic evidence over twenty years. *Journal of Telemedicine and Telecare*, *18*(1), 1–6. https://doi.org/10.1258/jtt.2011.110505

Musaiger, A. O., Hassan, A. S., & Obeid, O. (2011). The paradox of nutrition-related diseases in the Arab countries: The need for action. *International Journal of Environmental Research and Public Health*, *8*(9), 3637–3671. https://doi.org/10.3390/ijerph8093637

Peiris, D., Praveen, D., Johnson, C., & Mogulluru, K. (2014). Use of mHealth systems and tools for non-communicable diseases in low- and middle-income countries: A systematic review. *Journal of Cardiovascular Translational Research*, *7*(8), 677–691. https://doi.org/10.1007/s12265-014-9581-5

Piette, J. D., Lun, K. C., Moura Jr., L. A., Fraser, H. S., Mechael, P. N., Powell, J., & Khoja, S. R. (2012). Impacts of e-health on the outcomes of care in low- and middle-income countries: Where do we go from here? *Bulletin of the World Health Organization*, *90*, 365–372. https://doi.org/10.2471/BLT.11.099069

ReliefWeb / United Nations Reporting. (2025). *Sudan and other crisis reporting: displacement and humanitarian impact*. ReliefWeb. https://reliefweb.int/report/world/world-refugee-day-number-displaced-people-reaches-record-1232-million

Safeguarding Health in Conflict Coalition. (2024). *2023 attacks on health care in war zones* (Coalition Report). Physicians for Human Rights / SHCC. https://phr.org/news/2023-attacks-on-health-care-in-war-zones-most-ever-documented-safeguarding-health-in-conflict-coalition-shcc-report/

World Health Organization. (2025). *WHO health emergency appeal and snapshot 2025*. WHO.