

*Research Article*

Market-Oriented Digital Health Co-creation Framework for Stunting Prevention in Developing Countries: Evidence from Indonesia

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Abstract: Stunting is a complex public health challenge that requires coordinated action across multiple stakeholders, particularly as health services become increasingly digital. Existing digital health and sustainable business model approaches often separately address service delivery, stakeholder participation, sustainability, and governance. This study develops a market-oriented digital health co-creation framework that integrates these dimensions by combining Soft Systems Methodology (SSM) with the Triple Bottom Line Co-creation Canvas, using digital stunting management in Indonesia as the empirical setting. SSM was applied to structure stakeholders' interactions, institutional roles, operational constraints, and transformation processes. The outputs were then translated into practical elements of value creation, value delivery, collaboration, ecosystem support, governance, and sustainability. The findings identify four main user groups as community health posts, primary healthcare centers, public hospitals, and local health offices. The framework also maps stakeholder roles, collaborative activities, shared resources, co-creation mechanisms, and digital governance requirements across the stunting management ecosystem. This study further clarifies how coordination and shared digital resources can support integrated and sustainable public-health service delivery across organizational boundaries. The stakeholder-based assessment provided preliminary support for the practical relevance of the framework, while comparison with WHO guidance indicated conceptual alignment with internationally recognized digital health functions and implementation considerations. The feasibility and effectiveness of implementation require further empirical testing. This study contributes a structured approach for linking systems thinking, sustainability, multi-stakeholder collaboration, and digital governance in public health. The framework offers an analytically transferable structure that requires contextual adaptation and further empirical testing in other low- and middle-income settings. Indonesia serves as the demonstration context.

Keywords: Co-creation framework; Digital health; Soft systems methodology; Stunting prevention; Triple bottom line

1. Introduction

Stunting remains a major global public health challenge, affecting approximately 22% of children under five, particularly in low- and middle-income countries (Jalaludin et al., 2025; Mulyani et al., 2025). Its multidimensional determinants require coordinated interventions across healthcare, nutrition, sanitation, education, food security, and community services. Al-

though digitalization may strengthen this coordination, fragmented data systems, unclear institutional responsibilities, limited digital capacity, and weak long-term support often constrain implementation. Indonesia provides a relevant demonstration setting, as its stunting prevalence declined from 21.5% in 2023 to 19.8% in 2024 but remained above the 2025 target of 18.8% (Kemenko PMK, 2025; Muhawarman, 2025). Its digital stunting ecosystem involves community health services, healthcare providers, public authorities, technology actors, and supporting organizations, illustrating the need for an integrated framework linking governance, service delivery, stakeholder collaboration, and sustainability.

An integrated framework is needed to explain how stakeholder collaboration, digital governance, service delivery, and sustainability can be coordinated across the public health ecosystem in the context of digital stunting interventions. A business model perspective supports this framework by clarifying how multiple stakeholders create, deliver, and sustain value (Altafin et al., 2025; Teece, 2010). This perspective is relevant because digital interventions require the alignment of data, platforms, technological capabilities, institutional roles, and user interactions. However, business model tools alone are insufficient to capture the complexity of digital stunting interventions. Traditional Business Model Canvas approaches provide a useful structure for analyzing value creation and delivery, but they give limited attention to ecosystem relationships, institutional authority, digital governance, and coordination among public health actors (Brunner et al., 2025). They are also less responsive to digital innovation that is oriented toward sustainability and tend to emphasize economic value while providing limited representation of social and environmental outcomes (Altafin et al., 2025; Bachmann et al., 2025; Maresova et al., 2022). Therefore, a broader and more context-sensitive framework is required to integrate systems thinking, stakeholder collaboration, digital governance, and sustainability. The Triple Bottom Line Co-creation Canvas serves as an operational tool for structuring economic, social, and environmental value creation across stakeholder groups within this framework.

The Triple Bottom Line (TBL) framework integrates economic, social, and environmental considerations into organizational decision-making and long-term value creation (Garmann-Johnsen et al., 2024). Its practical value has been demonstrated in agricultural SMEs, where TBL practices supported business growth (Kabbera et al., 2024). Joyce and Paquin (2016) expanded the Business Model Canvas of Osterwalder and Pigneur (2010) into the Triple-Layered Business Model Canvas, comprising economic, social, and environmental layers with 27 building blocks. The model has been applied across diverse sustainability-oriented sectors (Basile, 2021; Fadila et al., 2024; García-Muiña et al., 2020; Otsuka et al., 2024; Wit et al., 2021). TBL-based approaches have also been extended to digital health. Garmann-Johnsen et al. (2024) developed the TBL Co-creation Canvas to support collaborative networks and sustainability among digital SMEs in eHealth and welfare technology. Van Limburg et al. (2015) emphasized the participation of patients, healthcare professionals, and institutions in digital health co-creation, whereas Fang et al. (2024) showed that value co-creation can improve user engagement and resource efficiency in IoT-based health information systems. These developments highlight the need for integrated and collaborative digital health models, particularly in developing countries where digital transformation can generate substantial social value (Braa et al., 2023; Garmann-Johnsen et al., 2021). In this study, market-oriented refers to designing public health strategies around users' needs, problems, and expected value. It does not imply the commercialization of public health services but represents the application of marketing principles to improve health interventions' relevance, adoption, and sustainability. Despite these advances, the existing literature remains fragmented across several research streams. Studies on sustainability-oriented business models have demonstrated the importance of integrating economic, social, and environmental dimensions; however, they generally provide limited explanations of digital governance and actor coordination within complex public health ecosystems. Digital health co-creation studies emphasize stakeholder participation, user engagement, and collaborative service development; however, they do not consistently connect these processes with market-oriented mechanisms for value creation, delivery, adoption, and long-term implementation. Consequently, these approaches

address important but largely separate dimensions of digital public health transformation.

To the best of our knowledge, no market-oriented co-creation framework that simultaneously integrates sustainability, multi-stakeholder collaboration, digital governance, and the complexity of public health ecosystems has been identified in the literature reviewed in this study. This gap is particularly important in digital stunting interventions, where the effectiveness and sustainability of technological solutions depend not only on technical functionality but also on the alignment of stakeholder roles, data governance, institutional authority, service delivery processes, user adoption, resource commitments, and economic, social, and environmental value creation. Without such an integrated framework, digital health initiatives may remain fragmented, project-based, and insufficiently connected to the operational and institutional conditions required for sustained implementation.

Accordingly, this study addresses the gap by developing a market-oriented digital health co-creation framework that integrates sustainability, stakeholder collaboration, digital governance, and public health ecosystem complexity. The framework combines Soft Systems Methodology (SSM) with the Triple Bottom Line Co-creation Canvas (Garmann-Johnsen et al., 2024; Pereira et al., 2016). SSM is used to structure the problem, map stakeholder perspectives and institutional relationships, and identify transformation processes (Checkland & Poulter, 2006; Warren et al., 2019). The TBL Co-creation Canvas then translates these findings into practical elements of value creation, value delivery, collaboration, ecosystem support, and sustainability (Garmann-Johnsen et al., 2024). The framework views digital stunting intervention as a multi-actor ecosystem involving government institutions, healthcare providers, technology startups, nongovernmental organizations (NGOs), higher education institutions, CSR-based private-sector actors, and communities. Digital co-creation is examined by mapping these actors' roles, interactions, resources, and contributions within the digital stunting ecosystem. Indonesia serves as the empirical setting for developing and demonstrating the framework, which is intended to inform similar digital public health initiatives in other low- and middle-income settings.

Previous studies have applied Soft Systems Methodology (SSM) in business, environmental management, public-sector performance, and community-based information systems, demonstrating its value in structuring complex problems, incorporating stakeholder perspectives, supporting participatory learning, and identifying context-sensitive improvements (Isa et al., 2020; Nordiawan et al., 2017; Schramm et al., 2022). However, its application in digital public health, particularly stunting management, remains limited. This study addresses the gap by using SSM to structure digital stunting challenges, map stakeholder relationships, and identify feasible systemic improvements, which are then integrated with the TBL Co-creation Canvas. The resulting market-oriented digital health framework contributes by incorporating digital governance and public health ecosystem complexity into sustainability-oriented business model research, linking SSM's problem-structuring capability with the economic, social, and environmental value architecture of Canvas, and configuring stakeholder roles, digital resources, governance mechanisms, market channels, and value-creation processes to support collaborative digital health interventions.

2. Methods

2.1 Research Approach

This study employs Soft Systems Methodology (SSM) as a methodological approach to understand the complexity of stunting-related problems and to structure collaboration among stakeholders involved in digital stunting prevention and management. The study focuses on four groups of non-governmental stakeholders, namely, non-governmental organizations, higher education institutions, CSR or nutrition companies, and technology startups, which provide co-creation and ecosystem support. Diverse stakeholder perspectives are translated into a layered TBL co-creation ecosystem that integrates governance, healthcare providers, the digital platform, patients and communities, and expected outcomes through the SSM process. Through

active stakeholder involvement, SSM is widely recognized as an effective approach for examining complex, irregular, and ill-structured problem situations (Aryee & Hansen, 2022; Checkland & Poulter, 2020; Purwaningsih et al., 2024; Shen & Feng, 2017). The SSM was selected because it is well suited to the exploratory and interpretive aim of structuring a complex, multi-stakeholder problem. Critical systems heuristics primarily examines boundary judgments, power relations, and normative assumptions (Ulrich & Reynolds, 2020), whereas system dynamics focuses on the formal modeling of feedback structures and time-dependent system behavior (Naugle et al., 2024; Sterman, 2000). The Viable System Model is more appropriate for analyzing organizational viability, recursive structures and control mechanisms (Espinosa et al., 2020). In contrast, SSM accommodates multiple worldviews and supports structured learning for practice in socially complex and ill-structured situations (Checkland, 2000; Checkland & Poulter, 2006). Therefore, it was considered the most appropriate approach for identifying stakeholder concerns, structuring the digital stunting problem, and informing the development of the proposed TBL co-creation framework.

This study integrates SSM with the TBL Co-creation Canvas. SSM was used to structure the problem situation, stakeholder perspectives, institutional relationships, and feasible changes, while the canvas translated these findings into stakeholder roles, collaborative activities, governance mechanisms, value propositions, shared resources, market channels, and sustainability outcomes. The empirical evidence comprised field observations, literature and policy documents, a health-technology startup interview, INSIST application-user feedback, and an FGD with non-governmental stakeholders. The preliminary framework was further assessed against the World Health Organization (WHO) Classification of Digital Interventions, Services and Applications in Health (World Health Organization, 2023) and the WHO Guideline on Digital Interventions for Health System Strengthening (World Health Organization, 2019).

2.2 Stages of SSM and Data Analysis Procedure

Figure 1 summarizes the application of SSM stages 1–6. Stages 1 and 2 structured the problem situation using literature, observations, interviews, and application-user feedback, which were synthesized through Rich Picture analysis and reformulated as a simplified systems map. Stage 3 used CATWOE to make the purposeful activity system. In Stage 4, the findings were translated into an initial TBL co-creation framework. Figure 2 presents the analytical dimensions used to develop the proposed framework. The framework was compared with stakeholder evidence and WHO guidance in Stage 5 and refined in Stage 6 through feasible and desirable changes. Stage 7 was outside the scope of this study.

2.3 Sampling Strategy and Participants

Purposive sampling was used to select participants who had direct knowledge, experience, or involvement in developing, implementing, or assessing digital stunting solutions. The INSIST application-user feedback was included as an existing supporting dataset rather than a purposively sampled participant group. Table 1 summarizes the participants and data sources. The sampling strategy was not intended to achieve statistical representativeness. Instead, data adequacy was assessed based on the relevance of the participants and sources, the richness of the information obtained, and triangulation across interviews, application-user feedback, field observations, literature, secondary data, and FGD-based stakeholder assessment and refinement.

2.4 Qualitative Data Collection, Stakeholder-Based Framework Assessment, and Conceptual Comparison with World Health Organization Guidance

Data collection and framework assessment were conducted through three complementary procedures: semi-structured interviews, preliminary stakeholder-based assessment and refinement through an FGD, and external conceptual comparison against WHO digital health guidance (Table 2). The interviews provided empirical evidence for problem structuring and frame-

work development. The FGD assessed the perceived practical relevance, anticipated feasibility, and consistency of the framework with the experiences of participating non-governmental stakeholders while also identifying the components to retain, revise, add, or remove. The WHO comparison assessed conceptual alignment with internationally recognized digital health functions and implementation considerations. These procedures served distinct analytical purposes and did not constitute comprehensive empirical validation.

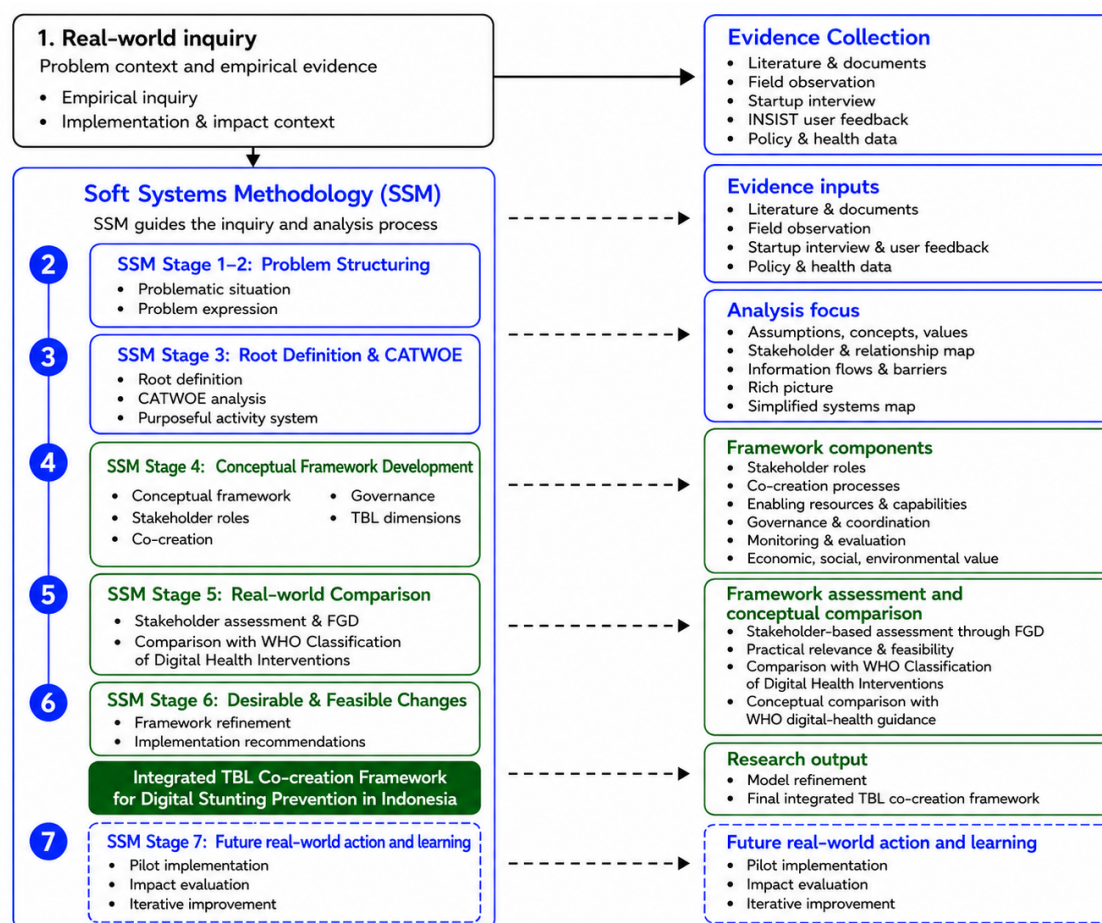


Figure 1 The research framework

All empirical materials were organized in a source-by-evidence matrix comprising interview records, application-user feedback, field-observation notes, relevant documents, and FGD records. The analysis proceeded iteratively through four steps. First, the units describing actors, operational problems, information flows, constraints, the expected benefits, and the proposed improvements were identified. Second, descriptive codes were assigned to these units, including fragmented data systems, duplicated data entry, referral discontinuity, workforce-capacity gaps, weak institutional coordination, and limited user engagement. Third, related codes were grouped into higher-order themes and mapped to the SSM analytical dimensions of stakeholders, relationships, information flows, systemic barriers, and transformation requirements. The themes were translated into CATWOE elements and TBL Co-creation Canvas components. A traceability matrix linked each evidence item to its initial code, higher-order theme, SSM interpretation, and resulting framework component. To support triangulation, convergence and divergence across data sources were recorded. Theme importance reflected cross-source recurrence and analytical relevance rather than statistical frequency alone. The preliminary mappings were subsequently assessed during the FGD, in which participants identified elements to retain, revise, add, or remove. After the empirical analysis, the WHO comparison was conducted as an external conceptual benchmark and did not generate empirical themes.



Figure 2 TBL Co-creation Business Model Canvas, adapted form (Garmann-Johnsen et al., 2024)

Table 1 Participants and data sources

Participant or data source	Participants or data coverage	Time and setting
Health-tech startup interview	INSIST, a Bandung-based technology startup with direct experience in designing, managing, implementing, and improving digital applications for stunting management. Participants represented startup personnel involved in developing and implementing the digital solution.	Offline interview at Telkom University on 11 February 2025; approximately three hours.
INSIST application-user feedback	An existing dataset comprising 156 responses from Community Health Posts cadres, Primary Healthcare Centers staff, local health-office staff, general practitioners, pediatricians, and midwives.	Collected from 24 June 2024 to 5 February 2025 across nine Indonesian cities and regencies.
FGD participants	Three external representatives from a nutrition company or CSR program, a technology startup, and a higher education institution.	Online via Google Meet on 27 September 2025; approximately 2 hours and 45 minutes.
Supporting sources	Field observations, scientific literature, national health reports, stunting-related policies and strategies, and relevant secondary documents.	Collected and reviewed throughout the research process.

Coding was conducted by one researcher and iteratively reviewed. Each code was checked against the original quotation, compared with similar evidence from other users, and cross-checked with the startup interview findings to support cross-source triangulation. Consistency among the initial codes, higher-order themes, SSM interpretations, and resulting framework components was also examined to maintain analytical traceability from the empirical evidence

to the framework. Table 3 presents an illustrative example of the coding and theme-development process to demonstrate the analytical traceability from empirical evidence to the resulting framework components. The examples demonstrate how evidence from different sources was progressively transformed into descriptive codes, higher-order themes, SSM interpretations, and framework components.

Table 2 Data collection, stakeholder-based framework assessment, and conceptual comparison with WHO guidance procedures

Stage	Purpose	Source or reference framework	Procedure
Semi-structured interview	To explore the initial problem situation in digital stunting management	Health-tech startup actors involved in developing and implementing digital stunting solutions	The interview examined the startup's role, implementation problems, user and data challenges, system integration, relevant stakeholders, and opportunities for improvement.
Stakeholder-based framework assessment & refinement	To assess the perceived practical relevance, anticipated feasibility, and consistency of the preliminary framework with the experience of participating non-governmental stakeholders	Three representatives from a nutrition company or CSR program, a technology startup, and a higher education institution	The framework was assessed component by component. Participants identified elements to retain, revise, add, or remove, and the discussion summaries were read back for confirmation. The procedure provided preliminary stakeholder-based assessment and refinement rather than comprehensive empirical validation.
External conceptual comparison with WHO guidance	To assess alignment with internationally recognized digital health functions	WHO <i>Classification of Digital Interventions, Services and Applications in Health</i> (CDISAH), second edition	The proposed framework was mapped against domains related to health service users, health-care providers, health-system management, data services, interoperability, governance, workforce capacity, and monitoring & evaluation (World Health Organization, 2023).

3. Results and Discussion

3.1 Stage 1: Identifying the Digital Stunting Problem

The evidence identified three interconnected levels of the stunting problem (Table 4). Individual-level determinants include inadequate nutrition and infectious diseases, whereas household and community determinants include caregiving practices, healthcare access, environmental conditions, and food affordability. Fragmented information systems, limited workforce capacity, weak cross-program coordination, financing inefficiencies, and low community participation at the institutional level constrain intervention continuity.

Digital platforms, such as e-PPGBM, ASIK, SATUSEHAT, SIGIZI Terpadu, and SISROUTE, remain insufficiently integrated, resulting in duplicated data entry and delayed reporting (Harahap et al., 2023). These findings indicate that the central problem is not the absence of programs or digital applications but their limited integration across actors and service levels.

Table 3 Illustrative coding and theme-development process

Evidence source	Illustrative evidence	Initial code	Higher-order theme	SSM interpretation	Framework implication
INSIST user feedback	Repeated entry across different applications	Duplicated data entry	Fragmented digital systems	Systemic barrier	Data integration and interoperability
Startup interview	Referral information does not continue across service levels	Referral discontinuity	Disconnected service pathways	Transformation requirement	Tiered digital referral
Field observation	Cadres require repeated technical assistance	Limited digital capability	Workforce-readiness gap	Environmental constraint	Capacity building and technical support
FGD	Features should be developed with users	Need for user participation	Stakeholder creation	Desirable and feasible change	Feature co-development & feedback loop

Table 4 Problem situation expressed in literature, observation & interviews

	Factors contributing to stunting prevalence	Issues based on literature study, observation & interview	Reference
Direct Causes	Child Nutritional Status	Children experience nutritional deficiencies during the first 1,000 days of life.	Khairuddin et al. (2024)
	Child Health Status	High prevalence of infectious diseases, including diarrhea, acute respiratory infections, and chronic infections.	Hardiana et al. (2026)
Indirect Causes	Access to Healthcare Services	Community Health Posts, primary healthcare centers & hospitals are available; however, the distribution of nutritionists & midwives remains uneven.	Muharram et al. (2024)
	Parental Care Practices & Education	Low levels of nutrition literacy, substandard complementary feeding practices, and suboptimal exclusive breastfeeding.	Yunitasari et al. (2021); Sudiarti et al. (2022)
	Residential Environment	Poor sanitation, limited access to clean water, and high housing density.	Hardiana et al. (2026)
	Affordability & Access to Nutritious Food	Low household purchasing power, unequal food distribution, and relatively high prices of healthy food.	Yunitasari et al. (2021)
Governance & Systemic Aspects	Fragmented Health Information Systems	Multiple health applications (e-PPGBM, ASIK, SATUSEHAT, SISROUTE) are not fully integrated.	Harahap et al. (2023); Interview; Observation
	Limited Health Human Resources	Insufficient training of Community Health Posts cadres, unequal distribution of nutritionists and psychologists, and high workloads.	Suparto et al. (2022); Interview
	Weak Cross-Program Coordination	Nutrition, maternal and child health, immunization, sanitation & education programs are implemented in silos.	Suparto et al. (2022); Interview
	Financing and Program Efficiency	Budgets are available, but disbursement is delayed and effectiveness indicators remain inconsistent.	Suparto et al. (2022); Interview
	Low Community Participation	Uneven attendance at Community Health Posts and low parental awareness of nutrition.	Sudiarti et al. (2022); Amalia (2025); Observation

3.2 Stage 2: Rich Picture Analysis and Simplified Systems Map

The next step involved expressing the problem situation identified in the preceding stage through Rich Picture analysis. Rich Picture analysis was used to map stakeholders, interactions, information flows, and systemic constraints within the digital stunting ecosystem (Khayame & Abdeljawad, 2020; Saragih et al., 2021). To improve readability, its principal elements were consolidated into the simplified system map presented in Figure 3. Figure 3 indicates that the

central weakness of Indonesia's digital stunting prevention ecosystem lies not in the absence of stakeholders, policies, or digital platforms but in their limited operational integration. Government institutions, healthcare providers, health workers, communities, non-governmental actors, and digital systems are institutionally connected through information, services, resources, and policy support. However, fragmentation across actors and service levels disrupts the continuous flow of data and interventions from community-based detection to primary care, referral services, program management, and policy evaluation. Platforms such as e-PPGBM, SIGIZI Terpadu, ASIK, and SATUSEHAT still function largely as separate data collection and reporting systems rather than as an integrated infrastructure for collaborative decision-making. Therefore, technology alone does not ensure continuity of care or program sustainability. Nondigital determinants, including caregiving practices, healthcare access, residential conditions, and food affordability, also influence the ecosystem. Although the five pillars of the national stunting-reduction policy provide an enabling structure, their implementation requires clearer stakeholder responsibilities, interoperable data standards, coordinated referral processes, shared monitoring mechanisms, and feedback loops connecting communities, health workers, service providers, public authorities, and supporting partners.

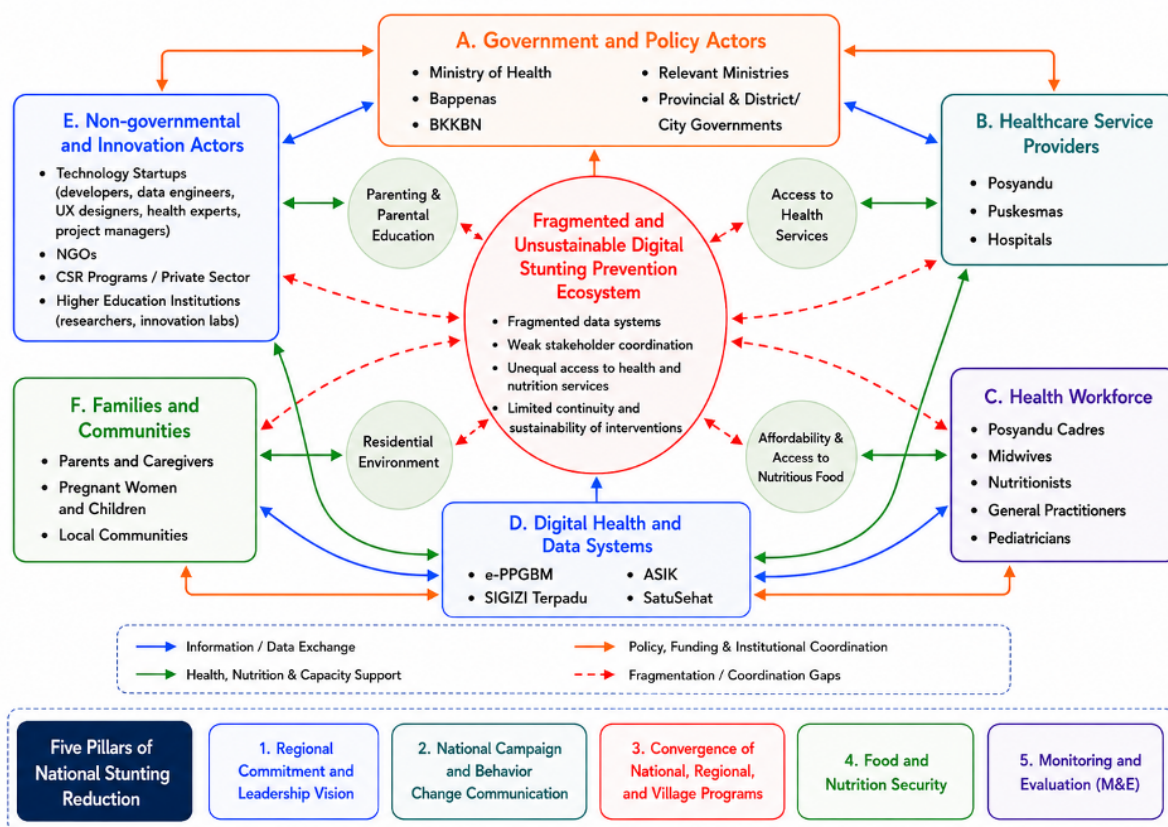


Figure 3 Simplified system map derived from the rich picture analysis

These findings are consistent with those of digital health governance research, which emphasizes authority, accountability, data stewardship, privacy, standards, and interoperability as prerequisites for digital transformation (Gotsadze et al., 2024; Heshajin et al., 2024). However, the proposed framework extends governance-oriented models by embedding these requirements within a co-creation architecture that links institutional actors' governance mechanisms to information, collaboration, and value flows. The findings also align with smart-health ecosystem studies highlighting connected technologies, continuous data exchange, and coordinated stakeholder participation (Benis et al., 2021; Nourse et al., 2023). This framework addresses population-level prevention in a resource-constrained public health setting, unlike models primarily designed for person-centered or chronic-care services. It explicitly incorporates community outreach, insti-

tutional authority, tiered referral, program coordination, and non-governmental ecosystem support. Therefore, its novelty lies in explaining not only which actors and technologies constitute a digital health ecosystem but also how governance, co-creation, and sustainability mechanisms can organize them for coordinated prevention of digital stunting.

3.3 Stage 3: Root Definition and CATWOE Analysis

A root definition was formulated and examined using CATWOE based on the problem-situation analysis, covering customers, actors, transformation, worldview, system owners, and environmental constraints (Devi et al., 2023; Ebekozien et al., 2024). Table 5 summarizes the resulting purposeful activity system and stakeholder roles shaping the transformation of digital stunting.

Table 5 Root definition with CATWOE

CATWOE	“Request to Answer”
C, Customers	Government institutions: The Ministry of Health and local Health Offices as data users in evidence-based decision-making for stunting-related policies. Healthcare service providers: Community Health Posts, Community Health Centers (Primary Healthcare Centers), and Hospitals as users of the digital stunting management system. End beneficiaries: Parents and children (the community) as the ultimate recipients of the benefits generated by stunting intervention programs.
A, Actors	Collaborating team: Technology startups (developers, data engineers, UX designers, health experts, and project managers), non-governmental organizations (NGOs), higher education institutions, and corporate social responsibility (CSR) programs.
T, Transformation Process (Proposed)	The transformation involves the digitalization of referral systems and manual child growth monitoring records through a digital application, enabling an integrated and tiered referral process. Digital transformation is conducted to generate reliable baseline data on stunting prevalence, which supports early detection, targeted interventions, and evidence-based decision-making.
W, World View	Digitalization is a critical enabler for accelerating stunting reduction efforts. Data interoperability & digital adoption enhance early detection and enable more accurate & timely decision-making for stunting interventions. An omnichannel approach combined with local contextual adaptation is essential to ensure the sustainability of digital health solutions.
O, System Owners	Startups act as key innovators. Local Health Offices & the Ministry of Health as the authorities overseeing and governing the national health system & its digital infrastructure. Higher education institutions, NGOs, and corporate CSR programs as enabling partners contributing expertise, capacity building, research support, and program sustainability.
E, Environment (Constraints)	Regulatory frameworks, including the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2020 on Child Anthropometric Standards and the Regulation of the Minister of Health No. 28 of 2019 on Recommended Dietary Allowances for the Indonesian population. Fragmented health information systems. Dependence on interoperability with government platforms. Health data governance regulations and patient data privacy requirements. Bureaucratic complexity & cross-government decision-making processes. Gaps in digital literacy among frontline health workers. Limited internet connectivity and infrastructure in remote, frontier, and disadvantaged (3T) regions.

3.4 Stage 4: Conceptual Development of the TBL Co-creation Framework

In the fourth stage, a conceptual model was developed to represent the prevention of digital stunting as an interconnected ecosystem rather than an isolated technological intervention. Conceptual models enable stakeholders from different institutional and professional backgrounds to develop a shared understanding of complex systems (Langen et al., 2025). Figure 4 shows that the framework consists of five connected layers: government and public-health governance, healthcare providers, the digital stunting management platform, patients and communities, and expected outcomes. The digital platform functions as an integrating mechanism connecting

data, services, referrals, feedback, and decision-making across the ecosystem. Therefore, its value lies in reducing fragmentation, improving continuity of care, and supporting coordinated action, resulting in earlier detection, integrated referral, data-driven decisions, stronger institutional capacity, and reduced stunting risk. Value is co-created across the ecosystem rather than generated by the digital platform alone. Communities contribute information and feedback, healthcare providers deliver and coordinate services, public authorities establish governance and institutional support, and non-governmental partners contribute technology, funding, research, training, and implementation capacity. These interactions may generate economic value through efficiency and improved resource allocation, social value through greater access, participation, and capacity building, and potential environmental value through reduced paper use and less process duplication. The environmental effects were not empirically measured in this study and should therefore be treated as proposed outcomes. Therefore, community health posts, primary healthcare centers, hospitals, and local public health authorities represent interdependent institutional users and co-creators with distinct roles, information needs, and value expectations.

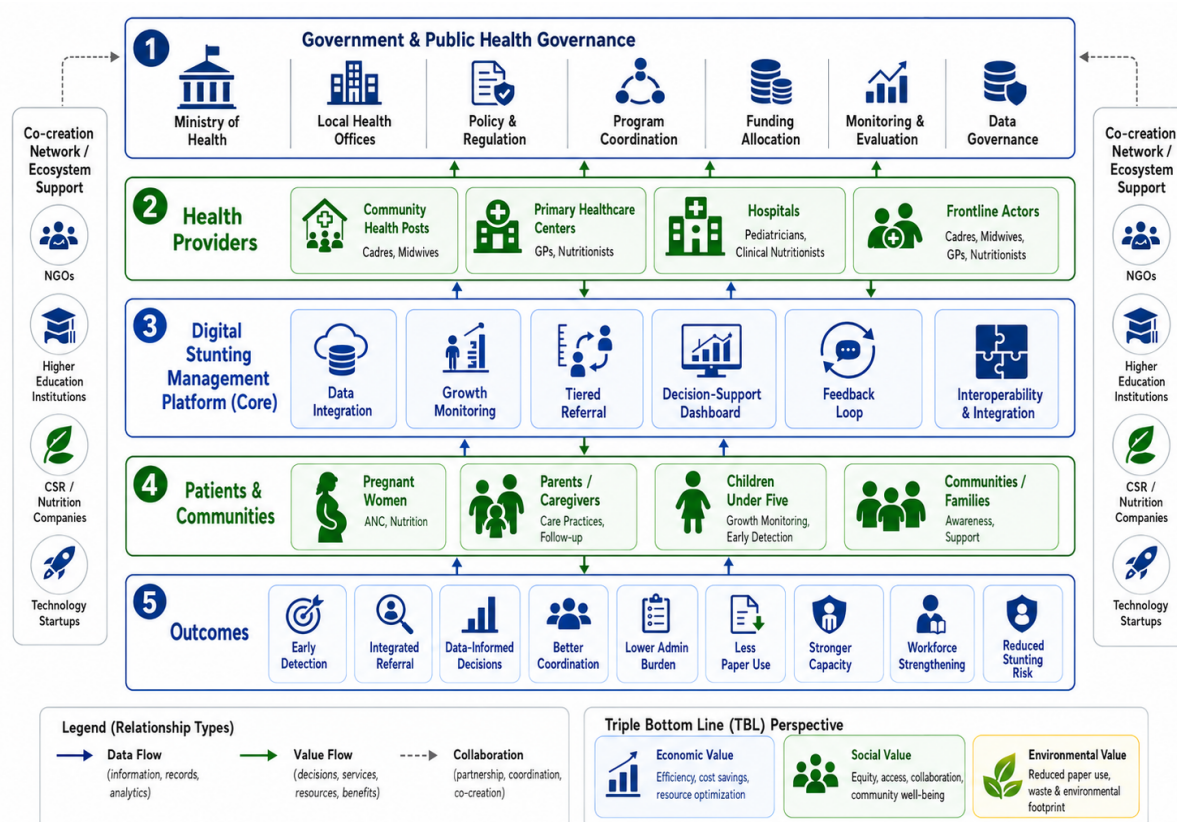


Figure 4 Layered ecosystem for prevention and management of digital stunting

Compared with the Triple-Layered Business Model Canvas of Joyce and Paquin (2016), the proposed framework shifts the unit of analysis from a focal organization to a multi-level public-health ecosystem. Economic, social, and environmental values are treated as integrated outcomes of interactions among governance, healthcare delivery, digital infrastructure, communities, and supporting partners rather than as three parallel organizational canvases. The framework also extends the TBL Co-creation Canvas of Garmann-Johnsen et al. (2024) in three respects. First, its components are derived from an SSM inquiry into a complex public health problem. Second, the core design requirements are public authority, data governance, interoperability, tiered referral, workforce capacity, and monitoring. Third, the study differentiates four institutional customer segments and their respective value expectations and digital capabilities. Thus, the framework transforms the canvas into a conceptually structured architecture to inform the future development and testing of a digitally enabled public-health ecosystem.

3.5 Stages 5 and 6: Real-world Comparison, Framework Refinement, and Market-Oriented Strategies

In SSM Stage 5, the initial framework was compared with real-world conditions using FGD findings and a structured assessment against the World Health Organization (WHO) Classification of Digital Interventions, Services and Applications in Health (World Health Organization, 2023) and the WHO Guideline on Digital Interventions for Health System Strengthening (World Health Organization, 2019). The comparison examined the conceptual and functional alignment of the framework with international digital health guidance and identified implementation considerations requiring further refinement. In Stage 6, the findings were translated into feasible and desirable changes. Table 6 summarizes the empirical findings, WHO-based assessment, and resulting framework refinements.

The comparative findings presented in Table 6 were further synthesized into two heatmaps. Figure 5 compares the prominence of TBL values across the four customer segments, while Figure 6 illustrates the relative importance of digital strategy components for each segment. Strong, moderate, and limited represent qualitative emphasis in the empirical findings and framework refinement process rather than statistical measurements.

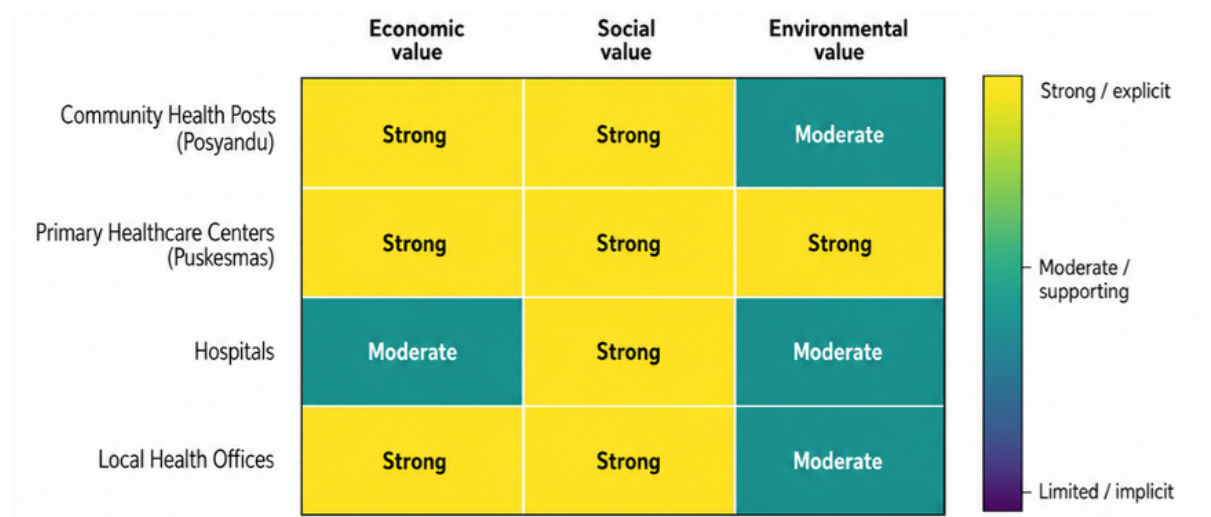


Figure 5 Comparative heatmap of triple bottom line values by customer segment

Figures 5 and 6 show that the value priorities and required digital capabilities of the four institutional customer segments differ. Social value is consistently important across segments, whereas requirements for digital strategy vary according to operational responsibilities. Community health posts emphasize usability, feature co-development, and capacity building; primary healthcare centers require end-to-end integration and referral support; hospitals prioritize clinical and data interoperability; and local health offices depend on monitoring, coordination, and decision-support capabilities. These differences indicate that a market orientation in digital public health requires segment-specific value propositions and capability configurations rather than a uniform platform design.

The World Health Organization (WHO) comparison indicated conceptual alignment between the framework and internationally recognized digital health functions and implementation considerations, while identifying areas not explicitly covered by WHO guidance, particularly stakeholder co-creation and integrated triple bottom line value creation (World Health Organization, 2019, 2023). Therefore, the framework complements WHO guidance by linking digital capabilities to specific institutional users, operational responsibilities, governance requirements, and sustainability outcomes. This segment-specific configuration operationalizes market orientation without implying the commercialization of public health services and provides the basis for the refined framework presented in Figure 7.

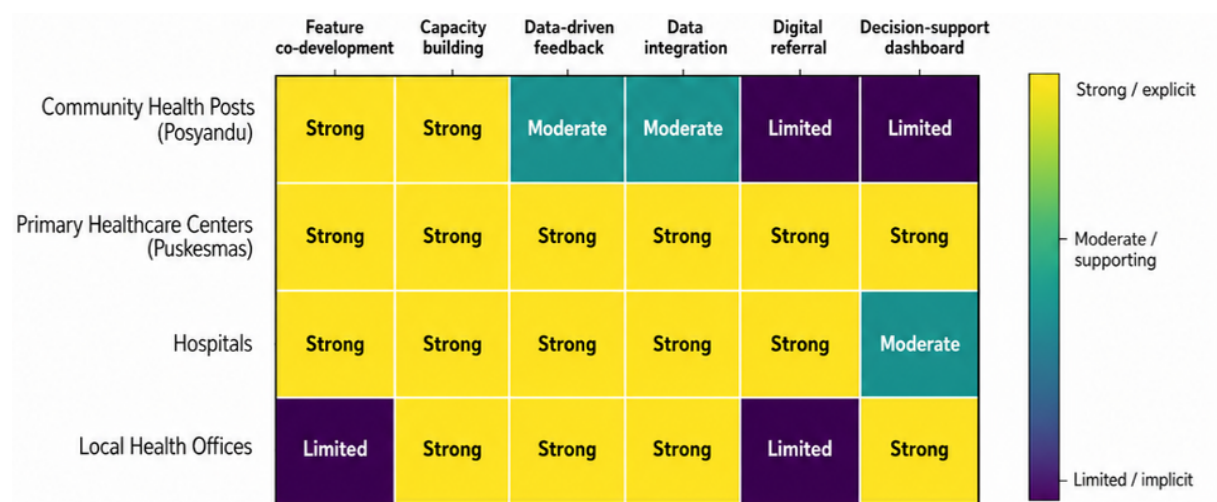


Figure 6 Comparative heatmap of digital strategy components by customer segment

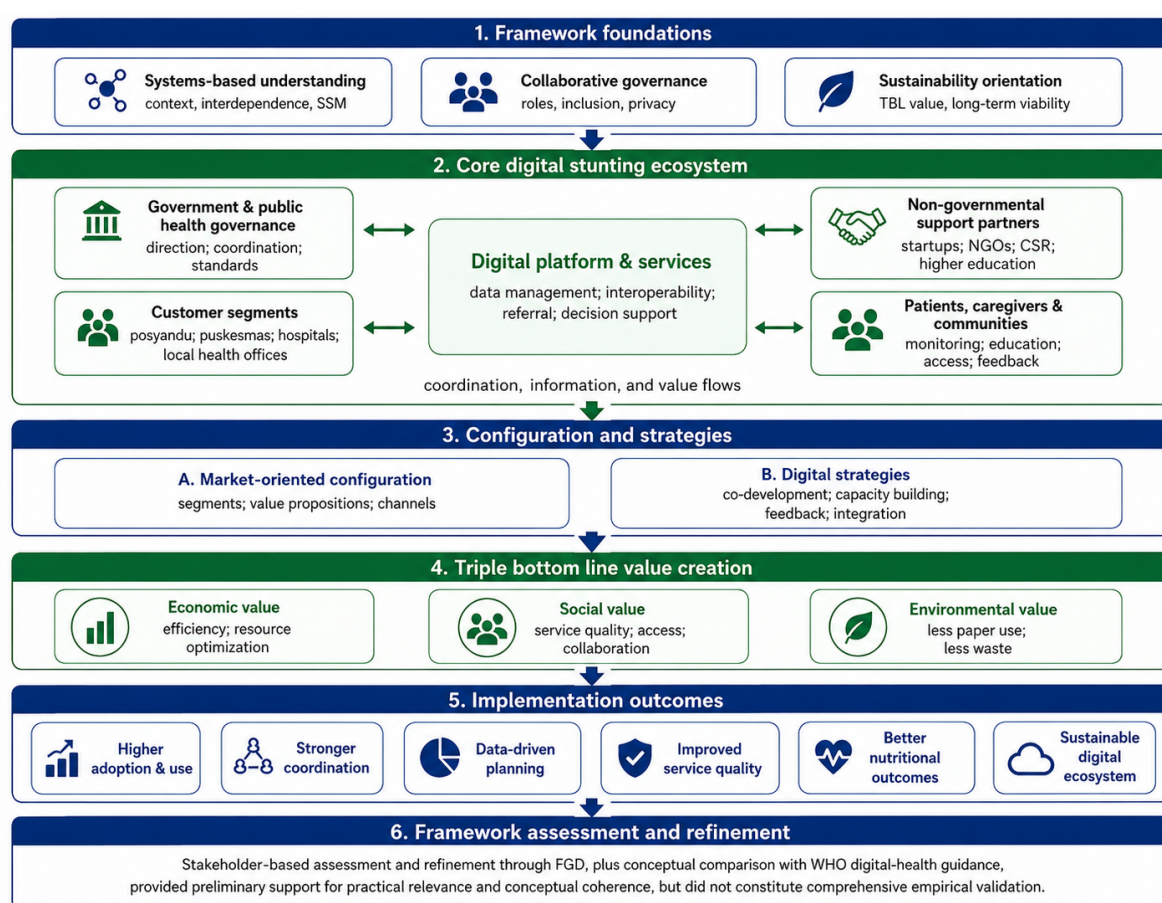


Figure 7 Refined market-oriented digital health co-creation framework for stunting prevention

Figure 7 demonstrates that effective digital stunting prevention depends less on introducing additional technologies than on aligning governance, stakeholder responsibilities, service processes, and data flows around institutional users' needs. Unlike platform-centered approaches, in which technology is the primary driver of change, the proposed framework positions the digital platform as an integrated infrastructure within a distributed ecosystem.

Table 6 Comparison of real-world findings & WHO digital health guidance

Framework dimension	Di-	Real-World and FGD Findings	WHO-Based Comparative Assessment	Framework Refinement
Stakeholder roles and institutional responsibilities		Community Health Posts, Primary Healthcare Centers, hospitals, local public health authorities were identified as the four main institutional customer segments. Health facilities generate and use service data; public health authorities coordinate programmes, manage data, validate information.	The findings align with (World Health Organization, 2023), which classifies digital interventions by intended users and health-system functions. (World Health Organization, 2019) stresses that digital interventions should strengthen, rather than replace, existing health systems.	Clarified the roles, responsibilities, information needs, accountability, and decision-making authority of each customer segment.
Digital platform and data integration		Fragmented applications, duplicate data entry, delayed reporting, and limited system integration remain major barriers.	This dimension aligns with (World Health Organization, 2023) principles on digital capabilities, data services, application types, and interoperability.	Positioned interoperability, data quality, integration, cross-platform connectivity as key digital-governance requirements.
Referral and decision support		Digital referral, growth monitoring, timely information exchange support continuous care and accurate intervention.	The findings correspond with (World Health Organization, 2023) provider-oriented interventions & decision-support functions.	Strengthened tiered digital referral, growth monitoring & decision-support dashboards.
Workforce capacity and digital adoption		Implementation requires continuous training, technical assistance, digital literacy, and iterative system improvement.	This dimension relates to (World Health Organization, 2023) healthcare-provider functions. (World Health Organization, 2019) identifies workforce readiness, implementation support as important for acceptability & feasibility.	Added continuous capacity building, digital-literacy development, technical assistance & user feedback.
Stakeholder co-creation engagement	&	Feature co-development, stakeholder participation, capacity building, and data-driven feedback were considered necessary for relevance, acceptance, and sustained adoption.	Although co-creation is not a separate (World Health Organization, 2023) category, participatory development can support person- & provider-oriented interventions, improve acceptability, feasibility, equity under (World Health Organization, 2019).	Added co-development, capacity building, technical support, data-driven feedback to support stakeholder engagement, user acceptance.
Monitoring and evaluation	and	Dashboards & programme monitoring were viewed as important for data-driven planning & institutional coordination.	(World Health Organization, 2023) supports consistent documentation and reporting, while (World Health Organization, 2019) identifies six assessment considerations.	Added key implementation, outcome, equity, and quality indicators.
Health service-user engagement		Patients, caregivers, and communities were recognized as beneficiaries and information providers, although direct digital engagement remains limited.	This dimension aligns with (World Health Organization, 2023) interventions addressing individual and health-sector needs. (World Health Organization, 2019) emphasizes acceptability and equity in digital implementation.	Identified communication, accessibility, digital inclusion, consent, community feedback as areas for further development.
Digital governance and data protection		Institutional authority, data validation, regulation, and cross-organizational coordination were considered essential for sustainable implementation.	(World Health Organization, 2023) supports classification, documentation, data services, and interoperability but is not a comprehensive privacy, cybersecurity, or governance standard.	Expanded digital governance to include accountability, data ownership, data quality, privacy, access control, interoperability standards, risk management.
Triple Line value creation	Bottom value cre-	Digitalization can create economic value through efficiency, social value through improved services and collaboration, and environmental value through reduced paper use, process duplication.	TBL value creation is not explicitly covered by (World Health Organization, 2023). Economic and social value partly relate to (World Health Organization, 2019) considerations, while environmental value remains a distinctive contribution of the framework.	Retained economic, social, and environmental value as integrated framework outcomes. Environmental effects are treated as proposed outcomes requiring future measurement of paper reduction, avoided travel, physical storage, digital-infrastructure energy use, and lifecycle trade-offs.
Implementation sustainability		Sustainability depends on digital infrastructure, multidisciplinary capabilities, institutional legitimacy, regulation, contextual adaptation, and cross-sector collaboration.	(World Health Organization, 2023) supports intervention classification and documentation but does not provide a complete sustainability framework. (World Health Organization, 2019) emphasizes feasibility, resource use, acceptability, equity, potential harms, and health-system capacity.	Emphasized infrastructure, financing, institutional ownership, workforce readiness, contextual adaptation, ecosystem readiness, and long-term support.

Public-health authorities provide policy direction, standards, coordination, and accountability; healthcare providers translate data into monitoring, intervention, and referral; communities contribute information and feedback; and non-governmental partners provide technological, financial, research, and capacity-building support. Therefore, value creation emerges from the interaction among these actors rather than from the digital platform alone. The framework also demonstrates that public health market orientation does not imply commercialization. Instead, it requires the systematic identification of different institutional needs and the configuration of appropriate value propositions, relationships, channels, and digital strategies. Community health posts require accessible tools and capacity building, primary healthcare centers require integrated monitoring and referral support, hospitals require clinical and data interoperability, and local health offices require coordination and decision-support capabilities. Feature co-development, data integration, continuous feedback, digital referral, and dashboards function as connecting mechanisms that translate these differences into coordinated action. Economic and social values are treated as interdependent ecosystem outcomes through this configuration, while environmental value remains a proposed outcome requiring empirical measurement.

The refined framework may be analytically applicable to low- and middle-income countries developing digital community-based nutrition or child health services while facing challenges related to coordination, interoperability, workforce, and data-governance. India and Bangladesh illustrate the relevance of integrated nutrition and health-data systems for monitoring, referral, coordination, and service planning (Khan et al., 2019; Ministry of Women and Child Development, Government of India, 2022; Sharma et al., 2023). Vietnam and the Philippines highlight the importance of interoperability, cybersecurity, infrastructure, leadership, stakeholder engagement, funding, system readiness, and workforce training in the implementation of digital health (Evio & Bonito, 2024; Tran et al., 2022). Kenya and Nigeria similarly emphasize multilevel coordination, data governance, integrated child health services, digital decision support, public-private collaboration, capacity development, and monitoring (Federal Ministry of Health and Social Welfare, 2025a, 2025b; Ministry of Health, Republic of Kenya, 2016; Republic of Kenya, 2023). These examples demonstrate the analytical transferability rather than direct generalizability of the framework. Its application would require adaptation to each country's governance, financing, digital readiness, workforce capacity, data-protection requirements, and existing health and nutrition programs, followed by broader stakeholder assessment and context-specific testing.

4. Conclusion

Theoretically, this study extends sustainable business models and digital health research by integrating the Soft Systems Methodology with the triple bottom line co-creation canvas within a multi-level public health ecosystem. The framework shifts the focus from a single organization or digital platform to the wider relationships among government institutions, healthcare providers, communities, technology actors, and supporting partners. It also positions economic, social, and environmental values as interconnected ecosystem outcomes. From a managerial perspective, the framework may help technology startups, corporate social responsibility programmes, universities, non-governmental organizations, and healthcare partners clarify responsibilities, combine resources, and align digital features with the needs of different users. Community health posts require accessible tools and continuous training, primary healthcare centers require integrated monitoring and referral support, hospitals require clinical and data interoperability, and local health offices require coordination, monitoring, and decision-support capabilities. Therefore, digital solutions should be developed through continuous co-creation, user feedback, technical support, and institutional commitment. From a policy perspective, sustainable digital stunting interventions require more than additional applications. Public authorities should establish clear institutional responsibilities, interoperability and data quality standards, data ownership, privacy protection, accountability, and coordination across healthcare levels. Policy support should also provide adequate infrastructure, long-term financing, workforce readiness, equitable

access, implementation monitoring, service quality, resource use, health outcomes, and potential risks. Because environmental effects were not measured in this study, future evaluation should include indicators such as paper reduction, avoided travel, reduced physical storage, digital infrastructure energy use, and lifecycle or environmental trade-offs.

The findings provide preliminary support for the practical relevance and conceptual coherence of the framework. This support was derived from a small-group stakeholder-based assessment involving non-governmental representatives and a conceptual comparison with WHO guidance. These procedures did not constitute comprehensive empirical validation or demonstrate readiness for implementation. Government implementers, frontline healthcare workers, caregivers, and communities were not comprehensively represented, and the framework has not yet been tested through pilot implementation or impact evaluation. Therefore, the findings are not intended for statistical generalization. Their broader contribution lies in their analytical transferability to digital public-health ecosystems, which are subject to contextual adaptation, wider stakeholder assessment, and further empirical testing. Future studies should validate the framework with broader stakeholder groups, including national and local governments, local public health authorities, community health posts, primary healthcare centers, hospitals, caregivers, and service users. Further research could quantitatively assess the relationships among co-creation mechanisms, digital adoption, governance quality, and triple bottom line outcomes. Longitudinal and comparative studies across regions, platforms, and public-health programs are also needed to examine the framework's implementation effectiveness, scalability, and long-term sustainability.

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Author Contributions

Sari Wulandari: Conceptualization, Methodology, Writing – Original Draft. **Tiara Verita Yastica:** Collecting data, Writing – Review & Editing.

Conflict of Interest

The authors declare no conflicts of interest.

Supplementary Materials

Supplementary figures and tables are available online.

Declaration of AI

Generative AI and AI-assisted tools were used to enhance the language and readability of this manuscript. The authors have reviewed and revised all AI-generated content to ensure its accuracy and alignment with the research. The authors remain fully responsible for the work's scientific content, conclusions, and integrity, and disclose the use of AI to ensure transparency and adherence to publisher guidelines.

References

- Altafin, B. G., Morini, C., & Capitani, D. H. D. (2025). Business model revisited: A novel canvas for digital transformation. *Revista de Gestão*, 32(2), 81–98. <https://doi.org/10.1108/REGE-12-2023-0142>
- Amalia, H. (2025). Determinants of low toddler attendance at the community health posts in Bobo village, Tidore Islands City. *Jurnal Sains Sosial dan Humaniora (JSSH)*, 5(2), 78–83. <https://doi.org/10.52046/jssh.v5i2.2665>
- Aryee, J., & Hansen, A. S. (2022). De-politicization of digital systems for trade facilitation at the port of Tema: A soft systems methodology approach. *Case Studies on Transport Policy*, 10(1), 105–117. <https://doi.org/10.1016/j.cstp.2021.11.009>
- Bachmann, N., Thienemann, A.-K., Tüzün, A., Brunner, M., Tripathi, S., Pöchtrager, S., & Jodlbauer, H. (2025). The evolution of the business model canvas for digital sustainability. *Procedia Computer Science*, 253, 1012–1023. <https://doi.org/10.1016/j.procs.2025.01.163>
- Basile, V. (2021). The triple layered business model canvas in smart agriculture: The case of Evja startup. *Piccola Impresa / Small Business*, (2), 79–113. <https://doi.org/10.14596/pisb.2844>
- Benis, A., Tamburis, O., Chronaki, C., & Moen, A. (2021). One digital health: A unified framework for future health ecosystems. *Journal of Medical Internet Research*, 23(2), e22189. <https://doi.org/10.2196/22189>
- Braa, J., Sahay, S., & Monteiro, E. (2023). Design theory for societal digital transformation: The case of digital global health. *Journal of the Association for Information Systems*, 24(6). <https://doi.org/10.17705/1jais.00816>
- Brunner, M., Bachmann, N., Thienemann, A.-K., Tuezuen, A., & Jodlbauer, H. (2025). To the end of the line – including intermediaries and end customers in the business model CANVAS. *Journal of Open Innovation: Technology, Market, and Complexity*, 11, 100623. <https://doi.org/10.1016/j.joitmc.2025.100623>
- Checkland, P. (2000). Soft systems methodology: A thirty year retrospective. *Systems Research and Behavioral Science*, 17, S11–S58.
- Checkland, P., & Poulter, J. (2006). *Learning for action: A short definitive account of soft systems methodology and its use for practitioners, teachers and students*. Wiley.
- Checkland, P., & Poulter, J. (2020). Soft systems methodology. In M. Reynolds & S. Holwell (Eds.), *Systems approaches to making change: A practical guide*.
- Devi, E. T., Wibisono, D., Mulyono, N. B., & Fitriati, R. (2023). Designing an information-sharing system to improve collaboration culture: A soft systems methodology approach in the digital service creation process. *Journal of Enterprise Information Management*, 36(5), 1240–1269. <https://doi.org/10.1108/JEIM-08-2022-0294>
- Ebekozien, A., Aigbavboa, C. O., Samsurijan, M. S., Muhammad, A. K., & Akinradewo, O. (2024). Developing a framework for housing financing: A case study of Nigeria's sustainable low-cost housing via soft system methodology. *Engineering, Construction and Architectural Management*, 32(13), 27–48. <https://doi.org/10.1108/ECAM-09-2023-0895>
- Espinosa, A., Lerch, M., & Schwaninger, M. (2020). Constitutive rules for guiding the use of the viable system model: Reflections on practice. *European Journal of Operational Research*, 287(2), 733–746. <https://doi.org/10.1016/j.ejor.2020.05.030>
- Evio, B. D., & Bonito, S. R. (2024). Formative evaluation of the implementation of eHealth in the Philippines: A qualitative study. *Acta Medica Philippina*, 58(12), 35–47. <https://doi.org/10.47895/amp.v58i12.9289>
- Fadila, R., Asnawi, Y. H., & Taryana, A. (2024). Sustainable business model development of salam rancage bogor using triple layered business model canvas. *Indonesian Journal of Business and Entrepreneurship*, 10(1), 25–39. <https://doi.org/10.17358/ijbe.10.1.25>
- Fang, J., Lee, V. C. S., & Wang, H. (2024). Optimal service resource management strategy for IoT-based health information system considering value co-creation of users. *Industrial*

- Management and Data Systems*, 124(3), 1132–1154. <https://doi.org/10.1108/IMDS-03-2023-0173>
- Federal Ministry of Health and Social Welfare. (2025a). *FG launches automated standing orders app for community health workers*.
- Federal Ministry of Health and Social Welfare. (2025b). *Nigeria child survival action plan 2025–2029*.
- García-Muiña, F. E., Medina-Salgado, M. S., Ferrari, A. M., & Cucchi, M. (2020). Sustainability transition in industry 4.0 and smart manufacturing with the triple-layered business model canvas. *Sustainability*, 12(6). <https://doi.org/10.3390/su12062364>
- Garmann-Johnsen, N. F., Eikebrokk, T. R., & Olsen, D. H. (2024). The triple bottom line co-creation canvas. *Procedia Computer Science*, 239, 322–329. <https://doi.org/10.1016/j.procs.2024.06.178>
- Garmann-Johnsen, N. F., Olsen, D. H., & Eikebrokk, T. R. (2021). The co-creation canvas. *Procedia Computer Science*, 181, 189–197. <https://doi.org/10.1016/j.procs.2021.01.120>
- Gotsadze, G., Zoidze, A., Gabunia, T., & Chin, B. (2024). Advancing governance for digital transformation in health: Insights from Georgia's experience. *BMJ Global Health*, 9(10), e015589. <https://doi.org/10.1136/bmjgh-2024-015589>
- Harahap, N. C., Handayani, P. W., & Hidayanto, A. N. (2023). Integrated personal health record in Indonesia: Design science research study. *JMIR Medical Informatics*, 11, e44784. <https://doi.org/10.2196/44784>
- Hardiana, Asmita, Suarna, Rosita, Cani, Nurdiana, Janu Lena Geken, Nurinaya Suleman, & Maswati. (2026). Common diseases in early childhood and their prevention strategies: A community health posts-based observational study in Parepare city. *Journal of Creative Power and Ambition (JCPA)*, 4(1), 271–286. <https://doi.org/10.70610/JCPA.V4I01.1178>
- Heshajin, S. G., Sedghi, S., Panahi, S., & Takian, A. (2024). A framework for health information governance: A scoping review. *Health Research Policy and Systems*, 22, 109. <https://doi.org/10.1186/s12961-024-01193-9>
- Isa, W. A. R. W. M., Noordin, N., Suhaimi, A. I. H., Ismail, I. N., Mahat, S. R., Aziz, N. S. A., Tumin, M., & Yaakob, N. H. M. (2020). Framing soft system methodology in community IT-based project: Case of ASNAF. *International Journal of Advanced Science and Technology*, 29(6), 1580–1587.
- Jalaludin, M. Y., Fauzi, M. D., Sidiartha, I. G. L., John, C., Aviella, S., Noverly, E., Permatasari, A., & Muhandi, L. (2025). Addressing stunting in children under five: Insights and opportunities from Nepal, Bangladesh, and Vietnam – a review of literature. *Children*, 12(5), 641. <https://doi.org/10.3390/children12050641>
- Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, 135, 1474–1486. <https://doi.org/10.1016/j.jclepro.2016.06.067>
- Kabbera, S., Tibaingana, A., Kiwala, Y., & Mugarura, J. T. (2024). Triple bottom line practices and the growth agro-processing enterprises in Uganda. *Cleaner and Circular Bioeconomy*, 8. <https://doi.org/10.1016/j.clcb.2024.100081>
- Kemenko PMK. (2025). *Prevalensi stunting tahun 2024 turun jadi 19,8 persen, pemerintah terus dorong penguatan gizi nasional [stunting prevalence in 2024 declines to 19.8 percent, government continues to strengthen national nutrition]*. Retrieved July 22, 2026, from <https://www.kemenkopmk.go.id/prevalensi-stunting-tahun-2024-turun-jadi-198-persen-pemerintah-terus-dorong-penguatan-gizi>
- Khairuddin, H., Pawitra Wulan, D., Hindriana, F., Putri, W., & Muchdi, A. M. (2024). The first 1000 days of life in urban district of Indonesia: A prevalence and descriptive epidemiology. *Malahayati Nursing Journal*, 6(9), 3809–3820. <https://doi.org/10.33024/MNJ.V6I9.15508>

- Khan, M. A. H., de Oliveira Cruz, V., & Azad, A. K. (2019). Bangladesh's digital health journey: Reflections on a decade of quiet revolution. *WHO South-East Asia Journal of Public Health*, 8(2), 71–76. <https://doi.org/10.4103/2224-3151.264849>
- Khayame, H. A., & Abdeljawad, M. M. (2020). Systems thinking in upstream social marketing: Using soft systems methodology to improve midwifery policy in Jordan. *Social Marketing Quarterly*, 26(2), 167–183. <https://doi.org/10.1177/1524500420925810>
- Langen, T., Falk, K., & Muller, G. (2025). Conceptual modeling for understanding and communicating complexity during human systems integration in manned–unmanned systems: A case study. *Systems*, 13(3). <https://doi.org/10.3390/systems13030143>
- Maresova, P., Javanmardi, E., Maskuriy, R., Selamat, A., & Kuca, K. (2022). Dynamic sustainable business modelling: Exploring the dynamics of business model components considering the product development framework. *Applied Economics*, 54(51), 5904–5931. <https://doi.org/10.1080/00036846.2022.2055740>
- Ministry of Health, Republic of Kenya. (2016). *Kenya national ehealth policy 2016–2030: Towards attainment of the highest standard of health through adoption and use of ICT*. Ministry of Health.
- Ministry of Women and Child Development, Government of India. (2022). *Mission saksham anganwadi and poshan 2.0: Scheme guidelines*. Government of India.
- Muharram, F. R., Sulistya, H. A., Swannjo, J. B., Firmansyah, F. F., Rizal, M. M., Izza, A., Isfandiari, M. A., Ariningtyas, N. D., & Romdhoni, A. C. (2024). Adequacy and distribution of the health workforce in Indonesia. *WHO South-East Asia Journal of Public Health*, 13(2), 45–55. https://doi.org/10.4103/WHO-SEAJPH.WHO-SEAJPH_28_24
- Muhawarman, A. (2025). *SSGI 2024: Prevalensi stunting nasional turun menjadi 19,8%*. Retrieved July 22, 2026, from <https://kemkes.go.id/id/ssgi-2024-prevalensi-stunting-nasional-turun-menjadi-198>
- Mulyani, A. T., Khairinisa, M. A., Khatib, A., & Chaerunisaa, A. Y. (2025). Understanding stunting: Impact, causes, and strategy to accelerate stunting reduction – a narrative review. *Nutrients*, 17(9), 1493. <https://doi.org/10.3390/nu17091493>
- Naugle, A., Langarudi, S., & Clancy, T. (2024). What is (quantitative) system dynamics modeling? defining characteristics and the opportunities they create [System Dynamics Review].
- Nordiawan, D., Prasajo, E., & Hardjosoekarto, S. (2017). Reconstruction of performance-driven culture: Application of soft systems methodology at East Java Province, Indonesia. *Proceedings of the European Conference on Research Methods in Business and Management Studies*.
- Nourse, R., Dingler, T., Kelly, J., Kwasnicka, D., & Maddison, R. (2023). The role of a smart health ecosystem in transforming the management of chronic health conditions. *Journal of Medical Internet Research*, 25, e44265. <https://doi.org/10.2196/44265>
- Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. John Wiley & Son.
- Otsuka, T., Ishizaki, R., Ahamed, T., & Noguchi, R. (2024). Three-layer business model canvas of oil-water separation equipment in restaurants and food processing factories. *Energy Nexus*, 13. <https://doi.org/10.1016/j.nexus.2024.100273>
- Pereira, S. G. M., Medina, F. A., Goncalves, R. F., & Silva, M. T. (2016). System thinking and business model canvas for collaborative business models design. In *Advances in production management systems*. https://doi.org/10.1007/978-981-10-6460-9_6
- Purwaningsih, M., Purwandari, B., & Hidayanto, A. N. (2024). A conceptual model e-collaboration for rural tourism – combining soft system methodology and UML. *Procedia Computer Science*, 234, 1119–1127. <https://doi.org/10.1016/j.procs.2024.03.107>
- Republic of Kenya. (2023). *The digital health act, 2023, no. 15 of 2023*. Government Printer.

- Saragih, L. R., Dachyar, M., & Zagloel, T. Y. M. (2021). Business process reengineering at ICT operations, in managing smart cities as new customers (non-human). *International Journal of Technology*, 12(2), 378–389. <https://doi.org/10.14716/ijtech.v12i2.4418>
- Schramm, V. B., Gomes Júnior, A., & Schramm, F. (2022). Facilitation model for supporting integrative water resource management. *Water Resources Management*, 36, 4913–4931. <https://doi.org/10.1007/s11269-022-03282-2>
- Sharma, R. S., Rohatgi, A., Jain, S., & Singh, D. (2023). The Ayushman Bharat digital mission (ABDM): Making of India's digital health story. *CSI Transactions on ICT*, 11(1), 3–9. <https://doi.org/10.1007/s40012-023-00375-0>
- Shen, X., & Feng, J. (2017). Approaching complex problematical situations in management of learning, teaching and assessment with soft systems thinking – an instantiation of the FMA model for research. *Journal of International Technology and Information Management*, 26(3), 20–45. <https://doi.org/10.58729/1941-6679.1326>
- Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. McGraw-Hill.
- Sudiarti, T., Amelia, T., & Hasanah, I. J. (2022). The capacity of community health posts cadres through complementary food for children by training. *Jurnal Pengabdian Kepada Masyarakat (Indonesian Journal of Community Engagement)*, 8(1), 12. <https://doi.org/10.22146/jpkm.52309>
- Suparto, T. A., Nur Azizah, N., Andriyani, S., Wahyoe Puspita, A. P., & Hermayanti, Y. (2022). The problems affecting the implementation of community health posts program: A literature review. *JIKO (Jurnal Ilmiah Keperawatan Orthopedi)*, 5(2), 55–61. <https://doi.org/10.46749/jiko.v5i2.75>
- Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), 172–194. <https://doi.org/10.1016/j.lrp.2009.07.003>
- Tran, D. M., Thwaites, C. L., Van Nuil, J. I., McKnight, J., Luu, A. P., & Paton, C. (2022). Digital health policy and programs for hospital care in Vietnam: Scoping review. *Journal of Medical Internet Research*, 24(2), e32392. <https://doi.org/10.2196/32392>
- Ulrich, W., & Reynolds, M. (2020). Critical systems heuristics: The idea and practice of boundary critique. In M. Reynolds & S. Holwell (Eds.), *Systems approaches to making change: A practical guide* (2nd, pp. 255–305).
- Van Limburg, M., Wentzel, J., Sanderman, R., & van Gemert-Pijnen, L. (2015). Business modeling to implement an eHealth portal for infection control: A reflection on co-creation with stakeholders. *JMIR Research Protocols*, 4(3), e104. <https://doi.org/10.2196/resprot.4519>
- Warren, S., Sauser, B., & Nowicki, D. (2019). A bibliographic and visual exploration of the historic impact of soft systems methodology on academic research and theory. *Systems*, 7(1), 10. <https://doi.org/10.3390/systems7010010>
- Wit, B., Dresler, P., & Surma-Syta, A. (2021). Innovation in start-up business model in energy-saving solutions for sustainable development. *Energies*, 14(12). <https://doi.org/10.3390/en14123583>
- World Health Organization. (2019). *WHO guideline: Recommendations on digital interventions for health system strengthening* [Accessed: 6 July 2026]. <https://www.who.int/publications/i/item/9789241550505>
- World Health Organization. (2023). *Classification of digital interventions, services and applications in health: A shared language to describe the uses of digital technology for health* (2nd) [Accessed: 6 July 2026]. <https://www.who.int/publications/i/item/9789240081949>
- Yunitasari, E., Hisyam Al Faisal, A., Efendi, F., Kusumaningrum, T., Cindra Yunita, F., & Chan Chong, M. (2021). Predictors of mortality among newborns admitted with perinatal asphyxia at public hospitals in Ethiopia: A prospective cohort study. *BMC Pediatrics*. <https://doi.org/10.1186/s12887-022-03728-x>