Available online at www.HEFJournal.org

ISSN: 2785-2997

Journal of
Human, Earth, and Future

Vol. 7, No. 1, March, 2026

Digital Health Orchestration: Innovating Beyond Applications to Address Elderly Loneliness in Aging Societies

Wattanee Prasertwong [1], Nattiporn Nokkaew [2], Thiraput Pitichat [3], Thadathibesra Phuthong [4*]

[1] *Technopreneurship and Innovation Management Program, Graduate School, Chulalongkorn University, Bangkok 10330, Thailand.*

[2] *Faculty of Sport Science, Chulalongkorn University, Bangkok 10330, Thailand.*

[3] *Chulalongkorn Business School, Chulalongkorn University, Bangkok 10330, Thailand.*

[4] *Department of Logistics Management, Faculty of Management Science, Silpakorn University, Phetchaburi, 76120, Thailand.*

Received 30 October 2025; Revised 04 February 2026; Accepted 09 February 2026; Published 01 March 2026

Abstract

Objectives: This study addressed elderly loneliness in aging societies by developing and evaluating SabuyJai, a culturally grounded digital health platform designed to assess, manage, and reduce social isolation among older adults. *Methods/Analysis*: A three-phase mixed-methods design was employed. Phase 1 used structural equation modeling (SEM) to identify loneliness determinants through qualitative analysis and surveys (n=205). Phase 2 implemented an eight-week quasi-experimental intervention (n=82), and Phase 3 evaluated technology acceptance and commercial viability (n=41) using the extended Technology Acceptance Model (TAM). *Findings*: Social connectedness emerged as the primary determinant of loneliness and mental health (β=–0.474, $p<0.001$; β=0.677, $p<0.001$), with meaningful reciprocity outweighing network size. The intervention achieved a 17.4% loneliness reduction ($p<0.001$). The platform demonstrated high perceived usefulness (M=4.35), ease of use (M=4.33), and trust (M=4.21), with positive three-year financial projections. *Novelty/Improvements*: This research contributes an integrated Digital Social Well-being Model, extending social support, social exchange, and social connectedness theories within the TAM framework, and advances digital health innovation by demonstrating that culturally adapted, theory-driven platforms can effectively bridge emotional health, digital inclusion, and well-being economy objectives in super-aged societies.

Keywords: Elderly Loneliness; Digital Social Well-being; Social Connectedness; TAM; Mixed-Methods Research; Aging Society.

1. Introduction

Thailand is facing an unprecedented demographic transformation as it rapidly transitions into an aging society. By 2025, over 20% of the population will be 60 years or older, officially classifying the population as a complete aged society, with projections indicating super-aged society status by 2033, defined as more than 28% of the population over 60 [1]. This demographic shift is occurring at an accelerated pace compared to many developed nations, creating urgent challenges for healthcare, social services, and economic sustainability.

The speed of this aging transition is concerning—progressing in only 20 years, compared to the 115 years it took France to reach similar demographic proportions [2]. As illustrated in Figure 1, this rapid change is characterized by two

* Corresponding author: phuthong_t@su.ac.th

https://doi.org/10.28991/HEF-2026-07-01-010

concurrent demographic trends: a steady increase in the proportion of the elderly population (aged 60+) from 5.4% in 1960 to a projected 28.1% by 2035, alongside a dramatic decline in total fertility rate (TFR) from 6.15 in 1960 to below 1.30 in recent years [3-5]. Traditional family structures are simultaneously evolving, with household sizes shrinking from 5.7 people in 1970 to 2.5 in 2023 [4], and single-person households projected to increase from 7.07 million in 2021 to 9.12 million by 2040 [6]. These converging trends have significantly weakened traditional care networks, intensifying the risks of social isolation and loneliness among older adults.

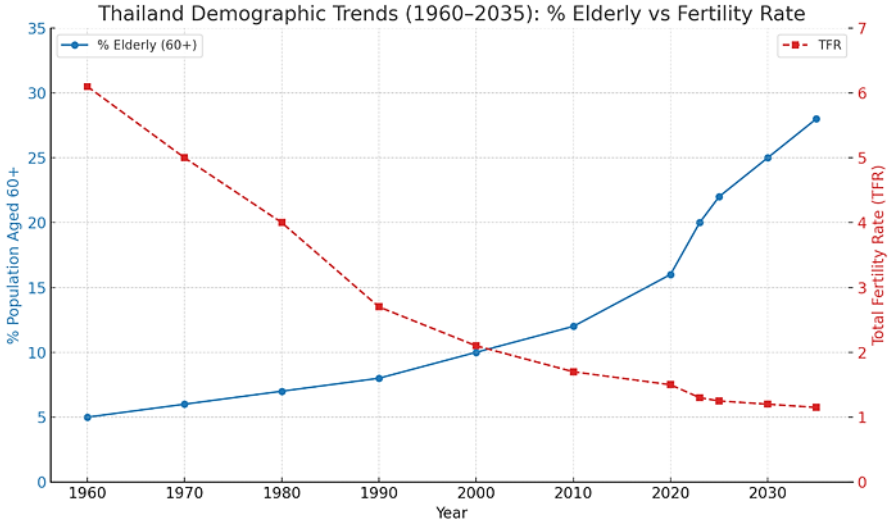


Figure 1. Demographic trends in Thailand (1960–2035) showing an increasing proportion of the elderly population (aged 60 and above) and a concurrent decline in the total fertility rate (TFR) (Adopted from: United Nations [3]; National Statistical Office [4]; Ministry of Public Health [5]).

Loneliness among the elderly represents a significant psychosocial burden and has become a growing public health concern. Loneliness, defined as distress arising from inadequate or unsatisfactory social connections, is a key risk factor for depression, dementia, cardiovascular disease, and premature mortality [7, 8]. In Thailand, mental health issues are now increasingly prevalent in the elderly population, with dementia and depression ranked among the top five health problems [9]. More alarmingly, suicide rates are highest among older adults, particularly in the 70-79 age group (10.86 per 100,000) and those over 80 (10.33 per 100,000) [10]. Without preventive interventions, Thailand's healthcare expenditure is projected to exceed 1.4 trillion Baht by 2032, primarily due to non-communicable and mental health conditions [11].

Thai seniors are increasingly embracing digital solutions, contrary to widespread assumptions about technology adoption. Recent data indicate that Baby Boomers (aged 59-77) in Thailand represent the fastest-growing group of internet users, averaging 7 hours and 19 minutes online daily, primarily for communication (92%), entertainment (77%), and financial services (68%) [12]. Furthermore, 80.8% of seniors use smartphones, and 97.3% use them to access the internet [13]. Challenges such as low confidence, fear of scams, and usability issues persist, but the rising digital literacy among the Thai elderly presents a timely opportunity for innovative digital health interventions.

However, despite this growing digital adoption and the urgent need to address loneliness, significant gaps remain in developing practical solutions for Thai seniors. First, existing interventions often lack cultural specificity, being primarily adapted from Western contexts without sufficient consideration for Thai cultural norms, family dynamics, and Buddhist-influenced approaches to aging. Chen & Schulz's [14] meta-analysis demonstrated the potential of technology-based interventions to reduce loneliness, with research by Findlay et al. [15] indicating limited effectiveness when these solutions are not culturally tailored. Second, digital literacy integration remains overlooked, as many programs presuppose a baseline level of digital competence without incorporating skill-building components. Numerous digital applications exist for elderly populations, but few systematically combine loneliness assessment and management within accessible, culturally-responsive platforms. Third, integrated assessment tools are scarce, with few culturally adapted measures of loneliness embedded into intervention platforms. Many existing projects also lack rigorous impact evaluation frameworks that measure effects on mental health, quality of life, and long-term sustainability. Fourth, sustainability poses a challenge, as most interventions are evaluated only in the short term, leaving long-term impacts underexplored. The effectiveness of technology-based interventions diminishes over time without sustained engagement strategies specifically designed for older adults. Finally, cross-sector collaboration remains limited, with insufficient coordination between healthcare, technology, community, and policy stakeholders. This siloed approach has hindered the development of comprehensive solutions that address the psychosocial and practical dimensions of elderly loneliness.

These aspects highlight the critical need for digital interventions that address elderly loneliness through a culturally-informed lens specific to the Thai context. Such solutions need to strike a balance between technological accessibility and meaningful social connection, providing tools for assessment and also pathways to sustained engagement that align with Thai values and practices. To address these five critical gaps identified above, this study investigated the determinants of loneliness among the elderly in Thailand and designed, developed, and evaluated a digital platform (SabuyJai) that integrates social connectedness theory, digital competency frameworks, and culturally appropriate intervention strategies. Four research questions guided this investigation: (1) What factors contribute to loneliness and social isolation among Thai seniors? (2) What are the current approaches to assessing and managing elderly loneliness in Thailand? (3) How can a digital platform be designed to reduce loneliness effectively? (4) What is the commercial viability and implementation pathway of such a platform?

These questions were addressed using a mixed-methods approach to increase the theoretical understanding and develop practical solutions to combat the growing challenge of elderly loneliness in Thailand. The significance of this study extends beyond academic contributions by addressing a pressing demographic and healthcare challenge, offering potential pathways for preventive mental health interventions to reduce healthcare costs, improve quality of life, and strengthen social cohesion across generations. The remainder of this paper is organized as follows: Section 2 provides a literature review examining theoretical frameworks, the prevalence and impacts of loneliness, and previous interventions; Section 3 outlines the three-phase mixed-methods research design; Section 4 presents the findings from each phase; Section 5 discusses the research implications, limitations, and recommendations; and Section 6 presents the conclusions.

2. Literature Review

2.1. Theoretical Frameworks of Loneliness and Social Connection in Older Adults

Understanding loneliness among the elderly requires a multifaceted perspective, as no single framework can fully capture its complexity. Social Support Theory emphasizes four distinct but interrelated dimensions: emotional, instrumental, informational, and appraisal support [16]. Among the Thai elderly, research suggests that perceptions of available support often outweigh the frequency of received support [17]. Reciprocity—the ability to both give and receive support—is highly aligned with Thai cultural values of respect, interdependence, and contribution [18]. Social Connectedness Theory highlights the subjective sense of belonging and interpersonal closeness [19]. Recent refinements have addressed the structural, functional, and qualitative aspects of social ties [20]. Results suggest that Thai seniors experience loneliness, despite having family or LINE contacts, because these interactions lack emotional depth or meaning.

Activity Theory posits that engagement in social roles and meaningful activities sustains well-being in later life [21, 22]. This framework is particularly salient in the Thai context, where temple-based activities, community rituals, and senior clubs offer culturally embedded opportunities for role maintenance. Finally, Social Exchange Theory conceptualizes relationships as reciprocal exchanges of tangible and intangible resources [23]. For older Thais, opportunities to share wisdom and mentor younger generations can help reinforce their dignity, strengthen social bonds, and mitigate feelings of loneliness [24]. These theories emphasize that loneliness or perceived social isolation does not result from a limited number of social contacts, but from the lack of reciprocity, belonging, and meaningful participation—principles that form the foundation of this study.

2.2. Loneliness Among Elderly Populations: Prevalence, Causes and Impacts

Loneliness is now increasingly recognized as a pressing public health concern, with global prevalence estimates ranging from 20% to 34% in Europe, 30% in Asia, and 30% in Singapore [25, 26]. Thailand's demographic transition has intensified this challenge, with a super-aged society status projected by 2040. Such a rapid transformation poses unique policy and intervention demands. Key contributors to loneliness include demographic changes, such as shrinking family size and an increase in single-person households, functional impairments, including mobility limitations and sensory decline, and significant life transitions such as bereavement and retirement. National data indicate a marked increase in the number of elderly people living alone, from 3.8% in 2007 to 6.5% in 2018. The consequences of loneliness are far-reaching. Empirical evidence links it to depression, cognitive decline, dementia, cardiovascular diseases, and even premature mortality [27, 28]. In the Thai context, the elderly population has the highest suicide rate [29]. Loneliness has become a psychosocial burden and also a fundamental determinant of healthy aging in Thailand.

2.3. Previous Interventions Addressing Elderly Loneliness

Global efforts to address loneliness among the elderly have taken diverse forms, but few have been systematically tailored to the Thai context. Interventions can be broadly categorized into activity-based, technology-based, psychosocial, community-based, and meaning-focused approaches. Table 1 presents a synthesis of these interventions, highlighting their core mechanisms, evidence bases, Thai contextual examples, and limitations. Activity-based strategies, such as group exercises or temple-centered programs, have shown positive effects, but these may diminish once participation declines. Technology-based approaches, including apps, chatbots, and even social robots, show

promise but are underutilized in Thailand, where most digital programs focus on literacy rather than reducing loneliness [30]. Psychosocial interventions like cognitive-behavioral therapy (CBT) are evidence-based but rarely applied in Thai elderly populations due to the need for specialized facilitators. Community-based strategies leveraging Village Health Volunteers—estimated at nearly one million nationwide [31]—offer strong potential but often face barriers due to limited community involvement in design. Finally, meaning-focused interventions that emphasize purpose, intergenerational roles, and spirituality, aligned with Buddhist practices, are not universally suitable. This review found that Thailand possesses unique cultural resources, including temples and volunteer networks, but lacks integrated, technology-enabled solutions.

Table 1. Comparative Summary of Interventions Addressing Elderly Loneliness

Intervention type	Key mechanism	Evidence base	Thai context example	Limitations
Activity-based	Structured group activities (e.g., art, music, exercise)	Cattan et al. [32]; Masi et al. [33]	Temple health promotion programs [40]	Effects fade if participation drops
Technology-based	Digital communication, mobile apps, VR/robots	Chen & Schulz [14]; Yang et al. [34]; Li et al. [35]	Chatbot program for digital literacy [30]	Few papers target loneliness directly, with limited local adaptation
Psychosocial (CBT)	Addressing maladaptive social cognition	Theeke & Mallow [36]; Masi et al. [33]	Limited use in Thai elderly programs	Requires trained facilitators; resource-intensive
Community-based	Leveraging local volunteers and networks	Gardiner et al. [37]	Village Health Volunteers (~1M nationwide [31])	Limited community involvement in planning
Meaning-focused	Enhancing purpose, volunteering, and intergenerational roles	Boyle et al. [38]; Frankl [39]	Religious and intergenerational programs influenced by Buddhism [41]	Not universally applicable across elderly groups

2.4. Digital Competency and Platform Development

Digital engagement represents both an opportunity and a challenge to address loneliness. Globally, internet use averages 68%, with significant disparities—40% in Africa compared to 89% in Europe [42]. In Thailand, digital access is high, with 96.7% of households owning mobile phones and 70.1% of seniors reporting smartphone usage [27]. Nevertheless, barriers remain, including language (English-based commands), limited technical skills, and security concerns. Digital competence can be defined as a combination of knowledge, skills, and attitudes [43, 44]. Thai scholars have identified six core competencies for elderly users as mobile device operation, use of cloud-based data, application management, communication, digital safety, and troubleshooting [45]. While obstacles persist, studies supported by government-led digital transformation initiatives have highlighted a strong willingness among Thai seniors to learn. These interventions simultaneously strengthen digital skills and foster social connection.

The success of any digital intervention hinges on the appropriateness of its design and development methodology. Progressive web applications (PWAs) are particularly advantageous for elderly populations, offering offline functionality, minimal storage requirements, and simplified access—benefits that are especially relevant for Thai seniors with older mobile devices [46]. Complementarily, the System Development Life Cycle (SDLC) provides a structured process that ensures user needs are integrated from initial analysis through ongoing maintenance, with accessibility features explicitly addressing age-related impairments such as vision and dexterity [47]. The extended Technology Acceptance Model (TAM) refines user adoption frameworks by incorporating perceived usefulness and ease of use, along with trust and enjoyment [48, 49]. These considerations are crucial for elderly users, many of whom express concerns about scams, while simultaneously valuing enjoyable and engaging interactions. These approaches provide a robust foundation for the design of the SabuyJai digital health platform, ensuring usability, cultural sensitivity, and sustainability.

2.5. Conceptual Framework

After synthesizing the reviewed evidence, a conceptual framework was proposed that integrated social networks, social support, social connectedness, and digital competency as primary determinants of loneliness, with downstream effects on mental health outcomes. Intervention strategies were theoretically grounded in Activity Theory, emphasizing meaningful engagement, Social Exchange Theory, highlighting reciprocity, and the extended TAM, focusing on usefulness, ease of use, trust, and enjoyment. The framework also directly aligned with the study's three-phase design: Phase 1 identified the key determinants of loneliness, Phase 2 designed interventions informed by theory and cultural context, and Phase 3 evaluated the psychosocial, technological, and commercial viability. This integrated model (Figure 2) depicts the pathways linking social and digital factors to loneliness and mental health, with targeted interventions serving as a moderator. By combining established theories with culturally specific and technology-driven considerations, the framework provides a comprehensive foundation for addressing loneliness among older adults in Thailand. The Technology Acceptance Model is not merely an evaluation tool; it also serves as a theoretical bridge that explains how technological factors interact with psychosocial constructs. When elderly users perceive digital platforms as practical, easy to use, trustworthy, and enjoyable (TAM constructs), their digital competency more effectively facilitates social connectedness, thereby reducing loneliness. This integration positions the TAM as a moderating framework that explains the 'how' of technology-mediated social engagement.

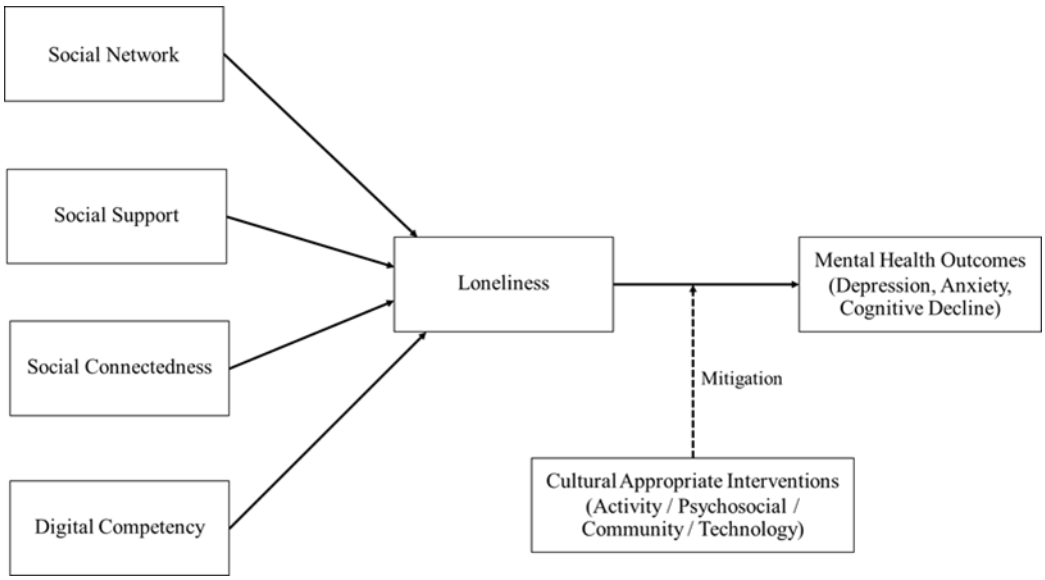


Figure 2. Conceptual framework linking social factors and digital competency to loneliness and mental health, moderated by interventions

3. Research Methodology

This study employed a systematic research and development approach, structured in three sequential phases that integrated qualitative and quantitative methods. This mixed-methods design [50] ensured a robust foundation for exploring the problem, developing evidence-based interventions, and evaluating the outcomes and commercial potential. The research flowchart is illustrated in Figure 3. The study adopted a sequential mixed-methods design and development approach, progressing through Phase 1: Requirement Analysis – Identifying factors, assessment approaches, and management strategies for loneliness, Phase 2: Design and Development – Creating and testing a technological intervention, and Phase 3: Implementation and Evaluation – Assessing technology acceptance and commercial viability. This design facilitated the integration of in-depth qualitative insights with empirical validation, followed by their translation into an evidence-based, market-ready innovation.

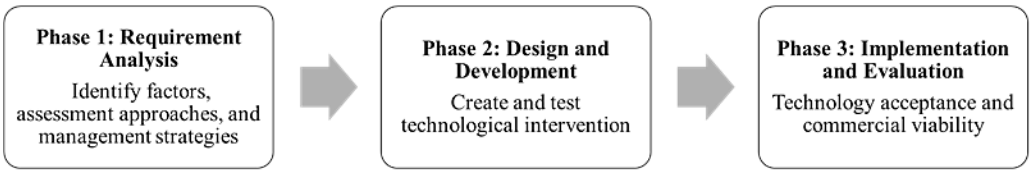


Figure 3. Research design flowchart of the three-phase study

3.1. Phase 1: Requirement Analysis

This study employed a sequential mixed-methods approach, combining qualitative and quantitative strategies to provide a comprehensive understanding of loneliness among Thai older adults and validate the design of an innovative intervention. The qualitative phase served as the foundation for exploring the lived experiences of elderly individuals and the perspectives of professionals. By contrast, the subsequent quantitative phase enabled empirical testing of the relationships between psychosocial, digital, and health-related variables. These complementary strands offered both depth and generalizability, thereby enhancing the robustness of the findings.

The qualitative phase engaged two stakeholder groups through purposive theoretical sampling [51]. The first group comprised experts (n = 10), including healthcare professionals (physicians, nurses, physiotherapists, and sports scientists), mental health specialists (psychologists), and social workers or public health officials. Eligibility criteria included previous experience in elderly care, fluency in Thai, and familiarity with health promotion among older adults. The second group consisted of elderly participants (n = 30), aged 60 years and older, recruited from senior wellness centers, elderly clubs at public health centers, community-based elderly groups, and elderly care facilities. The inclusion criteria specified being self-sufficient in daily living, proficient in Thai, possessing basic technology literacy, and a willingness to participate.

Semi-structured, in-depth interviews were conducted face-to-face, by telephone, or via video conferencing (Zoom and Microsoft Teams). The interview guide was validated using the index of Item-Objective Congruence (IOC) by three experts, with all items scoring above 0.50, indicating acceptable validity [52]. Key topics included experiences of

loneliness, influencing factors, management approaches, the role of technology, and recommendations for loneliness assessment and mental health screening. Data content analysis, following the approach of Hsieh & Shannon [53], was conducted in three stages as (i) verbatim transcription, anonymization, and integration of field notes, (ii) coding using a hybrid deductive-inductive approach, guided by theoretical concepts such as social networks, social support, social interaction, and technology use, while remaining open to emergent categories, and (iii) synthesis and interpretation to identify themes capturing problems, contributory factors, and management strategies related to elderly loneliness.

Building on the qualitative findings, the quantitative phase targeted Thai citizens aged 60 years and above. Proportional stratified random sampling ensured representation across age groups, with a minimum sample size of 161, as required by structural equation modeling (SEM) [54, 55]. A power analysis was conducted using G*Power [56]. The sample was stratified by age into 60–69 years (n = 90), 70–79 years (n = 48), and 80 years and older (n = 23). Data were collected through self-administered questionnaires distributed in both paper and online formats (Google Forms). The questionnaire comprised four sections: demographic and social characteristics; psychosocial and digital determinants including the adapted 12-item Lubben Social Network Scale [57], a 12-item social support scale [58], indicators of social connectedness, and digital competency measures; the Thai version of the 6-item Revised UCLA Loneliness Scale (RULS-6) [59]; and mental health status using the Thai version of the 21-item Depression, Anxiety, and Stress Scale (DASS-21) [60]. Preliminary testing confirmed acceptable psychometric properties, with IOC values above 0.50 and Cronbach's alpha coefficients exceeding 0.60.

Partial least squares structural equation modeling (PLS-SEM) was used to analyze the quantitative data. The analysis included evaluation of the measurement model through outer loadings, reliability and validity testing, and assessment of convergent and discriminant validity. Structural relationships were examined by testing the coefficient of determination (R^2), assessing the significance of path coefficients using bootstrapping with 5,000 samples, and analyzing both direct and total effects. This analytical framework enabled the simultaneous testing of complex interrelationships between social, psychological, and digital factors influencing loneliness and mental health among older adults [61-66].

3.2. Phase 2: Design and Development

The second phase of this research focused on the systematic design, development, and testing of an online group intervention model to alleviate loneliness among older adults. Drawing on the findings from Phase 1 and theoretical frameworks, this phase integrated intervention evaluation and platform prototyping to provide both empirical validation and technological feasibility.

To evaluate the intervention's efficacy, a two-group pretest–posttest quasi-experimental design was used. The target population was Thai older adults aged 60 years and above. The required sample size was calculated using G*Power, assuming a large effect size (0.80), a significance level of 0.05, and a statistical power of 0.80, consistent with Cohen's [67] guidelines. Allowing for a 30% attrition rate, 82 participants were recruited and assigned to two equal-sized groups (n = 41). Participants were selected through purposive sampling, drawing on eligible participants from Phase 1 and referrals from experts. Group allocation followed a non-random assignment process: the control group continued with traditional loneliness management activities, while the experimental group received the online group intervention.

The eight-week intervention was designed using insights from Phase 1 and theoretical underpinnings, specifically Social Support Theory [68-70] and Social Exchange Theory [23]. Three core components structured the intervention as (1) Social Network Building, including daily group interactions, buddy systems, and structured greeting exchanges, (2) Social Support, involving health-related information sharing, volunteer opportunities, hobbies, and informal peer training, and (3) Social Interaction, incorporating online activities to foster belonging, reciprocity, and sustained engagement. Ethical approval was obtained from Chulalongkorn University's Research Ethics Review Committee (COA No. 246/67). Data collection relied on the Thai version of the Revised UCLA Loneliness Scale (RULS-6), with established reliability in Thai elderly populations (Cronbach's alpha = .83) [59].

Data analysis included descriptive statistics (frequencies, percentages, means, and standard deviations) to summarize participant characteristics. Baseline comparability between groups was examined using chi-square tests. Within-group differences were analyzed using paired t-tests, while between-group differences in loneliness score changes were tested using independent t-tests. Statistical significance was set at $p < 0.05$. This design enabled a rigorous evaluation of the intervention's potential to reduce loneliness among older adults.

In parallel with intervention testing, a prototype platform was developed to support the intervention's scalability and sustainable implementation. The prototype, named SabuyJai (meaning "comfortable mind" in Thai), was designed using the System Development Life Cycle (SDLC) methodology [68]. The development process comprised three stages: analysis and specification, informed by Phase 1 findings, with user personas; logical design, including user flow mapping and information architecture; and physical design, implementing a progressive web application (PWA) with user interface design. Universal design principles were applied to accommodate accessibility for older adults with varying levels of digital literacy.

3.3. Phase 3: Technology Acceptance and Commercial Viability

The final phase focused on assessing both the acceptance of the developed digital intervention among elderly users and its potential for commercialization. User-centered technology acceptance testing was combined with structured business feasibility analysis to bridge the gap between academic research and practical application. Technology acceptance was evaluated using an extended TAM framework that combined traditional constructs (Perceived Usefulness, Ease of Use) with affective and social dimensions (Trust, Enjoyment) [22, 48, 69]. Forty-one participants from Phase 2 completed structured questionnaires using 5-point Likert scales. Expert evaluation confirmed content validity, with all items having IOC indices above 0.50, indicating relevance to the assessed constructs. Data analysis included descriptive statistics, such as percentages, means, and standard deviations, to summarize perceptions of the system. Contingency coefficients were also used to examine associations between user characteristics and acceptance factors.

Commercial viability analysis comprised five interrelated components as demand forecasting involving target market size and implementation costs, marketing analysis through a SWOT framework, industry attractiveness using Porter's Five Forces Model, marketing and operations planning, including target market definition, marketing mix strategies, and branding concepts, and financial feasibility through cost-benefit calculations and return-on-investment projections. These assessments provided an integrated evaluation of the SabuyJai platform's potential for scalability and sustainability. Table 2 presents a methodology summary.

Table 2. Methodology Summary

Phase	Participants	Methods	Analysis
Phase 1: Requirement Analysis	Experts (n=10); Elderly (n=30) qualitative; Elderly survey (n=165)	In-depth interviews, surveys	Directed content analysis; PLS-SEM
Phase 2: Design and Development	Elderly (n=82; exp. = 41, ctrl. = 41)	Eight-week quasi-experiment; prototype platform development	Paired and independent t-tests; descriptive statistics; user-centered SDLC
Phase 3: Implementation and Evaluation	Elderly (n=30–41)	TAM-based questionnaire; comparative SDS; business feasibility analysis	Descriptive statistics; correlation analysis; SWOT, Five Forces, financial modeling

4. Results

4.1. Phase 1: Requirement Analysis

The qualitative strand engaged ten experts representing diverse professional backgrounds in elderly health and social care. As summarized in Table 3, the participants included a physician, a physiotherapist, nurses, a gerontologist, a public health officer, and elderly care volunteers, with professional experience ranging from 5 to 30 years. Interviews were conducted between July and September 2024 across multiple elderly care centers in Ratchaburi and Nakhon Pathom Provinces.

Table 3. Details of Expert Interview Participants

Group of experts	Affiliation	Years of experience
Physician	Hospital	12
Physiotherapist	Elderly Care Development Center	18
Professional Nurse	Community Elderly Development Center, Ban Pong District, Ratchaburi	8
Professional Nurse	Community Elderly Development Center, Ban Pong District, Ratchaburi	14
Psychiatric Nurse	Community Elderly Development Center, Nakhon Pathom	15
Public Health Technical Officer	Community Elderly Development Center, Nakhon Pathom	20
Gerontologist	Elderly Care Center, Ban Pong District, Ratchaburi	30
Elderly Care Volunteer	Subdistrict Administrative Organization	5
Elderly Care Volunteer	Elderly Club, Ban Pong Municipality, Ratchaburi	7
Elderly Representative	Community Elderly Club	9

Thirty older adults participated in the qualitative interviews. Their demographic characteristics are summarized in Table 4. Most were female (80%), aged 60–79 years (80%), and lived with family members (73.3%). Over half (53.3%) had attained only primary education, reflecting the generally modest educational background of Thai seniors in semi-urban areas.

Table 4. General Characteristics of the Elderly Participants

Characteristic	Number	Percentage
Gender		
Male	6	20.0
Female	24	80.0
Age (Years)		
60–69	12	40.0
70–79	12	40.0
80 and above	6	20.0
Living arrangements		
Living with family	22	73.3
Living alone	8	26.7
Education level		
Primary education or lower	16	53.3
Secondary education or higher	14	46.7
Total	**30**	**100.0**

Thematic analyses of the interview transcripts yielded five interrelated themes that characterized loneliness among Thai older adults (Table 5) as (1) diminished social connectedness, (2) weakened family structures, (3) stigma and issues of self-worth, (4) gaps in digital competency, and (5) health-related vulnerabilities. These data demonstrated significant cultural differences in Thai seniors' loneliness compared with Western trends. Some people had over 200 LINE contacts but lacked genuine emotional ties. This paradox indicated that Thai senior participants prioritized connection quality over quantity, consistent with Buddhist ideas of absolute interconnectivity. One participant said, "Having many contacts means nothing if they don't truly see you" (P-23).

Table 5. Themes of Loneliness Characteristics and Examples (Phase 1)

Theme (Qualitative Insight)	Description from participant narratives	Illustrative quote	Aligned latent variable in Figure 4
Social Connectedness	Emotional depth and reciprocity in relationships were more critical than the number of contacts. Participants emphasized the importance of belonging, listening, and engaging in meaningful dialogue.	"Even though I have many LINE friends, I still feel no one truly listens."	*Social Connectedness→ Loneliness*
Family Structure Changes	Migration of children and smaller households reduced everyday interactions, increasing emotional distance and dependency.	"My son works in another province; I eat alone almost every day."	*Social Network → Loneliness*
Stigma and Self-worth	Reluctance to seek help due to fear of burdening others reflected internalized stigma and perceived loss of social value.	"I don't want to trouble anyone—it makes me feel weak."	*Social Support → Loneliness*
Digital Competency Gaps	Limited ability to use mobile applications, restricted participation in online activities, and connection with peers.	"I want to join online activities but I can't install applications myself."	*Digital Competency → Loneliness*
Health-related Vulnerabilities	Chronic illness and mobility limitations restricted social participation and increased dependence on others.	"Since my stroke, I rarely go out, and the loneliness is worse."	*Loneliness → Mental Health*

Weakening family structures were especially striking. Children leaving aging parents in semi-rural villages for Bangkok, Chiang Mai, or overseas had emotional effects. This travel pattern disrupted Thai filial piety-based family caregiving systems. Thai society values intergenerational homes and everyday family involvement, unlike Western cultures that value senior independence. Participants commonly feared becoming a burden to their children, thereby preventing them from seeking emotional support when needed. The digital competency gap created "a wall between me and my grandchildren's world" (P-15), excluding the development of social engagement. Thai seniors desired to study technology for family relationships and communal merit-making, not for broad access to information. Chronic diseases and mobility issues exacerbated isolation, with participants with chronic conditions reporting lower temple attendance and community involvement.

The quantitative phase involved 165 elderly respondents. As summarized in Table 6, the sample was predominantly female (73.9%) and concentrated in the 60–69-year age group (57.0%), followed by those aged 70–79 (29.1%) and 80 or above (13.9%). Educational attainment was high, with 74% completing at least upper secondary or vocational education. Regarding health status, 60% reported being healthy, while 51.5% had chronic diseases requiring ongoing management.

Table 6. Demographic Characteristics of the Survey Respondents (n = 165)

Characteristic	Number	Percentage
Gender		
Male	42	25.5
Female	122	73.9
Not specified	1	0.6
Age (Years)		
60–69	94	57.0
70–79	48	29.1
80 and above	23	13.9
Education level		
No formal education	7	4.3
Elementary	11	6.7
Lower secondary	25	15.2
Upper secondary / vocational	61	37.0
Bachelor's degree or higher	61	37.0
Health status		
Chronic illness	31	18.8
Healthy	99	60.0
Living with non-communicable diseases	17	10.3
Bedridden	5	3.0
Disabled	11	6.7
Having multiple conditions	2	1.2
Household members		
Living alone	7	4.2
2 persons	45	27.3
3–4 persons	80	48.5
5 or more persons	33	20.0
Household composition		
Living with children	95	57.6
Living with spouse	17	10.3
Living with relatives	33	20.0
Living with a caregiver	7	4.2
Living with parents	1	0.6
Living with grandchildren	4	2.4
Living alone	4	2.4
Current region of residence		
Bangkok Metropolitan Region	104	63.0
Northern Region	21	12.7
Northeastern Region	10	6.1
Central Region	4	2.4
Eastern Region	4	2.4
Western Region	21	12.7
Southern Region	1	0.6

Main occupation Before Age 60		
Agriculture	1	0.6
Own business / self-employed	57	34.5
Employee/laborer	12	7.3
Government officer/state enterprise	20	12.1
Homemaker	41	24.8
Unemployed	34	20.6
Current occupation (After Age 60)		
Agriculture	5	3.0
Own business / self-employed	52	31.5
Employee/laborer	13	7.9
Company employee	4	2.4
Government officer/state enterprise	4	2.4
Unemployed	76	46.1
Community volunteer	5	3.0
Tutor / part-time teacher	4	2.4
Average monthly income (THB)		
<10,000	10	6.1
10,001–20,000	27	16.4
20,001–30,000	42	25.5
30,001–40,000	29	17.6
>40,000	57	34.5
Main sources of income		
Employment	38	23.0
Savings	23	13.9
Family support	42	25.5
Investment	5	3.0
Pension	26	15.8
Allowance for the elderly	26	15.8
Other (e.g., insurance, rent, benefits)	5	3.0
Income sufficiency		
Sufficient	128	77.6
Insufficient	37	22.4
Total	165	100.0
Debt status		
In debt	36	21.8
No debt	129	78.2
Total	165	100.0
Health condition		
Normal/healthy	80	48.5
Having chronic diseases	85	51.5
Total	**165**	**100.0**

The measurement model evaluation (Table 7) confirmed satisfactory psychometric quality. Factor loadings ranged from 0.629 to 0.872, exceeding the minimum 0.60 threshold. Internal consistency reliability was confirmed through high composite reliability (0.847-0.973) and Cronbach's alpha (0.811-0.964). Convergent validity was verified through AVE values (0.504-0.680), exceeding the 0.50 criterion. Discriminant validity was assessed using the Fornell-Larcker criterion and HTMT ratios (Table 8), with all HTMT values below 0.85, confirming adequate discriminant validity.

Table 7. Measurement Model Assessment

Latent variable	Number of indicators	Convergent validity			Internal consistency reliability		Multi collinearity
		Factor loading	Indicator reliability range	AVE	Composite reliability	Cronbach's α	VIF
Social Network (SN)	6	0.629 – 0.747	0.396 – 0.549	0.504	0.847	0.811	1.352 – 2.618
Social Support (SS)	12	0.635 – 0.806	0.403 – 0.650	0.529	0.927	0.919	1.834 – 3.081
Social Connectedness (SC)	7	0.747 – 0.872	0.558 – 0.760	0.680	0.928	0.921	1.883 – 3.580
Digital Competency (DC)	25	0.630 – 0.836	0.397 – 0.699	0.532	0.973	0.964	2.296 – 4.996
Loneliness (LN)	6	0.781 – 0.847	0.610 – 0.717	0.532	0.973	0.904	2.004 – 2.936
Mental Health (MH)	19	0.636 – 0.813	0.404 – 0.661	0.542	0.954	0.953	1.893 – 3.253

Note. *Factor loadings = standardized loading coefficients for observed indicators; CR = Composite Reliability (internal consistency measure); α (Cronbach's alpha) = reliability coefficient; AVE = Average Variance Extracted (convergent validity measure); VIF = Variance Inflation Factor (multicollinearity diagnostic). All standardized loadings > 0.60; CR and α > 0.70 confirm internal consistency reliability; AVE > 0.50 supports convergent validity; VIF < 5 indicates no multicollinearity issues.*

Table 8. Discriminant Validity Assessment Using the Fornell–Larcker Criterion and HTMT Ratio

Constructs	DC	LN	MH	SC	SN	SS
Digital Competency (DC)	**0.729**	0.213	0.230	0.225	0.367	0.286
Loneliness (LN)	–0.238	**0.822**	0.724	0.655	0.407	0.471
Mental Health (MH)	–0.246	0.677	**0.736**	0.618	0.476	0.437
Social Connectedness (SC)	–0.246	0.608	0.856	**0.825**	0.523	0.500
Social Network (SN)	0.368	–0.464	–0.430	–0.477	**0.710**	0.737
Social Support (SS)	0.306	0.346	–0.365	–0.474	0.661	**0.727**

Note. *√AVE = square root of Average Variance Extracted (diagonal bold values); HTMT = Heterotrait-Monotrait ratio of correlations; upper triangle values = inter-construct correlations; lower triangle values = HTMT ratios.*

Diagonal values (bold) represent the square roots of the Average Variance Extracted (AVE) according to the Fornell–Larcker criterion.

Off-diagonal values indicate correlations (upper triangle) and HTMT ratios (lower triangle).

All the HTMT values were < 0.85, confirming adequate discriminant validity among the constructs [65].

Structural model analysis (Table 9, Figure 4) revealed that of the four exogenous predictors, only Social Connectedness significantly predicted Loneliness (β = –0.474, t = 6.780, p < 0.001). Social Network size (β = –0.151, p=0.083), Social Support (β = –0.114, p=0.135), and Digital Competency (β = –0.031, p=0.631) were not statistically significant. The Loneliness→Mental Health pathway exhibited a strong positive coefficient (β = 0.677, t=11.767, p<0.001), indicating higher loneliness was directly associated with poorer mental health outcomes [8, 71, 72]. The model explained substantial variance in Loneliness (R^2 = 0.416) and Mental Health (R^2 = 0.459).

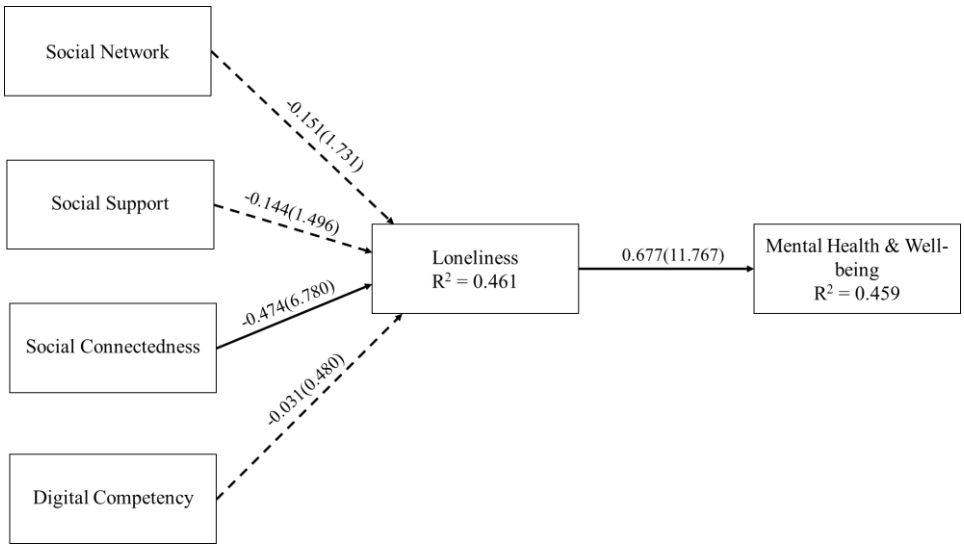
Mediation analysis revealed that only Social Connectedness showed a significant indirect effect on Mental Health via Loneliness (β=0.321, t=5.166, p<0.001), confirming its dual influence—both directly reducing loneliness and indirectly enhancing mental health through emotional connection [73]. These results provided strong empirical support for the theoretical model, consistent with Phase 1 qualitative findings that emphasized emotional reciprocity and belonging as primary mechanisms for alleviating loneliness.

Table 9. Hypothesis Testing and Mediation Effects

Structural relationship	Path coefficient (β)	T value	p value	Decision	R^2	f^2	Q^2 predict
Direct effects							
Social Network → Loneliness	–0.151	1.731	0.083	Not supported	0.416	0.020	0.368
Social Support → Loneliness	–0.114	1.496	0.135	Not supported	0.416	0.012	0.368
Social Connectedness → Loneliness	–0.474	6.780	0.000*	Supported	0.416	0.279	0.368
Digital Competency → Loneliness	–0.031	0.480	0.631	Not supported	0.416	0.001	0.368
Loneliness → Mental Health	0.677	11.767	0.000*	Supported	0.459	0.847	0.322
Mediation effects							
Social Network → Loneliness → Mental Health	–0.102	1.735	0.083	No	–	–	–
Social Support → Loneliness → Mental Health	–0.077	1.447	0.148	No	–	–	–
Social Connectedness → Loneliness → Mental Health	0.321	5.166	0.000*	Yes	–	–	–
Digital Competency → Loneliness → Mental Health	–0.021	0.478	0.633	No	–	–	–

Note. *β = standardized path coefficient (direct effect); t = t-statistic value from bootstrapping procedure (5,000 resamples); p = probability value indicating statistical significance (p < 0.05); R^2 = coefficient of determination (proportion of variance explained); Q^2 = Stone-Geisse's Q^2 (cross-validated redundancy/predictive relevance).*

The model demonstrated moderate predictive power (R^2 > 0.40) and satisfactory cross-validated redundancy (Q^2 > 0).



*Note: Path coefficients (β) represent standardized effects; *** indicates p < 0.001; R² values show proportion of variance explained in endogenous variables (Loneliness and Mental Health).*

Figure 4. Structural equation model of loneliness determinants with standardized path coefficients

4.2. Phase 2: Intervention Results

Eighty-two participants were recruited and assigned to the intervention (n=41) and control (n=41) groups. Baseline demographic information (Table 10) showed that the groups were comparable: most were female (85%), aged 60–69 years (41%), and held at least a bachelor's degree (63%), while 80% were retired or unemployed. Seventy-eight percent reported sufficient income, and 59% described their health as usual or stable.

Table 10. Baseline Characteristics of Participants

Characteristic	Intervention group (n = 41)	Control group (n = 41)
Gender	Female: 35 (85.37%) / Male: 6 (14.63%)	Female: 36 (87.80%) / Male: 5 (12.20%)
Age (years)	60–69: 17 (41.46%) / 70–79: 18 (43.90%) / 80+: 6 (14.63%)	60–69: 18 (43.90%) / 70–79: 17 (41.46%) / 80+: 6 (14.63%)
Education	Bachelor's degree: 26 (63.41%) / Postgraduate: 5 (12.20%) / Lower levels: 10 (24.39%)	Bachelor's degree: 26 (63.41%) / Postgraduate: 4 (9.76%) / Lower levels: 11 (26.83%)
Marital status	Married: 32 (78.05%) / Single or Widowed: 9 (21.95%)	Married: 33 (80.49%) / Single or Widowed: 8 (19.51%)
Family members	2 people: 8 (19.51%) / 3–4 people: 14 (34.15%) / ≥5 people: 6 (14.63%)	2 people: 10 (24.39%) / 3–4 people: 16 (39.02%) / ≥5 people: 9 (21.95%)
Occupation	Working: 8 (19.51%) / Not working: 33 (80.49%)	Working: 9 (21.95%) / Not working: 32 (78.05%)
Income Sufficiency	Sufficient: 32 (78.05%) / Insufficient: 9 (21.95%)	Sufficient: 33 (80.49%) / Insufficient: 8 (19.51%)
Health status	Healthy: 24 (58.54%) / Chronic illness: 17 (41.46%)	Healthy: 25 (60.98%) / Chronic illness: 16 (39.02%)

Results (Table 11) showed that the intervention significantly reduced loneliness in the intervention group. The mean loneliness score fell 17.4% from pretest (M=3.45, SD=0.52) to posttest (M=2.85, SD=0.48; t=-6.72, p<0.001), while the control group showed no significant change between pretest and posttest (M=3.39, SD=0.47, p=0.311). The effect size was medium-to-large (Cohen's d = 0.62). Retention rate was 87.8%. The improvement was clinically significant, with individuals shifting from 'moderate loneliness' to 'low-moderate loneliness' on the UCLA scale.

Table 11. Pre and Posttest Loneliness Scores of the Intervention and Control Groups

Group	n	Pretest mean (SD)	Posttest Mean (SD)	Mean difference	t-value	p-value
Intervention	41	3.45 (0.52)	2.85 (0.48)	–0.60	–6.72	0.000*
Control	41	3.39 (0.47)	3.37 (0.45)	–0.02	–1.02	0.311

Note. *M = Mean score; SD = Standard deviation; t = t-statistic from paired samples t-test; p = probability value (significance level); % reduction = percentage change from pretest to posttest. p < 0.05 indicates statistical significance. A significant reduction in loneliness was observed only in the intervention group, confirming the effectiveness of the online group-based program delivered through the SabuyJai platform.*

Qualitative debriefing validated these findings. Participants felt "heard" and "valued" in their groups. After the program ended, many organized spontaneous group discussions, shared morning greetings, and coordinated online temple visits, demonstrating ongoing behavioral change. One participant stated, "At first I joined because the researchers

asked, but now these friends are part of my daily life" (P-19). Self-organized birthday parties, health check-in groups, and recipe-sharing demonstrated that the intervention fostered lasting social bonds [74-76].

The SabuyJai platform (Figure 5) was designed to integrate five essential components as emotional exchange through chat and voice interaction, reciprocity through group-based challenges, informational support through curated articles, instrumental assistance through activity coordination, and self-expression through personal profiles and badges. Key features included Home Dashboard providing daily activity suggestions and motivational messages incorporating Thai cultural idioms, Group Chat and Sharing Wall allowing real-time communication, Activity Hub hosting interactive sessions such as "Morning Greeting," "Memory Lane," and "Kindness Exchange," and Learning Zone offering digital literacy tutorials, and Health and Mood Tracker using Thai emotional vocabulary.

Figure 5. Prototype mockups and core features of the SabuyJai platform

User feedback indicated high levels of satisfaction across ease of use, emotional fulfilment, and trust. Participants particularly valued the simplicity, warmth of social interaction, and culturally familiar elements—Thai idioms, soft color palettes, and symbols of kindness. One participant stated: "This doesn't feel like a computer program—it feels like visiting friends at the temple" (P-37). The platform's success stemmed from cultural resonance—making digital interaction feel emotionally safe and socially meaningful.

4.3. Phase 3: Technology Acceptance and Commercial Viability

Forty-one participants evaluated the SabuyJai platform (Table 12). Most were female (85.4%), aged 65-69 years (41.5%), held at least a bachelor's degree (63.4%), and reported sufficient income (78.0%). The extended TAM evaluation (Figure 6) revealed strong acceptance across all the dimensions of Perceived Usefulness (M=4.35, SD=0.43), Ease of Use (M=4.33, SD=0.45), Trust (M=4.21, SD=0.50), Enjoyment (M=4.27, SD=0.48), and Behavioral Intention (M=4.30, SD=0.44). These scores substantially exceeded typical acceptance thresholds (3.5-4.0) for elderly app adoption [74, 77], likely due to the Thai-language interface, familiar visual metaphors, culturally relevant motivating messages, and collaborative development with senior feedback.

Table 12. Demographic Characteristics of the Participants (n = 41)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	6	14.6
	Female	35	85.4
Age (years)	60–64	13	31.7
	65–69	17	41.5
	70–74	7	17.1
	75–79	2	4.9
	≥ 80	2	4.9
Education level	Secondary	3	7.3
	Vocational/High School	7	17.1
	Bachelor's degree	26	63.4
	Postgraduate	5	12.2
Marital status	Single	6	14.6
	Married	15	36.6
	Widowed/Divorced	20	48.8
Family composition	Living alone	13	31.7
	2 people	8	19.5
	3–4 people	14	34.1
	≥ 5 people	6	14.6
Income sufficiency	Sufficient	32	78.0
	Insufficient	9	22.0
Health status	Healthy/Normal	24	58.5
	Having chronic conditions	17	41.5
	Total	**41**	**100.0**

Note. *Most participants were female, aged 60–69 years, held a bachelor's degree or higher, and reported having a sufficient income and a moderate level of health. These demographic characteristics represented typical elderly users of digital wellness applications in the Thai context.*

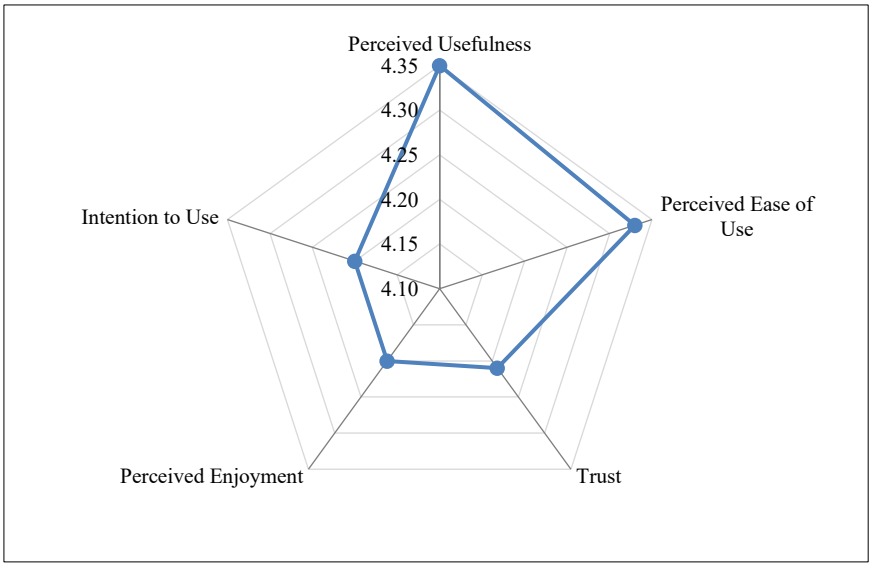


Figure 6. Radar chart of TAM dimensions (PU = Perceived Usefulness; PEOU = Perceived Ease of Use; PE = Perceived Enjoyment; TR = Trust; ATU = Attitude Toward Use; BI = Behavioral Intention to Use; values represent M = Mean score on a 5-point Likert scale; error bars represent SD = Standard deviation).

SWOT analysis (Table 13) identified core strengths, including cultural fit, inclusive design, and a trust-based community model, while weaknesses centered on digital training needs and localized support. Opportunities included partnerships with healthcare institutions and local governments, while threats related to limited digital infrastructure in rural areas. Financial projections (Figure 7) indicated positive feasibility, with profitability expected within the first operational year. By Year 5, net profit was forecasted to exceed 16 million THB, supported by scalable B2B and B2G partnerships in preventive health and elder care sectors. These results confirmed SabuyJai's potential as both a socially impactful intervention and a commercially sustainable product.

Table 13. SWOT Highlights and Financial Projections of the SabuyJai Platform

Component	Key findings	Strategic implications
Strengths	Evidence-based design; cultural fit with Thai elderly; strong trust and usability ratings; preventive health positioning	Leverage in branding and policy partnerships
Weaknesses	Limited digital literacy among some elderly, prototype stage, resource constraints	Integrate digital literacy training; phased rollout with pilot sites
Opportunities	Expanding aged population; government digital health agenda; CSR and B2G collaboration potential	Partnerships with hospitals, municipalities, and corporate sponsors
Threats	Competition from generic social apps, policy shifts, cybersecurity risks	Emphasize trust, safety, and healthcare credibility in promotions
Target market	Elderly aged 60+, urban and semi-urban communities; healthcare institutions; senior clubs	Prioritize community-based adoption and partnerships
Marketing mix (4Ps)	Product: Social-health digital platform (SabuyJai) Price: Affordable subscription / B2B-B2G contracts Place: Hospitals, senior centers, online distribution Promotion: Trust/safety branding; engagement campaigns	Reinforce market differentiation and accessibility
Operations roadmap	Lean organizational structure; scalable PWA platform; community outreach via elderly clubs and health volunteers	Support long-term sustainability and scalability

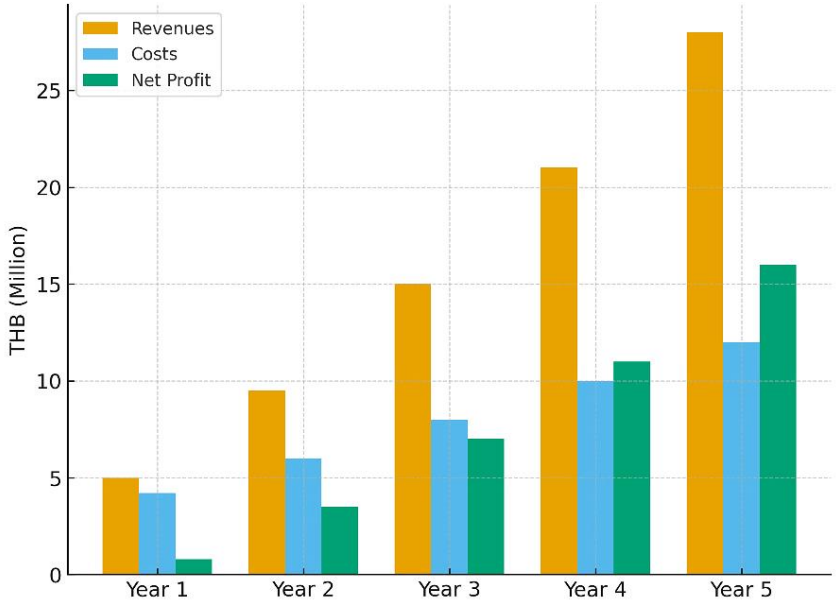


Figure 7. Five-year financial projection and growth curve

5. Discussion

5.1. Interpretation of Key Findings

This study examined the psychosocial and technological determinants of loneliness among older adults in Thailand using a three-phase mixed-methods design. Findings reinforced the centrality of social connectedness as the pivotal construct linking social, emotional, and digital dimensions of elderly well-being. Consistent with Social Support Theory [16] and Social Exchange Theory [23], the results highlighted that reciprocity—the capacity to both give and receive support—was more influential than frequency or volume of interactions in mitigating loneliness [78, 79]. The structural equation model confirmed that meaningful, reciprocal relationships significantly reduced loneliness ($\beta = –0.474$, $p < .001$), which, in turn, strongly predicted improved mental health ($\beta = 0.677$, $p < .001$) [80, 81]. These empirical findings extended Social Connectedness Theory [19], highlighting that quality and emotional depth of relationships, rather than network size, are crucial for protecting psychological well-being.

The nonsignificant effects of network size and social support suggested that unidirectional help may inadvertently reinforce dependency, consistent with Social Exchange Theory's emphasis on reciprocity as a basis for relational balance and self-worth in later life [23]. A significant contribution of this research lies in integrating digital competency into the psychosocial framework of loneliness. Digital literacy did not directly predict loneliness, but qualitative findings and user feedback from the SabuyJai platform revealed that technology served as a powerful enabler when designed to foster human connection. This finding aligned with recent digital aging studies [82, 83], suggesting that technology mitigates loneliness only when it enhances social meaning rather than merely facilitating communication. The high ratings for perceived usefulness (M = 4.35) and ease of use (M = 4.33) from the Technology Acceptance Model (TAM) evaluation demonstrated that older adults successfully adopt digital platforms when interfaces are intuitive and culturally relevant. The observed role of trust and enjoyment extended classical TAM frameworks [22] by introducing emotional and relational dimensions that are particularly salient in elderly populations.

The findings contribute to the global discourse on active and healthy aging by presenting a culturally adapted model that integrates social theory and digital innovation. In collectivist societies, such as Thailand, where harmony, respect, and interdependence are deeply ingrained cultural values, interventions that emphasize reciprocity and shared emotional experiences resonate more strongly than those focused solely on technical training or material support. The SabuyJai model thus represents an advancement in the localization of digital health innovation—bridging psychosocial theory with human-centered design to promote emotional well-being, community belonging, and digital inclusion among older adults.

5.2. Theoretical Implications

Four significant theoretical refinements emerged from the results. First, Social Support Theory [16] was extended by shifting the focus from received support to reciprocal support. The perceived reciprocity of social interactions—being both a giver and receiver of care—was more critical in alleviating loneliness. This refinement recognized that one-way support can inadvertently reinforce dependency and diminish self-worth, particularly in collectivist cultures where self-reliance and dignity remain valued aspects of aging. Thus, the model reconceptualized social support as a bidirectional relational exchange, in which balanced emotional contribution fosters empowerment and a sense of belonging.

Second, the findings extended Social Exchange Theory [23] by empirically validating that reciprocity serves as a psychological mechanism linking social connectedness to well-being. Older adults who reported mutual interaction and emotional reciprocity exhibited significantly lower levels of loneliness and higher mental health scores, supporting the principle that perceived fairness and mutual benefit sustain long-term relationships and emotional equilibrium. The framework moved beyond transactional interpretations of exchange toward an affective-exchange model—one grounded in empathy, gratitude, and shared experience as the 'emotional currency' that sustains meaningful bonds in later life.

Third, consistent with Social Connectedness Theory [19], the results reinforced the notion that the quality of relationships—characterized by trust, emotional intimacy, and mutual recognition—holds primacy over the quantity of social ties. The empirical evidence ($\beta = -0.474$, $p < .001$) underscored that meaningful connection exerts a more substantial influence on loneliness than network size or structural factors such as frequency of contact. The framework, therefore, distinguished between structural connectedness (network access) and functional connectedness (emotional depth).

Fourth, the extended TAM incorporated affective and cultural dimensions into the study of technology adoption among older adults. Traditional TAM assumes a rational evaluation of functionality; however, this study found that emotional resonance—such as enjoyment and trust—also plays an equally decisive role in shaping behavioral intention. The design of the SabuyJai platform, rooted in familiarity, simplicity, and cultural relevance, demonstrated that trust-based emotional experiences can enhance both usability and sustained engagement. This enriched TAM by introducing affective trust and perceived belonging as key determinants of technology acceptance in elderly populations. This study combined these theories into an Integrated Model of Digital Social Well-being, explicitly defining TAM characteristics as supporting factors that enable social connectivity through digital platforms.

5.3. Practical Implications

At the community level, the results emphasized the need to reorient elderly support programs from service delivery to social empowerment. Rather than treating older adults as passive recipients of care, community centers, subdistrict administrative organizations (SAOs), and senior clubs should promote reciprocal participation, allowing elderly members to contribute skills, advice, or peer support in exchange for social engagement. Examples include 'Mutual Learning Circles' or 'Elder-to-Elder Buddy Systems', where participants share life experiences, digital skills, or caregiving tips. These initiatives operationalize Social Exchange Theory by strengthening dignity, agency, and mutual respect. Integrating digital engagement into local wellness programs—such as hybrid social activities via LINE or Facebook Live—can increase participation among homebound seniors [84].

For digital designers and technology developers, this study highlights the importance of human-centered and culturally responsive design. The SabuyJai prototype demonstrated that elderly users prioritize trust, simplicity, emotional warmth, and social purpose over advanced technical functions. Therefore, developers should embed socially interactive features and positive emotional cues that reinforce a sense of belonging and comfort. Incorporating reciprocity-driven interfaces—such as feedback badges ('I listened today,' 'I supported a friend')—can transform digital tools into spaces for emotional exchange. Providing adaptive digital literacy tutorials within the platform reduces anxiety and enhances Perceived Ease of Use and Trust.

At the policy level, the study contributes to Thailand's National Aging Plan (2023–2037) and supports the government's 'Digital Society for All' agenda. Policymakers should integrate digital social health into national aging strategies by funding interventions that combine psychosocial care with digital inclusion. Specific policy integration mechanisms include (1) establishing loneliness screening protocols within primary care geriatric assessments, with positive screens triggering referrals to SabuyJai or equivalent digital social interventions, (2) developing reimbursement frameworks where health insurance or government programs cover platform subscription costs as preventive mental health services, (3) creating cross-ministerial task forces linking the Ministry of Public Health, Ministry of Digital Economy and Society, and the Department of Older Persons to coordinate integrated implementation, and (4) mandating that new elderly care facilities and community centers provide device access and internet connectivity as basic infrastructure requirements.

5.4. Study Limitations and Future Research Directions

Several limitations are acknowledged to contextualize the findings and guide future investigations. First, this study was conducted among older adults in semi-urban and urban areas of central Thailand, providing rich cultural and social diversity. However, the findings may not be fully generalizable to rural or highland elderly populations with different cultural norms, family structures, or levels of digital access. Future research should expand sampling across regional and cross-cultural contexts.

Second, while valid instruments and rigorous mixed-methods methodology were used, the inability to prove causation between social connectivity and mental health remains a significant issue. In Phase 2, cross-sectional structural equation modeling created statistical connections but could not determine temporal precedence. The quasi-experimental intervention demonstrated a reduction in loneliness over eight weeks. However, causal inference remained limited due to the lack of random assignment, selection bias, and the absence of active control conditions. Future research should employ randomized controlled trials with more extended follow-up periods, multiple assessment waves, and mediation analyses.

Third, the eight-week intervention period was sufficient to detect significant reductions in loneliness but may not capture broader psychosocial or physiological benefits, such as stress reduction, improved sleep quality, or enhanced cognitive resilience. Extending the program duration and incorporating multi-component interventions would provide a more holistic assessment. Fourth, the pilot-scale implementation limited the scalability of the conclusions, but broader deployment, including subjects with sensory or cognitive impairments, is needed.

Fifth, the study focused on positive outcomes without validated negative outcome measures. Future research should assess potential harms, including relationship displacement, technology-related stress, and time displacement effects. Finally, integrating complementary frameworks such as Socioemotional Selectivity Theory [85] and Self-Determination Theory [86] would yield a more comprehensive understanding of digital social well-being and its cross-disciplinary applications.

6. Conclusions

This study advanced the understanding of loneliness, social connectedness, and digital well-being among older adults by integrating psychosocial theory, empirical analysis, and technological innovation within a unified research framework. Three sequential phases—requirement analysis, design and development, and implementation and evaluation—identified meaningful social connectedness as the most influential determinant of loneliness reduction and mental health improvement in the Thai aging population.

The findings revealed that network size and material support provided structural resources, but reciprocity, empathy, and emotional intimacy within relationships determined psychological resilience. The development and validation of the SabuyJai platform translated these insights into a practical intervention that effectively combined social participation, emotional exchange, and digital accessibility. The platform demonstrated strong user acceptance and commercial viability, confirming that elderly individuals can embrace technology when it is designed with trust, simplicity, and cultural resonance.

Theoretically, this study extended classical frameworks—Social Support Theory, Social Exchange Theory, Social Connectedness Theory, and the Technology Acceptance Model (TAM)—by integrating emotional reciprocity and digital inclusion into a cohesive model of Digital Social Well-being, establishing a replicable foundation for digital interventions that can promote healthy aging through technology-mediated community engagement.

Addressing loneliness in later life requires a connection with meaning that cannot be provided by infrastructure or access alone. The SabuyJai initiative exemplifies how human-centered design grounded in social theory can transform digital tools into vehicles of compassion, dignity, and empowerment. This study merged social innovation with digital transformation and developed a scalable model to promote inclusive, connected, and emotionally enriched aging, thereby contributing to both academic knowledge and the future of socially sustainable digital health in Thailand and beyond.

7. Declarations

7.1. Author Contributions

Conceptualization, W.P., N.N., T.P., and T.P.; methodology, W.P., N.N., T.P., and T.P.; software, W.P. and T.P.; validation, W.P., N.N., T.P.; formal analysis, W.P. and T.P.; investigation, W.P. and T.P.; resources, W.P., N.N., and T.P.; data curation, W.P., N.N., T.P., and T.P.; writing—original draft preparation, W.P. and T.P.; writing—review and editing, W.P. and T.P; visualization, W.P. and T.P.; supervision, W.P., N.N., T.P., and T.P.; project administration, W.P., N.N., and T.P.; funding acquisition, W.P. All the authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Institutional Review Board Statement

This study was approved by the Chulalongkorn University's Research Ethics Review System for Research Involving Human Participants (COA No. 246/67), through the Institutional Review Board Committee Group 2 for Social Sciences, Humanities, and Fine Arts.

7.5. Informed Consent Statement

Before participation, all the subjects were informed about the study's purpose and methodology, and their rights as participants, with informed consent obtained. The questionnaire included an explicit confirmation of voluntary participation. The participants were informed of their right to withdraw from the study at any time and assured that their data would remain confidential.

7.6. Declaration of Competing Interest

The authors declare that there are no conflicts of interest concerning the publication of this manuscript. Furthermore, all ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

8. References

[1] TGRI. (2021). The situation of Thai elderly in 2021. Foundation of Thai Gerontology Research and Development Institute (TGRI), Bangkok, Thailand. Available online: https://thaitgri.org/?p=40101 (accessed on January 2026).

[2] NSO. (2022). The 2022 Household Survey on the Use of Information and Communication Technology (Quarter 3). National Statistical Office, Ministry of Digital Economy and Society, Bangkok, Thailand. Available online: https://www.nso.go.th/nsoweb/storage/survey_detail/2023/20230430131327_66165.pdf (accessed on January 2026).

[3] United Nations. (2023). Leaving No One Behind in an Ageing World. United Nations, New York, United States. Available online: https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2023/01/2023wsr-chapter1-.pdf (accessed on January 2026).

[4] NSO. (2024). Statistical Yearbook of Thailand 2024. National Statistical Office, Ministry of Digital Economy and Society, Bangkok, Thailand. Available online: https://www.nso.go.th/public/e-book/Statistical-Yearbook/SYB-2024/index.html (accessed on January 2026).

[5] NESDC (2019). Population and Development for a Sustainable Future in Thailand: 25 Years after the ICPD. National Economic and Social Development Council (NESDC), Bangkok, Thailand.

[6] Euromonitor. (2020). Half the World's New Single Person Households to Emerge in Asia Pacific. Euromonitor International, London, United Kingdom Available online: https://www.euromonitor.com/article/half-the-worlds-new-single-person-households-to-emerge-in-asia-pacific (accessed on January 2026).

[7] Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. Perspectives on Psychological Science, 10(2), 227–237. doi:10.1177/1745691614568352.

[8] Valtorta, N. K., Kanaan, M., Gilbody, S., Ronzi, S., & Hanratty, B. (2016). Loneliness and social isolation as risk factors for coronary heart disease and stroke: Systematic review and meta-analysis of longitudinal observational studies. Heart, 102(13), 1009–1016. doi:10.1136/heartjnl-2015-308790.

[9] Department of Mental Health. (2022). Revealing statistics on depression and Thai society: The silent emotional threat of the modern era. Ministry of Public Health, Bangkok, Thailand. Available online: https://dmh.go.th/news-dmh/view.asp?id=31459 (accessed on January 2026).

[10] Department of Mental Health. (2026). Report on the suicide situation in Thailand, fiscal year. Ministry of Public Health, Bangkok, Thailand. Available online: https://suicide.dmh.go.th/news/view.asp?id=92 (accessed on February 2026).

[11] Thailand Development Research Institute. (2018). Is the future of Thailand's health care in danger? Thailand Development Research Institute, Bangkok, Thailand. Available online: https://tdri.or.th/en/2018/03/future-thailands-health-care-danger (accessed on February 2026).

[12] ETDA. (2024). Thailand Internet User Behavior 2023. Electronic Transactions Development Agency (ETDA), Ministry of Digital Economy and Society, Bangkok, Thailand.

[13] Tipayalai, K., Chittavimongkhon, N., & Sattayanurak, P. (2025). Not over the hill: Exploring the digital divide among vulnerable older adults in Thailand (PIER Discussion Paper No. 234). Puey Ungphakorn Institute for Economic Research, Bangkok, Thailand.

[14] Chen, Y. R. R., & Schulz, P. J. (2016). The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review. Journal of Medical Internet Research, 18(1), 18. doi:10.2196/jmir.4596.

[15] Findlay, R. A. (2003). Interventions to reduce social isolation amongst older people: Where is the evidence? Ageing and Society, 23(5), 647–658. doi:10.1017/S0144686X03001296.

[16] Deutsch, S., & House, J. S. (1983). Work Stress and Social Support. Contemporary Sociology. Addison-Wesley, Boston, United States. doi:10.2307/2069001.

[17] Krause, N., & Markides, K. (1990). Measuring social support among older adults. International Journal of Aging and Human Development, 30(1), 37–53. doi:10.2190/CY26-XCKW-WY1V-VGK3.

[18] Hays, J. C. (2012). Social Networks and Social Support Encyclopedia of Health & Aging. Wiley, New Jersey, United States. doi:10.4135/9781412956208.n206.

[19] Lee, R. M., & Robbins, S. B. (1995). Measuring Belongingness: The Social Connectedness and the Social Assurance Scales. Journal of Counseling Psychology, 42(2), 232–241. doi:10.1037/0022-0167.42.2.232.

[20] Holt-Lunstad, J. (2021). The Major Health Implications of Social Connection. Current Directions in Psychological Science, 30(3), 251–259. doi:10.1177/0963721421999630.

[21] Mitchell, J. C. (1969). Social networks in urban situations: analyses of personal relationships in Central African towns. Manchester University Press, Manchester, United Kingdom.

[22] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly: Management Information Systems, 13(3), 319–339. doi:10.2307/249008.

[23] Homans, G. C. (1958). Social Behavior as Exchange. American Journal of Sociology, 63(6), 597–606. doi:10.1086/222355.

[24] Akhter-Khan, S. C., Aein, N. M. P., Wongfu, C., Prina, M., Wai, K. M., Mayston, R., & Suwannaporn, S. (2023). Social relationship expectations, care, and loneliness in later life: Perspectives from Thai and Myanmar adults in northern Thailand. SSM - Mental Health, 4, 100279. doi:10.1016/j.ssmmh.2023.100279.

[25] W.H.O. (2020). Decade of healthy ageing: baseline report. World Health Organization, Geneva, Switzerland. Available online: https://www.who.int/publications/i/item/9789240017900 (accessed on February 2026).

[26] Chan, A., Malhotra, R., Visaria, A., Sung, P., Ching, B. J. S. S., & Wen, T. Y. (2020). Transitions in health, employment, social engagement and intergenerational transfers in Singapore Study (THE SIGNS Study) – II: Cross-sectional and longitudinal analyses of key aspects of successful ageing. Centre for Ageing Research and Education, Singapore.

[27] Phiaaia, P., & Panpakdee, C. (2025). Factors influencing internet usage preferences of tribal farmers in Northern Thailand. Telecommunications Policy, 103036. doi:10.1016/j.telpol.2025.103036.

[28] Mushtaq, R., Shoib, S., Shah, T., & Mushtaq, S. (2014). Relationship between loneliness, Psychiatric disorders and physical health ? A review on the psychological aspects of loneliness. Journal of Clinical and Diagnostic Research, 8(9), WE01–WE04. doi:10.7860/JCDR/2014/10077.4828.

[29] Poonsiri, N., Laohasiriwong, W., Puttanapong, N., & Mahato, R. K. (2024). Spatial Association between Socioeconomic Factors, Physical Geographic Factors, and Suicide in Thailand. The Open Public Health Journal, 16(1), 18749445281992. doi:10.2174/0118749445281992231205072631.

[30] Sriwisathiyakun, K., & Dhamanitayakul, C. (2022). Enhancing digital literacy with an intelligent conversational agent for senior citizens in Thailand. Education and Information Technologies, 27(5), 6251–6271. doi:10.1007/s10639-021-10862-z.

[31] Kassai, R., Van Weel, C., Flegg, K., Tong, S. F., Han, T. M., Noknoy, S., Dashtseren, M., Le An, P., Ng, C. J., Khoo, E. M., Noh, K. M., Lee, M. C., Howe, A., & Goodyear-Smith, F. (2020). Priorities for primary health care policy implementation: Recommendations from the combined experience of six countries in the Asia-Pacific. Australian Journal of Primary Health, 26(5), 351–357. doi:10.1071/PY19194.

[32] Cattan, M., White, M., Bond, J., & Learmouth, A. (2005). Preventing social isolation and loneliness among older people: A systematic review of health promotion interventions. Ageing and Society, 25(1), 41–67. doi:10.1017/S0144686X04002594.

[33] Masi, C. M., Chen, H. Y., Hawkley, L. C., & Cacioppo, J. T. (2011). A meta-analysis of interventions to reduce loneliness. Personality and Social Psychology Review, 15(3), 219–266. doi:10.1177/1088868310377394.

[34] Yang, S. Y., Yang, C. C., Lee, Y. C., Hsieh, P. L., & Lin, Y. L. (2023). Investigating the effectiveness of online interactive courses on loneliness and quality of life of older adults in the community during the COVID-19 pandemic: A pilot study and a randomized controlled trial. Geriatrics and Gerontology International, 23(2), 91–97. doi:10.1111/ggi.14526.

[35] Li, Y., Shiyanov, I., & Muschalla, B. (2024). Older Adults' Acceptance of a Virtual Reality Group Intervention in Nursing Homes: Pre-Post Study Under Naturalistic Conditions. JMIR Human Factors, 11, 56278. doi:10.2196/56278.

[36] Theeke, L. A., & Mallow, J. A. (2015). The Development of LISTEN: A Novel Intervention for Loneliness. Open Journal of Nursing, 5(2), 136–143. doi:10.4236/ojn.2015.52016.

[37] Gardiner, C., Geldenhuys, G., & Gott, M. (2018). Interventions to reduce social isolation and loneliness among older people: an integrative review. Health and Social Care in the Community, 26(2), 147–157. doi:10.1111/hsc.12367.

[38] Boyle, P. A., Barnes, L. L., Buchman, A. S., & Bennett, D. A. (2009). Purpose in life is associated with mortality among community-dwelling older persons. Psychosomatic Medicine, 71(5), 574–579. doi:10.1097/PSY.0b013e3181a5a7c0.

[39] Frankl, V. E. (1984). Man's Search for Meaning: An Introduction to Logotherapy. Simon & Schuster, New York, United States.

[40] Treerutkuarkul, A. (2008). Thailand's unsung heroes. Bulletin of the World Health Organization, 86(1), 5–6. doi:10.2471/BLT.08.010108.

[41] Langgapin, S., Boonchieng, W., Chautrakarn, S., Maneeton, N., & Senawan, S. (2024). Development of a Monk-Led Elderly Mental Health Counseling Program in Thai Buddhist Communities. Religions, 15(8), 998. doi:10.3390/rel15080998.

[42] United Nations. (2022). Measuring digital development: Facts and figures 2022. International Telecommunication Union, Geneva, Switzerland. Available online: https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx (accessed on Feb 2026)

[43] Ferrari, A. (2012). Digital competence in practice: An analysis of frameworks (EUR 25351 EN). Publications Office of the European Union, Luxembourg. doi:10.2791/82116. doi:10.2791/82116.

[44] European Union. (2019). Key competences for lifelong learning. Publications Office of the European Union, Luxembourg. doi:10.2766/569540.

[45] Chanyawudhiwan, G., & Mingsiritham, K. (2022). An Analysis of Elderly Use of Digital Technology in Thailand. International Journal of Interactive Mobile Technologies, 16(7), 173–181. doi:10.3991/ijim.v16i07.28755.

[46] Mozilla. (2024). Mobile web development. Mozilla, United States. Available online: https://developer.mozilla.org/en-US/docs/Web/Guide/Mobile (accessed on February 2026).

[47] Valacich, J. S., George, J. F., & Hoffer, J. A. (2017). Modern systems analysis and design. Pearson Education, London, United Kingdom.

[48] Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and tam in online shopping: AN integrated model. MIS Quarterly: Management Information Systems, 27(1), 51–90. doi:10.2307/30036519.

[49] Van Der Heijden, H. (2004). User acceptance of hedonic information systems. MIS Quarterly: Management Information Systems, 28(4), 695–704. doi:10.2307/25148660.

[50] Richey, R. C., & Klein, J. D. (2014). Design and Developtnent Research: Methods, Strategies, and Issues. In Design and Developtnent Research: Methods, Strategies, and Issues. Routledge, New Jersey, United States. doi:10.4324/9780203826034.

[51] Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory. Sage Publications, New Jersey, United States.

[52] Rovinelli, R. J., & Hambleton, R. K. (1977). On the Use of Content Specialists in the Assessment of Criterion-Referenced Test Item Validity. Dutch Journal of Educational Research, 2(49–60), 49–60.

[53] Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. Qualitative Health Research, 15(9), 1277–1288. doi:10.1177/1049732305276687.

[54] Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate data analysis. Pearson, New York, United States.

[55] Kline, R. B. (1998). Principles and Practice of Structural Equation Modeling. The Guilford Press, New York, United States.

[56] Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39(2), 175–191. doi:10.3758/BF03193146.

[57] Lubben, J., Blozik, E., Gillmann, G., Iliffe, S., Von Kruse, W. R., Beck, J. C., & Stuck, A. E. (2006). Performance of an abbreviated version of the lubben social network scale among three European community-dwelling older adult populations. Gerontologist, 46(4), 503–513. doi:10.1093/geront/46.4.503.

[58] Thanakwang, K. (2008). Social Networks and Social Support Influencing Health-Promoting Behaviors among Thai Community-Dwelling Elderly. Pacific Rim International Journal of Nursing Research, 12(4), 243–258.

[59] Wongpakaran, N., Wongpakaran, T., Pinyopornpanish, M., Simcharoen, S., Suradom, C., Varnado, P., & Kuntawong, P. (2020). Development and validation of a 6-item Revised UCLA Loneliness Scale (RULS-6) using Rasch analysis. British Journal of Health Psychology, 25(2), 233–256. doi:10.1111/bjhp.12404.

[60] Oei, T. P. S., Sawang, S., Goh, Y. W., & Mukhtar, F. (2013). Using the Depression Anxiety Stress Scale 21 (DASS-21) across cultures. International Journal of Psychology, 48(6), 1018–1029. doi:10.1080/00207594.2012.755535.

[61] Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Evaluation of Reflective Measurement Models. In Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R. Classroom Companion: Business, 75–90. doi:10.1007/978-3-030-80519-7_4.

[62] Sarstedt, M., Hair, J. F., Pick, M., Liengaard, B. D., Radomir, L., & Ringle, C. M. (2022). Progress in partial least squares structural equation modeling use in marketing research in the last decade. Psychology and Marketing, 39(5), 1035–1064. doi:10.1002/mar.21640.

[63] dos Santos, P. M., & Cirillo, M. Â. (2023). Construction of the average variance extracted index for construct validation in structural equation models with adaptive regressions. Communications in Statistics: Simulation and Computation, 52(4), 1639–1650. doi:10.1080/03610918.2021.1888122.

[64] Asyraf, W. M., & Afthanorhan, B. W. (2013). A comparison of partial least square structural equation modeling (PLS-SEM) and covariance based structural equation modeling (CB-SEM) for confirmatory factor analysis. International Journal of Engineering Science and Innovative Technology, 2(5), 198–205.

[65] Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115–135. doi:10.1007/s11747-014-0403-8.

[66] Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. doi:10.1108/EBR-11-2018-0203.

[67] Cohen, J. (2013). Statistical Power Analysis for the Behavioral Sciences. In Statistical Power Analysis for the Behavioral Sciences. Routledge, New Jersey, United States. doi:10.4324/9780203771587.

[68] Kendall, K. E., & Kendall, J. E. (2011). System Analysis and Design. Pearson Publishing, New Jersey, United States.

[69] Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. Decision Sciences, 39(2), 273–315. doi:10.1111/j.1540-5915.2008.00192.x.

[70] House, J. S. (1987). Social support and social structure. Sociological Forum, 2(1), 135–146. doi:10.1007/BF01107897.

[71] Liu, Y., Wang, Y., Yang, Z., Xu, W., Tian, G., Gao, Y., Zhao, M., Lu, R., & Zhong, Y. (2025). Internet use and life satisfaction among empty nesters in rural areas of Yangzhou: based on propensity score matching and mediating effect model. BMC Geriatrics, 25(1), 128. doi:10.1186/s12877-025-05788-x.

[72] Cacioppo, J. T., & Cacioppo, S. (2018). Loneliness in the Modern Age: An Evolutionary Theory of Loneliness (ETL). Advances in Experimental Social Psychology, 58, 127–197. doi:10.1016/bs.aesp.2018.03.003.

[73] Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. PLoS Medicine, 7(7), 1000316. doi:10.1371/journal.pmed.1000316.

[74] Amouzadeh, E., Dianat, I., Faradmal, J., & Babamiri, M. (2025). Optimizing mobile app design for older adults: systematic review of age-friendly design. Aging Clinical and Experimental Research, 37(1), 248. doi:10.1007/s40520-025-03157-7.

[75] Zhang, C., Mohamad, E., Azlan, A. A., Wu, A., Ma, Y., & Qi, Y. (2025). Social Media and eHealth Literacy among Older Adults: Systematic Literature Review. Journal of Medical Internet Research, 27, 66058. doi:10.2196/66058.

[76] Dunbar, R. I. M. (2016). Do online social media cut through the constraints that limit the size of offline social networks? Royal Society Open Science, 3(1), 150292. doi:10.1098/rsos.150292.

[77] Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly: Management Information Systems, 27(3), 425–478. doi:10.2307/30036540.

[78] Department of Older Persons. (2024). Situation of the Thai older persons 2023. Ministry of Social Development and Human Security, Bangkok, Thailand.

[79] Phuangcharoen, C., & Thayansin, S. (2022). The Loneliness of Older Adults Associated with Various Types of Thai Families. Journal of Population and Social Studies, 30, 207–221. doi:10.25133/JPSSV302022.013.

[80] Perlman, D., & Peplau, L. A. (1984). Loneliness Research: a Survey of Empirical Findings. Preventing the harmful consequences of severe and persistent loneliness, 13–46.

[81] Li, H., & Wang, C. (2021). The Relationships among Structural Social Support, Functional Social Support, and Loneliness in Older Adults: Analysis of Regional Differences Based on a Multigroup Structural Equation Model. Frontiers in Psychology, 12, 732173. doi:10.3389/fpsyg.2021.732173.

[82] Sen, K., Prybutok, G., & Prybutok, V. (2022). The use of digital technology for social wellbeing reduces social isolation in older adults: A systematic review. SSM - Population Health, 17, 101020. doi:10.1016/j.ssmph.2021.101020.

[83] Gunnes, M., Løe, I. C., & Kalseth, J. (2024). Exploring the impact of information and communication technologies on loneliness and social isolation in community-dwelling older adults: a scoping review of reviews. BMC Geriatrics, 24(1), 215. doi:10.1186/s12877-024-04837-1.

[84] W.H.O. (2019). Health data overview for the Kingdom of Thailand. World Health Organization, Geneva, Switzerland. Available online: https://data.who.int/countries/764 (accessed on February 2026).

[85] Carstensen, L. L. (2021). Socioemotional Selectivity Theory: The Role of Perceived Endings in Human Motivation. Gerontologist, 61(8), 1188–1196. doi:10.1093/geront/gnab116.

[86] Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), 68–78. doi:10.1037/0003-066X.55.1.68.