Inclusive Digital Health Platform for Well-Being and Loneliness in SOGIESC Older Adults

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***Abstract*—This research and development (R&D) project aims to design, test, and enhance a digital platform for assessing and promoting the health of late middle-aged and older adults who are diverse in sexual orientations, gender identities, gender expressions, and sex characteristics (SOGIESC). It displays people's opinions regarding a personal health reporting system that would make diverse SOGIESC late middle-aged and older adults (aged 50 years and above) feel better and less alone. Mental health, bodily health, social health, and intellectual or spiritual health are the four pillars of the holistic health framework around which the initiative is built. "Loneliness" is a significant factor that impacts elderly people's quality of life. The platform's user-centered design creates a secure, friendly, and inclusive online environment for individuals of all gender identities. The study employs a mixed-methods approach, which means that it deliberately blends quantitative and qualitative research techniques. The platform's structure and features were improved during the development process with the use of quantitative data from health evaluations and system usage statistics. Simultaneously, qualitative data was gathered through user behavior observation, prototype usability testing, and detailed opinion recording in order to examine user experiences in terms of comprehension and usage, design and user experience, system performance, and perceived value and advantages. According to the research findings, the platform can help diverse SOGIESC late middle-aged and older adults feel more socially connected, encourage self-evaluation, and raise health awareness. However, system complexity, early usage difficulty, system stability, and the requirement to create data and result presentations appropriate for the learning context and technological proficiency of the elderly were also identified as limits. With an average score of 4.10 and a standard deviation of 0.88, the overall satisfaction and suggestions showed that customers gave their level of satisfaction a high rating. According to this study, the creation of a digital health platform for senior citizens with a range of sexual orientations should give priority to straightforward, fair, and reliable designs that may produce definite experiential value in order to encourage consistent and long-term use. By providing policy and practical guidance for creating digital tools that effectively fulfill the needs of vulnerable older people in modern society, this research adds to the body of knowledge in comprehensive health technology research and development.**

***Keywords*—Digital health platform; friendly space; well-being and loneliness; LGBTQ; older adults**

I. Introduction

The number of older adults with diverse sexual orientations, gender identities, gender expressions, and sex characteristics (SOGIESC) is anticipated to increase due to demographic shifts and increased opportunities to disclose their identities following the country's same-sex marriage law, which was passed on June 18, 2024, given that nearly 20% of Thailand's population is 60 years of age or older [1]. A study on the relationships, mental health, and sexual health of older persons who are sexually and gender diverse in Thailand was carried out by Thammasat University's Faculty of Learning Sciences and Education between October 2023 and March 2024. In-depth interviews were used to collect qualitative data for the study, and surveys were used to collect quantitative data. The study's primary conclusions are as follows: 1) One in three middle-aged and older adults (aged 50 and above) with diverse SOGIESC lives alone, and what they desire most is a supportive circle of friends. 2) Most older adults aged 60 years and above with diverse SOGIESC still need to work, with many relying on employment as their primary source of income. Approximately one in three reported earning an income below or close to the national poverty line. 3) Many middle-aged and older adults with diverse SOGIESC still lack access to social networks and specialized knowledge related to sexual and gender diversity [2].

Given the circumstances, it is crucial to create friendly spaces for middle-aged and older adults with diverse SOGIESC. To connect the efforts of individuals, groups, or organizations working with the elderly and sexual minorities, there is a notion to construct a system that would provide friendly spaces that are communities for middle-aged and older adults with diverse SOGIESC. This seeks to give Thai society's sexually and gender diverse older adults a supportive community, access to mental health services, and the opportunity to build the connections, knowledge, and abilities needed for overall well-being. For middle-aged and older adults with diverse SOGIESC, a digital health platform has been developed and will be linked to the GenDHL website. This approach allows users to evaluate their physical, mental, social, and intellectual/spiritual well-being via a questionnaire. Individual evaluation results, including descriptions, recommendations, and the degree of well-being, will be provided after the assessment is complete.

II. Related Works

A. Main Concept: Creating a Friendly and Easy-to Understand Experience for the Elderly

The Digital Health Platform for Well-being, an online platform that explores loneliness and well-being among older adults with diverse SOGIESC, was created with the goal of providing a welcoming online environment where older adults with diverse SOGIESC can access services for self-care and health evaluation, including mental, social, spiritual, and physical health. The system analyzes reports on every facet and provides explanations and recommendations for additional growth in different areas, empowering older adults with diverse

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SOGIESC to take care of themselves, recognize their own value, and cultivate positive relationships with others. Additionally, it uses the established platform to establish an online network of older adults with diverse SOGIESC.

The fundamental design tenets of this system are “simplicity" and “intuitiveness" to guarantee that people are not perplexed or uneasy when using technology [3]. Rather than merely serving as an assessment tool, the system is intended to be like “a friend who listens and gives advice".

B. User Experience Design (UX)

This system's user experience design mainly follows the principles of user-centered design, which emphasize problem-solving from the viewpoint of the user [4]. The goal is to provide users, especially older people with a variety of gender identities—with a welcoming and simple experience. To lessen cognitive load and avoid misunderstanding, Progressive Disclosure is used to convey information and functionality step-by-step in a methodical manner. For example, survey questions are displayed one at a time. Additionally, to prevent users from becoming lost during the usage process, responsive guidance provides clear, succinct explanations at each stage. Design takes into account the following important factors:

1) User-Centered Design (UCD): The User-Centered Design (UCD) approach, which stresses methodically comprehending the wants, experiences, and limits of the target group from the very beginning of development, is followed in the design of this platform [5]. The design method involves testing prototypes to determine usability and convenience as well as gathering qualitative data through in-depth interviews to investigate the expectations, worries, and technology usage experiences of older people with a range of sexual orientations. Testing is also used to compare performance in terms of comprehension and task completion time for certain UI components, like the arrangement of “Next" or “Back" buttons, the location of instructions, and the format of score displays. By analyzing data from these procedures, usability barriers are decreased, and the user interface is improved to better reflect the target group's real habits.

2) Progressive disclosure: The platform's architecture was based on the Progressive Disclosure principle, a user experience concept that attempts to reduce cognitive load by giving information or services in segments rather than all at once. On the evaluation site, for example, users will see one question at a time with clear control options like “Next" and "Back," instead of all the questions on one page. This approach reduces confusion, enhances focus while responding to inquiries, and allows for gradual progress, particularly for elderly people who may not be as tech-savvy. Additionally, because of its architecture, the system can provide additional explanations at specific periods without packing the screen.

3) Responsive guidance: Contextual advice has been incorporated into each screen of the system to aid in user decision-making and lessen usage uncertainty. For instance, showing brief instructions like “Press the 'Next' button to continue" or “Choose the answer that best fits you". These suggestions are meant to be unobtrusive and only show up when required. In addition to increasing the assessment's completion rate and lowering the risk of drop-off rates, this design gives people with little experience with technology confidence.

4) Receiving feedback and creating a positive atmosphere: To promote a positive attitude among the target demographic utilizing the system, a message offering recommendations and practical suggestions will be shown once the user has finished the assessment. The system will provide the results of the evaluation together with motivational statements and practical recommendations relevant to the assessment level. In order to keep users from feeling stigmatized or evaluated by the outcomes, this section is structured according to the positive reinforcement principle. The suggestion messages are written in straightforward, courteous language that demonstrates an awareness of the situation of senior citizens with a range of sexual orientations. This strategy is essential for encouraging recurring use and sustained platform acceptance.

5) Design for accessibility: Using the WCAG (Web Content Accessibility Guidelines) as a reference, the design will take into account senior citizens with visual problems. This involves assuring screen reader compatibility, utilizing alt language for images, and allowing touch-only system use [6]. To accommodate people with visual impairments, it's also critical to choose colors with the right contrast ratios. The platform design takes into account the accessibility concerns of senior folks who may have visual difficulties. Elements and buttons are made to be controlled by the keyboard or touch. These rules lessen physical obstacles to use and improve equity in system access.

6) Data structure design: Developing the data structure and organizing the thorough gathering and processing of information about loneliness and other facets of well-being to produce full and precise reports. A relational database structure is designed to allow the storing of user profile data, assessment response data, and the methodical computation of the loneliness index. The design of the data structure is an essential part of the system. This layout is intended to facilitate upcoming analytical processing and minimize redundant data (data normalization). To improve the accuracy of the results, data validation procedures are devised prior to the calculation process. To produce thorough, accurate results that can suitably support health-related decision-making, the generated reports rely on processed data.

C. User Interface (UI)

The goal of user interface (UI) design is to improve the pleasant experience that comes from UX design by making it visually appealing and easy to use. In order to create a cozy and user-friendly space, a tranquil and safe color scheme is used by using hues like white that express relaxation and safety. Bright hues that could be uncomfortable for consumers are also avoided [7]. In order to guarantee reading, clear, appropriately large fonts are also used with great consideration.

Other components that are important for effective design include four main aspects that affect the usability of the interface

design: functional framework, interaction logic, visual design, and user experience. These elements impact user interaction [8]. Such buttons and interactive features are made to be large and have colors that contrast sharply with the background to make them easier for older people with limited vision and motor skills to utilize. Additionally, intuitive icons that convey universal and obvious meanings are employed to help users use the system quickly and accurately [9]. Additionally, report visualization is offered in simple graphic styles, such as spider charts, along with succinct explanations and useful suggestions that assist consumers in understanding the data and using it to effectively improve their health [10].

D. Older Adults' Perceptions of Loneliness and Health (Well-Being and Reduced Loneliness)

Elderly people who suffer loneliness, anxiety, and a lack of social engagement are more likely to feel depressed and bored, which lowers their sense of self-worth and leads to social exclusion [11]. When people believe their social connections are inadequate in terms of both quantity and quality, they experience this complex emotional and psychological condition. This differs from social isolation, which refers to a lack of quantitative interactions. Therefore, rather than being a result of the quantity of people present, loneliness is an internal sensation connected to the perception and expectations of connections.

Retirement, the death of a spouse or close friend, chronic disease, and mobility issues are all factors that lead to a decline in social networks as people age. Several studies show that loneliness is linked to a higher risk of anxiety and depression as well as a reduction in general quality of life [12], [13]. Loneliness has also been connected to an increased risk of long-term conditions like heart disease, high blood pressure, and cognitive loss [14]. According to the World Health Organization's definition of well-being, which includes social, mental, and physical aspects [15], loneliness is seen as a factor that compromises health in all of these areas, especially in the mental dimension, which is linked to hopelessness, low self-esteem, and feelings of worthlessness. According to Hawkley and Cacioppo [14], loneliness can set off the body's chronic stress processes, which can have an impact on long-term health and the immune system. Therefore, developing meaningful relationships, establishing a sense of belonging, and encouraging important roles in the community should be the main goals of avoiding loneliness among the elderly. This is in line with the Active Aging concept of the World Health Organization, which prioritizes security, involvement, and health in old age [16]. These steps will improve general well-being and lessen the detrimental effects of loneliness on people as well as society.

E. Comparison with Existing Digital Health Platforms

As summarized in Table I, existing studies have predominantly addressed isolated dimensions of digital health for older adults, including human-centered design principles, interface usability, accessibility, health information visualization, and loneliness monitoring. Although these studies provide valuable design insights for age-friendly digital systems, the majority remain confined to conceptual frameworks or systematic reviews, without the implementation and empirical validation of a comprehensive digital health platform. Furthermore, prior research has largely concentrated on the general older adult population, while limited attention has been given to sexual and gender diverse older adults. In addition, existing systems rarely integrate multidimensional well-being assessment, loneliness evaluation, personalized health reporting, and inclusive interface design within a single platform. To address these gaps, the present study extends previous work by developing and evaluating a functional digital health platform specifically designed for SOGIESC older adults, employing a user-centered design approach, accessibility principles, and a mixed-method evaluation. This research gap underscores the originality and practical contribution of the present study to the emerging field of inclusive digital health.

TABLE I. COMPARISON OF RECENT STUDIES RELATED TO INCLUSIVE DIGITAL HEALTH PLATFORMS FOR OLDER ADULTS.

Research Study	Key Contribution and Research Gap	Advancement of the Present Study
Research Paper [17]	Systematic review of HCD processes for mHealth applications using the ISO 9241-210 framework. No operational platform was implemented or evaluated.	Implements HCD in an operational platform integrating well-being, loneliness assessment, and inclusive design for SOGIESC older adults.
Research Paper [18]	Systematic umbrella review of technology interventions for loneliness and social connectedness. Evidence remained limited despite promising ICT-based interventions.	Extends previous technology interventions through an operational platform integrating loneliness assessment, multidimensional well-being assessment, and personalized reporting.
Research Paper [10]	Systematic review of PROM visualization, focusing on interpretation and presentation formats. No operational platform was developed.	Integrates PROM visualization with multidimensional assessment, personalized interpretation, and health recommendations.
Research Paper [8]	Systematic review of telemedicine interface usability and design recommendations for older adults. No operational platform was implemented.	Applies age-friendly usability principles within an operational digital health platform validated through mixed-method evaluation.
Research Paper [9]	Systematic review of age-friendly mobile app design, accessibility, and user-centered design strategies. No operational platform was evaluated.	Translates age-friendly design principles into an inclusive platform with multidimensional assessment and personalized reporting.
Research Paper [19]	Developed a user-centered interface design framework for loneliness monitoring. Focused on design indicators without platform implementation.	Extends the framework into an operational platform integrating loneliness, well-being assessment, and mixed-method evaluation.
Present Study	Develops an inclusive digital health platform integrating validated assessment instruments, user-centered design, multidimensional well-being assessment, and personalized reporting. Preliminary mixed-method evaluation involved 10 participants.	Provides an operational platform for SOGIESC older adults integrating inclusive design, validated assessment, and mixed-method evaluation.

Existing literature provides substantial evidence that user-centered design has become the prevailing framework guiding the development of digital health technologies for older adults. A considerable number of studies have identified age-friendly interface design, accessibility, usability testing, and sustained user participation as key determinants of successful technology adoption within aging populations [8], [9], [19]. Collectively, these contributions have deepened the theoretical and practical understanding of human-computer interaction in digital health, while simultaneously establishing core design principles that enhance system accessibility and usability. In addition, recent systematic reviews have emphasized the increasing significance of embedding digital health technologies into community-based healthcare frameworks as a strategy for promoting healthy aging and sustaining independent living among older adults.

Notwithstanding these advances, several critical limitations persist within the existing body of research. Most current platforms tend to emphasize a single dimension such as usability enhancement, interface optimization, or disease-specific monitoring rather than incorporating a multidimensional well-being assessment within a unified digital environment. Loneliness, in particular, is commonly examined as a standalone psychological construct rather than being evaluated in conjunction with broader physical, mental, social, and spiritual well-being dimensions. Furthermore, although health disparities among sexual and gender diverse older adults have gained increasing recognition, only a limited number of digital health studies have explicitly addressed their distinct psychosocial characteristics, healthcare experiences, and identity-related needs. As a result, empirical evidence supporting the development of inclusive digital health platforms tailored to SOGIESC older adults remains scarce.

III. Methodology and System Architecture

This study employed a research and development (R&D) methodology integrated with a mixed-methods design to guide the architectural design, implementation, and evaluation of an inclusive digital health platform for well-being and loneliness assessment among sexual and gender diverse older adults. The platform was developed following a user-centered design framework to ensure accessibility, inclusivity, and usability while addressing the psychosocial well-being needs of the target population. Quantitative and qualitative data were collected concurrently, analyzed separately, and integrated during interpretation to provide a comprehensive assessment of system performance, usability, and user experience.

Participants consisted of ten Sexual and Gender Diverse older adults in Thailand (n = 10) recruited through purposive sampling. A purposive sampling strategy involving ten participants was adopted, given that the study centered on formative usability evaluation within a narrowly defined and inherently difficult-to-reach population, namely Thai SOGIESC adults aged 50 years and above. This sample size was deemed sufficient for identifying salient usability issues and eliciting in-depth qualitative insights during the early stage of system development. However, it should be noted that the sample was not statistically powered to estimate population parameters.

Quantitative data were gathered using usability and satisfaction assessments, whereas qualitative data were collected through observation, think-aloud usability testing, and semi-structured interviews. The research process encompassed user needs assessment, system architecture design, platform development, implementation, and evaluation. Findings from both data strands were integrated throughout the development cycle to support iterative system refinement and methodological triangulation. The resulting evidence informed improvements in system functionality, accessibility, and user experience.

Quantitative and qualitative findings were integrated at the interpretation stage to enhance the credibility of the evaluation and to provide complementary evidence regarding the usability, user experience, and perceived usefulness of the proposed platform.

The methodological procedures adopted in this study are presented in the following sections.

A. Development of the Digital Health Platform on the GenDHL Website

Users of mobile devices or internet-connected PCs can access the individual health assessment reporting system, which is designed to facilitate usage through the GenDHL website. SOGIESC adults aged 50 years and above are the main target demographic. The system gathers user data, processes it, and centrally stores it (see Fig. 1). With “loneliness" as the primary focus of the analysis, encompassing both emotional and social loneliness, this comprises health assessments in four primary dimensions: physical health, mental health, social health, and spiritual health. In order to systematically synthesize results and produce individual health assessment reports that include a health overview, assessment results, and pertinent suggestions, all data is processed in a computational storage system. In terms of policy and practice, the system can be used to successfully plan, promote, and enhance the target group's quality of life. It also strives to support a thorough understanding of users' health.

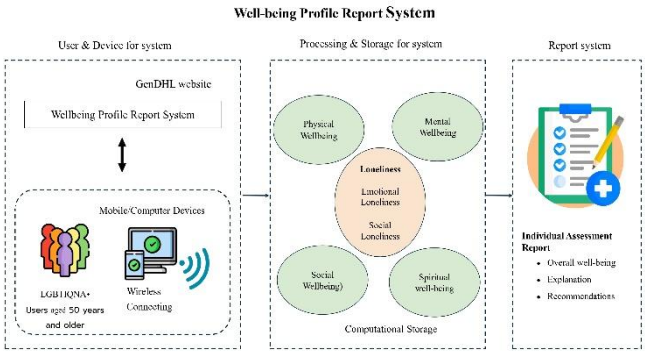

Fig. 1. Framework for developing the Digital Health Platform on the GenDHL website.

B. System Development Process

The PDCA principle, also known as the “Deming Cycle”, was used to identify the system development process for the online platform system, Digital Health Platform for Well-being, which is a management method for consistently enhancing productivity. It can be used at any point in the system development process to guarantee that the final product is excellent and genuinely satisfies the requirements. There are four primary steps: 1) Making a plan, 2) Acting (Act), 3)

Verifying and Assessing (Verify), and 4) Improving and Acting (Act) [20], which includes the following information.

1) *Step 1: Planning (Plan):* The planning process includes the following details:

- Needs analysis: To comprehend the actual difficulties and requirements of the target user group, which is made up of senior citizens with a variety of sexual orientations, examine their needs and context.
- Describe the primary idea: Create the system with the idea of "an online-friendly space" in mind, emphasizing convenience, security, and an emphasis on comprehensive healthcare. This covers the key ideas: making an approachable and simple-to-understand experience for senior citizens, user experience (UX) design concepts, user interface (UI) design concepts, and concepts pertaining to senior citizens' loneliness and well-being.

2) Step 2: Implementation (Do): The first step's development plan was implemented during the implementation phase (Do), with an emphasis on developing a comprehensive system that achieves the predetermined goals. A holistic health survey form comprising four domains physical, mental, social, and spiritual health was developed as part of the development of core functions. These were created utilizing a thorough and simple inquiry format. A processing system and report generation were built in tandem with the creation of key functions; comprehensive data processing was used to produce concrete reports, and coding was used to generate scores in every aspect of health. Score summaries, general findings, and useful suggestions for successful self-improvement were all included in these reports. Additionally, the front-end was created with an emphasis on usability and aesthetics in accordance with UX/UI design, enabling customers to view previous reports and clearly identify changes in their health. In conclusion, the following planned phases were followed in the development of the platform.

- Develop the primary function: Construct a system for health surveys that addresses all four aspects.
- Create the system for processing and reporting: Write code to process each area's results and produce a comprehensive report with clear justifications and suggestions.
- Create the front-end by designing the displays in accordance with the intended UX/UI so that users may observe changes in their health status and view previous reports.

In order to produce comprehensive and accurate reports, the first stage of system design will involve designing the data structure and planning for the gathering and processing of data pertaining to loneliness and other aspects of well-being. The GenDHL website's online platform technology is depicted in an example image.

The workflow of the Digital Health Platform for Well-Being will be depicted in the graphic, beginning with the login procedure and segmenting users into administrators (Admin) and senior citizens. Target users complete a four-dimensional health evaluation that covers mental, physical, social, intellectual, and spiritual dimensions in addition to personal information and activities. Before entering the data into the database and processing it to produce personal health reports, the system verifies that the data is accurate. In the meantime, the administrator is in charge of overseeing and validating the data to efficiently support activity development and long-term health monitoring. Fig. 2 presents the data structure diagram.

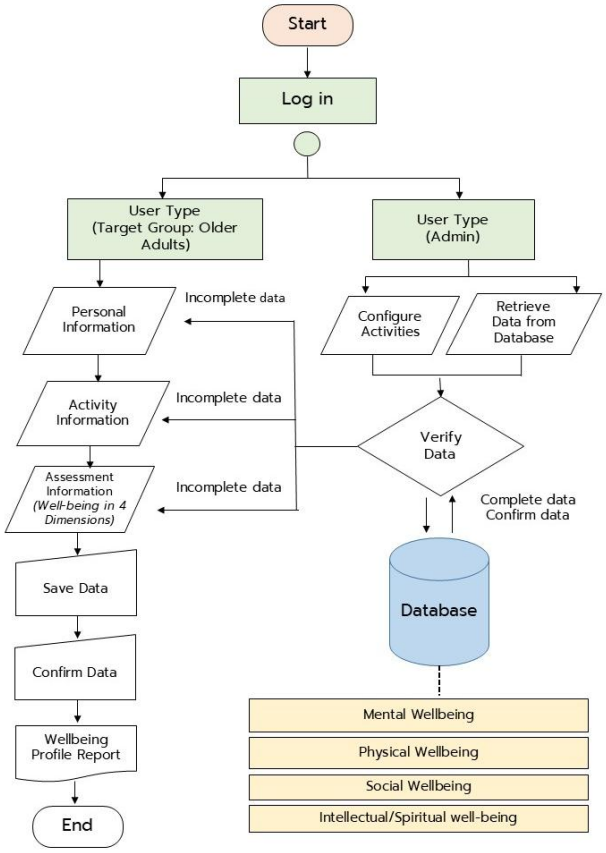

Fig. 2. Data structure diagram for the online platform system on the GenDHL website.

The emphasis will be on user-centered design in the design of the user interface and user experience (User Interface & User Experience), taking into consideration the limitations of the elderly through the use of clear iconography, eye-friendly colors, and appropriate text sizes. This is to guarantee that using a smartphone is as convenient and natural as possible, taking into account the following important factors:

- Emphasis on user-centered design: Begin by thoroughly comprehending the requirements and habits of the intended audience. This can be achieved by conducting in-depth interviews to obtain input on user experience or by comparing button placements to determine which layout works best for the target population.

- Progressive disclosure: The technology will show functions and information gradually rather than all at once. For instance, in order to minimize confusion and facilitate data submission, users will only view one question at a time rather than all ten on the assessment page.
- Responsive guidance system: To keep users from getting lost, each screen will have brief instructions that inform them what to do next, like “Select the answer that best matches you" or “Press the 'Back' button to go to the previous page".
- Getting feedback and fostering a good attitude once the user finishes the evaluation. Messages offering helpful guidance and recommendations will be shown to boost the system's target users' positive emotions.

The idea of modular deconstruction has been used in the system architecture and modular design of the inclusive digital health platform to improve future system scalability, maintenance flexibility, and development clarity. Five primary modules comprise the framework of the system: 1) Authentication Module; 2) User Profile Management Module; 3) Assessment Engine Module; 4) Report Generation Module; and 5) Admin Control Module. Workflow-driven integration connects each module, each of which has a distinct function.

- *The module for access control and authentication:* In order to clearly distinguish the use rights between “ordinary users" and “administrators (Admin)", the Authentication Module manages the process of safely accessing the system, including login, logout, and role-based access control. This module facilitates the governance of sensitive health data in compliance with user privacy and personal data protection rules and helps lower the risk of improper data access.
- Module for managing user profiles: In order to provide a health assessment context and enable user identity modification through the development of avatars, the user profile management module is in charge of gathering and documenting personal data. In an all-encompassing digital environment, this is an essential component for guaranteeing a sense of security and ownership. The module facilitates the creation, updating, and retrieval of profile data, which lessens the strain of repetitive data entry, improves the continuity of the user experience, and permits the reuse of basic data in later evaluations.
- Module for the assessment engine: The foundation of the platform's business logic is the assessment processing module. It operates by obtaining input data from loneliness-related and health assessments, validating the input, processing scores in accordance with predetermined criteria, and computing key indicators like the loneliness index to summarize the risk or condition level based on the assessment results. In order to improve calculation accuracy and make it easier to develop or modify calculation criteria in the future without impacting the user interface, this module is made to be independent of the presentation layer.
- Module for report generation: The purpose of the Report Module is to transform the Assessment Engine's evaluation results into a user-friendly manner. In order to facilitate meaningful self-review and health awareness, this involves producing summary reports that synthesize the evaluation data into interpretive summaries and visualizations like graphs or summary diagrams. Furthermore, in situations where the system records repeated evaluation findings that represent trends in health changes, the report module can be made to provide longitudinal comparisons.
- Module for admin control: Access to statistical data (monitoring and analytics), general usage monitoring, and the management of platform-related actions or content (activity and content management) are all supported by the admin control module. This module is essential for preserving data quality, ensuring service continuity, and overseeing community components or initiatives related to advancing the target group's well-being. To guarantee the security and suitability of data management, the Authentication Module controls the access privileges of administrators.

Fig. 3. Show a preview of the login page.

Fig. 4. Display the main menu of the system.

Fig. 5. Show your avatar through personal identity.

Fig. 6. Show the results of the health comparison.

Additionally, the design places a strong emphasis on fostering a positive environment by showcasing uplifting messages and practical guidance following the exam, encouraging a positive outlook on one's own health. The design adheres to the web content accessibility guidelines requirements for complete accessibility for users [21]. Lastly, the information architecture has been carefully designed to guarantee the accurate and thorough processing, storage, and display of reports on loneliness and other elements of well-being (see Fig. 3 to Fig. 6).

3) Step 3: Check and Evaluation: The proposed platform was assessed through a pilot implementation that emphasized usability, user experience, and system feasibility, rather than predictive model validation. Given that the assessment engine relies on deterministic scoring rules derived from validated assessment instruments, benchmark datasets typically employed in machine learning evaluation were deemed inapplicable in this context. Accordingly, the evaluation prioritized user satisfaction, usability, and the practical applicability of the platform within the target population.

Before being implemented in the real-world, the designed system will be thoroughly tested with real user groups during the Check phase to assess its accuracy and performance. Usability testing, which focuses on gathering behavioral data from the target population of older users to evaluate the system's usability, specifically in terms of navigation comprehension and the clarity of the instructions displayed on the screen, will comprise the three main components of the operations.

Arrange for the report's results to be verified in order to make sure that the suggestions and score processing are both academically correct and helpful to real users.

Plan to interview customers in-depth to learn about their overall experience, how they feel about using the system, and any further needs they may have. The data gathered from this verification procedure is essential for enhancing and expanding the system in the next stages. In conclusion, the system was tested with a sample of real users after development was finished, as described below:

- To determine whether the system is genuinely user-friendly and to pinpoint areas that require development, such as navigation comprehension and instruction clarity, usability testing gathers data from the target group of senior users.
- Report accuracy verification: Verify that the information provided is valid and helpful by checking the accuracy of the score processing and the suggestions in the report.
- Gathering feedback: Conduct user interviews to learn about their thoughts on the system as a whole, their experiences, and any further requirements.

4) Step 4: Improvement and Implementation (Act): In order to improve and enhance the system's quality, the assessment results and input gathered from the Check phase were examined in the Act phase, the last stage of system development. One of the primary responsibilities was to improve the UX/UI, which included making improvements to displays and usage procedures when users were reported to be confused or not comprehending. This was carried out to guarantee a more seamless and user-friendly navigation method. The report's recommendations and material were also broadened to offer greater diversity, thoroughness, and usefulness.

Simultaneously, the next phase's development goals have been outlined, providing guidance for potential additions of additional features like the creation of a notification system, online community activities, or user-expert connections. This PDCA cycle's implementation guarantees that the system will be continuously improved to sustainably satisfy user needs rather than staying stagnant.

- The data from step 3's inspection has been examined to further enhance the system, as explained below: Enhance UX/UI: Update screens and usage instructions that older consumers still find unclear or difficult to comprehend.
- Expand information and recommendations: To make the report more thorough and beneficial, add a wider range of recommendations.
- Make a plan for future development: Describe how you intend to add new features in the future, including expert connections, online community activities, or notification systems.

C. Well-being and Loneliness Assessment Instrument

The proposed platform integrates five validated assessment instruments to evaluate multidimensional well-being and loneliness among SOGIESC older adults. Loneliness was assessed using the 6-item De Jong Gierveld Loneliness Scale, which measures emotional and social loneliness [22]. Mental well-being was evaluated using the Thai Geriatric Mental Health Assessment Tool–Short Form (T-GMHA-15), a culturally validated instrument for Thai older adults that assesses mood, anxiety, self-esteem, and cognitive-emotional stability [23]. Functional ability was assessed using items adapted from the Functional Activities Questionnaire (FAQ), which measures independence in instrumental activities of daily living [24]. Social well-being was measured using a 15-item instrument based on Keyes' Social Well-Being framework, covering social actualization, social acceptance, social coherence, social contribution, and social integration [25]. Spiritual well-being was assessed using the Functional Assessment of Chronic Illness Therapy Spiritual Well-Being Scale (FACIT-Sp-12), which evaluates the domains of meaning, peace, and faith [26].

D. Assessment and Report-Generation Workflow

The proposed platform utilizes a deterministic, rule-based assessment engine to process user responses, rather than a trainable machine-learning model. As depicted in Fig. 7, the workflow commences with user authentication, followed by the completion of multidimensional assessment instruments. Subsequently, the system verifies response completeness and value validity prior to applying instrument-specific scoring rules, including reverse scoring where applicable. Domain scores encompassing loneliness, mental well-being, functional ability, social well-being, and spiritual well-being are then computed in accordance with the validated scoring procedures established for each respective instrument.

The resulting scores are subsequently mapped onto predefined interpretation criteria to generate personalized health reports, graphical summaries, and formative recommendations. User responses and assessment outcomes are securely stored within the database to facilitate future retrieval and longitudinal monitoring. As the assessment engine operates entirely on rule-based logic, no model training, hyperparameter tuning, or optimization procedures are necessary. Instead, the operational parameters comprise predefined scoring rules, permissible response ranges, reverse-scoring procedures, and interpretation criteria derived from their corresponding validated assessment instruments (see Fig. 7).

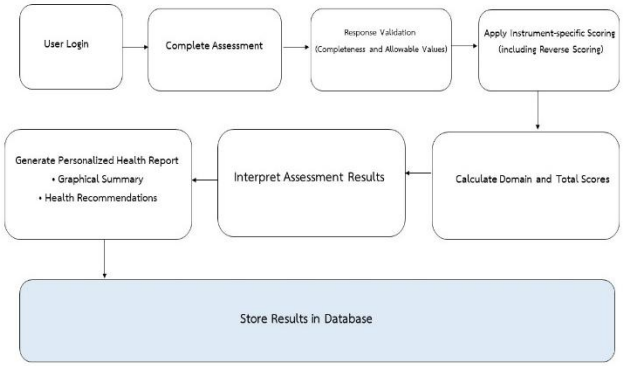

Fig. 7. Workflow of the rule-based assessment and report-generation process implemented in the proposed digital health platform.

E. Data Collection

Data collection was conducted using a mixed-methods approach comprising usability testing, participant observation, a structured satisfaction questionnaire, and semi-structured interviews. During the usability testing sessions, participants performed a set of predefined tasks on the GenDHL platform while researchers observed their interactions and documented emerging usability issues. Following task completion, participants completed a satisfaction questionnaire and subsequently engaged in semi-structured interviews to elicit in-depth feedback regarding their user experience, perceived usefulness, and recommendations for system enhancement.

F. Data Analysis

The evaluation aimed to conduct a formative usability assessment of the proposed platform rather than a confirmatory effectiveness study. Accordingly, the analysis emphasized descriptive statistics and qualitative interpretation to identify usability issues, explore user experiences, and generate recommendations for iterative system refinement.

Given that this study was designed as a preliminary pilot evaluation involving a small purposive sample, quantitative data were analyzed descriptively using frequencies, percentages, means, and standard deviations, supplemented where appropriate by medians and ranges. No inferential statistical tests were performed, as the study was not intended to support population-level statistical generalization. Rather, the quantitative findings were designed to provide preliminary descriptive evidence of participants' perceptions. Qualitative data derived from participant observations and semi-structured interviews were analyzed thematically and employed to explain, contextualize, and enrich the interpretation of the quantitative satisfaction ratings.

Qualitative data obtained from participant observations and semi-structured interviews were examined through thematic analysis. The resulting themes served to explain, contextualize, and enrich the interpretation of the quantitative findings, thereby facilitating a comprehensive understanding of participants' usability experiences and their perceived value of the proposed platform. The thematic analysis adhered to the procedural stages of familiarization, initial coding, theme development, theme review, and theme refinement in order to identify recurrent usability issues and user experience patterns [27].

IV. Results and Discussion

The following specific conclusions about the system testing results were found after examining usage observations and conducting user interviews to get input on the system as a whole, user sentiments, and further requirements:

A. Usability and Learnability

Although the majority of users, particularly the elderly, were initially unfamiliar with the system, they were able to comprehend the platform's goals. The process of registering, logging in, and inputting personal data was perceived as needing constant supervision or teaching from others throughout the system's trial use. Many users noted that the system might constitute a barrier to long-term self-use in the absence of support or an understandable manual, particularly for older people living alone. Here are some thorough remarks:

"Overall, the system is not difficult to use. You can learn and understand it quite quickly on your own. Although at first you might need to try clicking around and exploring the various menus, after using it for a while, you will start to get familiar with it and be able to use it more smoothly."

(Participant A, November 13, 2025)

"Overall, I feel that the system is quite user-friendly. The text and various elements are easy to read, making it possible to see the information clearly and helping to understand how to use it without confusion."

(Participant C, November 13, 2025)

B. Interface and Experience Design

Users' perceptions vary; some think the website is well-organized and simple to read. However, a prevalent problem is that icons and pictures often fail to adequately represent sexual variety, making it more difficult for users to comprehend and learn how to utilize the system. Here are a few specific instances of the comments:

"The main functions of the system are quite clear, making it easy to know where to start using it. Each menu is arranged in order, so it doesn't make you feel confused or lost while using it."

(Participant B, November 13, 2025)

"The presence of avatars in the system enhances interest and a sense of friendliness, making the overall atmosphere more enjoyable and helping to reduce tension during use."

(Participant D, November 13, 2025)

"The icons used in the system are quite clear in their meanings, allowing users to understand the functions of each part without much guessing, making it more convenient and seamless to use."

(Participant E, November 13, 2025)

C. Functionality and Performance

The system can function in accordance with fundamental goals, like report generation and health assessments. Nevertheless, there are still problems with system speed and stability, like sluggish data loading and system freezes at specific stages. A step-by-step usage guide, voice command functionality, audio explanations for inquiries, and the elimination of unnecessary steps in data entry are just a few of the enhancements that users have proposed to help the elderly. The target group would find it easier to use and more convenient as a result. Here are some thorough remarks:

"Overall, I feel that the system is not difficult to use. The various steps are quite understandable on their own. Even though it was my first time trying it out, I was able to learn gradually. After using it for a while, I started to get familiar with the menus and the system's operation, allowing me to continue using it without much hassle."

(Participant A, November 13, 2025)

"I feel that the system isn't complicated at all. The usage is quite straightforward, making it easy to understand, even without prior experience with such systems. Once you try clicking through the menus one by one, you can figure out how to use it on your own."

(Participant C, November 13, 2025)

"I feel that the system isn't very complicated. At first, it might take some time to understand, but after using it for a while, I think I'll start to get familiar with it and be able to use it more smoothly. The steps aren't very difficult and can be learned on my own."

(Participant D, November 13, 2025)

D. Usefulness and Value

In terms of encouraging introspection, raising awareness of health issues, and reflecting on loneliness and quality of life, the majority of users found the system beneficial. In order to make the evaluation results useful in everyday life, users have recommended that the results be presented more simply, with more visuals or symbols and a focus on concise explanations. Here are some thorough remarks:

"I feel that the system helps me reflect on my thoughts and feelings more, allowing me to revisit certain aspects of myself that I usually don't have the opportunity or importance to consider."

(Participant A, November 13, 2025)

"When I saw the results from the system, it made me more aware and accepting of my own feelings. I felt that I might actually be lonely, which is something I had never really noticed or thought about seriously before."

(Participant F, November 13, 2025)

"It only takes a few minutes to receive information or results related to oneself, making it feel convenient and quick, and helping to understand oneself better in a short period."

(Participant G, November 13, 2025)

E. Overall Satisfaction and Suggestions

Overall, the data shows that the degree of system comprehension and platform stability are closely correlated with user happiness. The platform has a great chance of becoming a well-known and regularly utilized digital health tool across the

diverse senior population if user experience and technical performance continue to improve. Here are some thorough remarks:

"If the system continues to develop and improve in this manner, I think there will be interest and a desire to use it again in the future."

(Participant B, November 13, 2025)

"Using the system creates a feeling as if there is something that understands one's own feelings, resulting in a greater reflection and awareness of one's own emotions."

(Participant C, November 13, 2025)

In conclusion, the study's qualitative behavioral data show that digital systems are more than just technical tools; they also contribute to self-awareness, emotional introspection, and the evaluation of users' mental health. The framework of digital mental health and well-being, which prioritizes a user-centered experience, is consistent with this.

According to the satisfaction survey results, the overall satisfaction score reported by this pilot cohort yielded a descriptive mean of 4.10 (SD = 0.88). Such values provide an initial overview of participants' perceptions of the platform; nevertheless, they should not be construed as population-level estimates or as evidence of the platform's effectiveness. All things considered, the system's merits were emphasized in terms of precisely identifying target groups and initiatives to establish a secure environment for senior citizens of various sexual orientations. At the same time, it was unanimously agreed that future system development should concentrate on making it simple to use right away, speeding up system output, modifying the design to make it suitable for the elderly, and providing clear value and incentives to encourage users to keep using it and to maximize benefits in terms of policy development and quality of life. The evaluation's findings will serve as a reference for future system efficiency improvements (see Fig. 8).

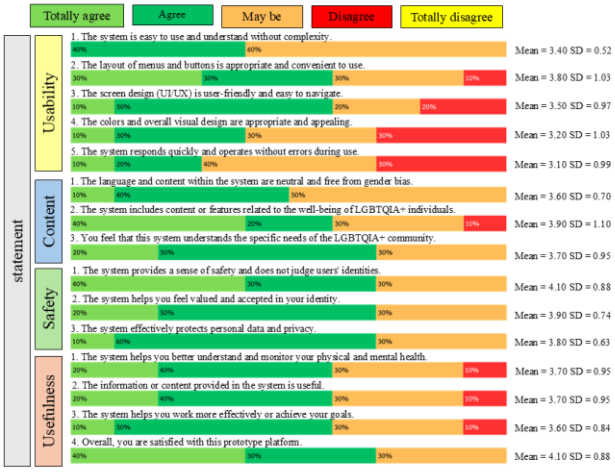

Fig. 8. A summary of the satisfaction survey findings for the Digital Health Platform system from a sample of ten participants.

System usage behavior can be explained within the frameworks of digital health and mental well-being, according to an overview of the study of quantitative data about opinions on the system and qualitative data from research participant interviews. These concepts highlight how technology can be used in daily life to promote self-awareness, emotional introspection, and mental health services [28]. Some respondents mentioned that utilizing the system makes people more conscious of their emotional states and feelings. System users engage with the system in a way that is similar to self-reflection. This conduct is consistent with the idea of self-awareness, which is an essential part of mental health and a basic process that makes preventive mental health care possible. When it comes to using technology for mental health (digital mental health), informants assess the system based on their real-world usage experiences and the emotions they experience while using it. It also illustrates the system's function as an emotionally secure environment where users can evaluate themselves and consider their emotions without being directly pressured by others. This trait is consistent with the idea of "digital well-being", which holds that user-considered technology can promote mental health without creating stress or emotions of condemnation [29].

V. Conclusion

This study successfully developed and preliminarily evaluated an inclusive digital health platform embedded within the GenDHL website, designed to support well-being and loneliness assessment among late middle-aged and older adults with diverse sexual orientations, gender identities, gender expressions, and sex characteristics (SOGIESC). The evaluation findings indicated that participants generally perceived the platform as comprehensible, user-friendly, and beneficial in promoting self-awareness, emotional well-being, and health literacy. Through its intuitive digital environment, the platform enables users to assess their physical, mental, social, and spiritual well-being while receiving personalized health reports and practical recommendations. Throughout the system development process, particular emphasis was placed on the application of user-centered design principles to ensure simplicity, intuitive interaction, and ease of use for older adults. This design approach aligns with the user-centered interface framework proposed by Zhou et al. [19], which emphasizes the necessity of minimizing interaction barriers and enhancing usability in digital health systems designed for older adults. Building upon these user-centered principles, the present study further incorporates inclusive design considerations and multidimensional health assessment to address the specific psychosocial and healthcare needs of SOGIESC older adults.

The positive usability outcomes observed in this study, together with participants' qualitative reflections, can be attributed to the integration of user-centered design principles, accessibility oriented interface design, progressive disclosure, and personalized health feedback embedded throughout the platform. Prior studies have shown that simplified navigation, age-friendly interface components, and accessible interaction substantially enhance usability among older adults [8], [9], while Zhou et al. [19] emphasized that user-centered interface design constitutes an essential foundation for reducing interaction barriers and fostering user engagement in digital health systems. In contrast to previous studies, which primarily concentrated on interface usability, age-friendly design guidelines, or conceptual design frameworks, the proposed

platform integrates multidimensional well-being assessment, loneliness evaluation, personalized feedback, and inclusive identity representation within a single operational environment specifically tailored for SOGIESC older adults. This comprehensive integration may account for the favorable usability, positive emotional responses, and enhanced self-reflection reported by participants during the pilot implementation, thereby suggesting that combining technical usability with psychosocial support can strengthen user engagement and perceived value.

These findings further indicate that one should not assess the effectiveness of inclusive digital health platforms solely in terms of technical usability or system performance. Rather, psychosocial dimensions including identity recognition, emotional support, perceived inclusiveness, opportunities for self-reflection, and social connectedness appear to be an equally important part in determining users' acceptance and sustained engagement. This finding emphasizes the necessity of designing digital health systems that simultaneously address technological accessibility, psychological well-being, and social inclusion. Such an integrated perspective extends current digital health research by illustrating that inclusive platform design should move beyond conventional health monitoring toward fostering holistic well-being among underserved populations, particularly sexual and gender-diverse older adults.

This study advances the nascent field of inclusive digital health by providing empirical evidence that user-centered design, inclusive design principles, and multidimensional health assessment can be effectively amalgamated within a single digital platform. Compared with existing state-of-the-art digital health platforms reported by Nimmanterdwong et al. [17], Amouzadeh et al. [9], and Zhou et al. [19], the proposed system extends prior approaches by incorporating multidimensional well-being assessment, loneliness evaluation, personalized health reporting, and inclusive interface design within a single operational platform. Whereas previous studies have predominantly emphasized user-centered design, accessibility, technology acceptance, or isolated health dimensions among older adults, relatively few have concurrently addressed comprehensive health assessment alongside the distinct psychosocial and healthcare needs of sexual and gender-diverse older adults. Accordingly, the proposed platform advances current digital health research by combining validated assessment instruments with an operational, user-centered, and inclusive digital health service specifically designed for SOGIESC older adults. Unlike previous studies that mainly suggested conceptual frameworks, usability guidelines, or standalone assessment tools, this research illustrates the practical viability of deploying and assessing an operational digital health platform via a mixed-methods approach. Therefore, the proposed platform contributes not only a practical technological solution but also an evidence-based framework capable of guiding future digital health service development for marginalized aging populations. These findings may further assist healthcare professionals, community organizations, and policymakers in promoting healthy aging, mitigating loneliness, and enhancing equitable access to digital health services.

Despite these encouraging findings, several limitations warrant acknowledgment. First, the study was conducted as a pilot implementation involving a relatively small sample of ten participants, thereby constraining the generalizability of the quantitative findings. Second, the evaluation primarily concentrated on usability, user experience, and preliminary user perceptions rather than long-term behavioral outcomes, clinical effectiveness, or longitudinal health impacts. Third, the proposed platform was not benchmarked against existing digital health platforms or validated using standardized benchmark datasets, thereby limiting direct comparison with alternative approaches. In addition, the current assessment engine remains rule-based and lacks predictive analytics or artificial intelligence techniques, while computational performance, scalability, and large-scale deployment were not examined. These limitations, when interpreting the findings, are crucial to consider, as they provide important context and highlight significant directions for future research.

Addressing these limitations offers several important directions for future research and system enhancement. Subsequent development should adopt a more modular software architecture by decoupling the assessment engine from the presentation and data layers, thereby improving maintainability, interoperability, and integration with external healthcare services through standardized APIs. System performance should be further strengthened through response time optimization, concurrent user testing, database optimization, and cloud-based deployment to support broader implementation. Future studies should also explore the integration of artificial intelligence and predictive analytics to enable adaptive and personalized health recommendations, while validating the platform with larger and more diverse participant groups across multiple healthcare settings. Such developments would facilitate the transition of the current research prototype into a reliable, secure, scalable, and sustainable digital health platform suitable for real-world deployment. Overall, the findings of this study establish a foundation for the future development of inclusive, evidence-based, and scalable digital health ecosystems capable of supporting healthy ageing and reducing health disparities among sexual and gender diverse older adults.

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