

Design and Conceptual Architecture of a Persuasive M-Health System for Menopause Care

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ABSTRACT

Menopause, a natural phase in women's lives, often brings significant physical, psychological, and sexual health challenges, primarily due to declining estrogen levels. Effective management of these multifaceted issues is important for improving women's quality of life. Mobile health (M-Health) technologies have emerged as promising tools, offering personalized and accessible approaches for symptom management and well-being support. This study presents a conceptual M-Health framework that integrates persuasive strategies, trustworthiness, and user-centered design (UCD) to potentially improve user engagement and support health management among menopausal women. The framework incorporates features such as self-monitoring, educational content, and virtual support, which may assist women in managing symptoms more independently while fostering a sense of connection. As a conceptual study, this work does not include empirical validation; rather, it aims to provide an initial design and theoretical foundation for future development and evaluation. The proposed framework may offer guidance for healthcare providers in adopting digital tools, inform policymakers in supporting M-Health initiatives, and assist technology developers in designing user-friendly applications tailored to menopausal women's needs. By addressing gaps in existing M-Health frameworks, this study contributes to ongoing discussions in academic research, public health, and digital health innovation. It highlights the potential role of M-Health in supporting menopause management and provides a basis for future empirical investigation.

1. INTRODUCTION

Menopause is a significant phase in a woman's life characterized by the cessation of menstrual cycles, typically occurring between the ages of 45 and 55, although it can occur earlier due to various factors such as medical treatments or genetic predispositions (Cronin et al., 2023). The transition into menopause, known as perimenopause, can last several years and is marked by fluctuating hormone levels, particularly

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estrogen, leading to a range of physical, psychological, and sexual health implications (Simpson et al., 2023).

The decline in estrogen levels during menopause profoundly affects various bodily systems, notably the cardiovascular system (Dehghan et al., 2022). Research indicates that menopause is associated with an increased risk of cardiovascular diseases due to alterations in vascular function and lipid profiles (Lee et al., 2023). Furthermore, women experiencing menopause may also face heightened risks of metabolic syndrome, which encompasses conditions like obesity, hypertension, and insulin resistance, all of which can exacerbate cardiovascular risks (Mutahar et al., 2021; Palacios et al., 2019).

Psychologically, menopause can lead to significant mood disturbances, including anxiety and depression (Palacios et al., 2019). The relationship between menopausal symptoms and mental health is complex. For instance, sleep disturbances, which are prevalent during this transition, can contribute to or exacerbate depressive symptoms (Cronin et al., 2021). Studies have shown that insomnia and other sleep disorders are common complaints among menopausal women, which can negatively impact their overall quality of life and work productivity (Cronin et al., 2021).

Sexual health is another critical aspect affected by menopause (Jafari et al., 2017). The decrease in estrogen can lead to vaginal atrophy, dryness, and discomfort during intercourse, which can significantly impact sexual function and satisfaction (Alvisi et al., 2019). Additionally, the psychological effects of menopause, including changes in mood and self-esteem, can further complicate sexual health (Heidari et al., 2019).

Physical activity has been identified as a beneficial intervention for managing menopausal symptoms (Bahri et al., 2019). Regular exercise has been shown to improve quality of life, enhance mood, and mitigate some physical symptoms associated with menopause (Nguyen et al., 2020). Moreover, lifestyle modifications, including dietary changes and increased physical activity, are encouraged as they can serve as a "window of opportunity" for women to adopt healthier habits during this transitional phase (Simpson et al., 2023).

Menopause is a complex process that has significant health implications across multiple areas, including cardiovascular health, mental well-being, and sexual function. Recognizing these implications is essential for creating effective management strategies and interventions that can improve the quality of life for women experiencing this natural transition.

However, despite the availability of various management strategies, existing approaches remain fragmented and often fail to address the comprehensive and interconnected needs of menopausal women. In particular, current M-Health solutions lack an integrated framework that combines persuasive strategies, trustworthiness, and user-centered design to effectively support sustained engagement and holistic menopause management. This gap highlights the need for a structured conceptual framework to guide the design and development of more effective M-Health interventions.

1.1 Importance of M-Health in supporting menopause management

The integration of mobile health (M-Health) technologies into the management of menopause represents a significant advancement in supporting women's health during this transitional phase (Lee et al., 2015; Senette et al., 2018). M-Health applications offer a range of functionalities that empower women to manage their menopausal symptoms effectively, providing personalized information and fostering self-care practices (Osman et al., 2021). The increasing prevalence of M-Health platforms reflects a growing recognition of the need for accessible, user-friendly tools that cater specifically to the unique challenges faced by menopausal women (Rafati et al., 2023).

One of the primary benefits of M-Health applications is their ability to facilitate self-management of menopausal symptoms (Wang & Qi, 2021). These applications can track various health metrics, including

physical activity, dietary habits, and symptom severity, thereby enabling women to monitor their health and make informed decisions regarding lifestyle changes (AlSwayied et al., 2022). For instance, a study demonstrated that mobile application-based self-care training significantly improved the quality of marital relations and reduced the severity of menopausal symptoms in postmenopausal women (Rafati et al., 2023). This highlights the potential of M-Health to enhance not only physical health but also psychosocial well-being during menopause.

Moreover, M-Health applications can serve as platforms for education and support. Women often express a desire for more information about menopause and coping strategies, which can be effectively delivered through mobile platforms (Jafari et al., 2017). These applications can provide tailored educational content, resources for managing symptoms, and access to community support networks, thereby fostering a sense of connection among users (Cowell et al., 2024). The ability to access information at any time and place enhances the usability of these tools, making them an attractive option for many women (Rafati et al., 2023).

The effectiveness of M-Health interventions is further supported by systematic reviews indicating positive outcomes associated with their use. For example, a systematic review of mobile-based physical activity interventions found that these applications were well-accepted and effective in promoting physical activity among midlife women during menopause (AlSwayied et al., 2022). Additionally, studies have shown that virtual interventions can improve both physical and psychosocial health outcomes for women undergoing menopause (Li et al., 2023).

Beyond these benefits, user engagement and adherence remain critical factors influencing the long-term success of M-Health applications. While these apps have shown potential in improving health outcomes and promoting physical activity, challenges such as motivation, loss of interest, and cost contribute to app abandonment (Mustafa et al., 2022). Incorporating gamification elements and theory-driven approaches, such as self-determination theory, can enhance motivation and adherence (Wang et al., 2021). Personalization based on psychological characteristics, including self-efficacy, health consciousness, and personality traits, can improve perceived persuasiveness and continued use (Tao et al., 2023). Additionally, factors like perceived usefulness, ease of use, and task-technology fit play significant roles in user acceptance and long-term engagement (Tao et al., 2023; Wang et al., 2021). Future research should focus on refining app designs based on user feedback and testing in larger samples to enhance sustained usage and health outcomes (Haque et al., 2019).

However, it is essential to consider the privacy and security of data shared through M-Health applications. Concerns regarding data privacy and security must be addressed to ensure user trust and engagement (Baltzer & Bonancina, 2023). Developers of M-Health solutions must prioritize robust data protection measures to safeguard sensitive health information.

M-Health technologies play a crucial role in supporting menopause management by empowering women with tools for self-care, education, and community support. Integrating these technologies into healthcare practices can significantly enhance the quality of life for women experiencing menopause, making it imperative for healthcare providers to embrace and promote these innovations.

1.2 Purpose and significance of the study

1.2.1 Purpose

The primary purpose of this study is to design and propose a conceptual M-Health framework tailored to address the multifaceted health and lifestyle challenges faced by menopausal women. By leveraging persuasive strategies, trustworthiness, and user-centered design (UCD), the framework aims to deliver effective, accessible, and personalized digital health solutions that promote self-care, enhance symptom management, and support overall well-being during menopause. This initiative addresses gaps in existing

M-Health frameworks by focusing on trustworthiness, and personalization to optimize user engagement and outcomes.

1.2.2 Significance

The significance of this research is wide-reaching, with benefits for various stakeholders involved in menopause care. Below are the key areas of impact:

(i) Menopausal Women

This study is essential for menopausal women, as it delves into the powerful role of M-Health technologies in managing symptoms and improving quality of life. M-Health interventions deliver personalized support, empowering women to take charge of their health by monitoring symptoms, accessing crucial information, and communicating with healthcare professionals. By equipping women with tools for autonomy and informed decision-making, this research aspires to significantly enhance their overall well-being during this pivotal life stage.

(ii) Healthcare Providers

This research will serve as a guide for healthcare providers to incorporate M-Health tools into their practice. The study will provide valuable insights into how digital health technologies can improve patient education, monitoring, and personalized care for menopausal women. It equips healthcare practitioners with the knowledge to effectively leverage M-Health solutions to enhance the quality of care, enabling them to adapt to technological advancements and improve patient outcomes.

(iii) Government Institutions and Policymakers

This research has significant implications for policymakers and government institutions, especially in formulating healthcare policies and allocating resources. It highlights the importance of M-Health in managing menopause and promoting health equity among older adults. By understanding the benefits of M-Health, governments can create policies that support its integration into healthcare systems, ensuring better healthcare availability and improving outcomes for menopausal women. It also aligns with the United Nations' Sustainable Development Goal number 3, which focuses on "Good Health and Well-Being."

(iv) Technology Developers and Industry Stakeholders

For technology developers and the digital health sector, this research identifies the key features and technological requirements necessary for effective M-Health solutions. The study provides insights into user preferences, helping to create scalable, culturally sensitive, and user-friendly applications. By addressing the specific needs of menopausal women, the research encourages the development of innovative M-Health products that not only enhance user experience but also drive growth in the digital health industry.

(v) Academic Research and Healthcare Innovation

The study's findings will contribute significantly to academic research by fostering a deeper understanding of M-Health's role in menopause management. It encourages collaboration between researchers, healthcare providers, and policymakers to explore new methodologies and tools for evaluating digital health interventions. This research will contribute to ongoing advancements in women's health and healthcare innovation, providing a foundation for future studies that can improve long-term health outcomes for menopausal women.

(vi) Society and Public Health

Integrating M-Health technologies into menopause care can have a profound impact on public health. By reducing the burden of menopausal symptoms on individuals, families, and healthcare systems, this research supports improved productivity, well-being, and social participation among menopausal women.

Promoting M-Health adoption fosters a culture of health innovation, empowering women and contributing to the broader goal of improving the overall quality of life for the aging population.

2. BACKGROUND AND LITERATURE REVIEW

2.1 Current approaches and challenges in menopause management

Menopause is a significant transition in a woman's life marked by various physical, psychological, and emotional changes, necessitating effective management strategies to improve quality of life (Dehghan et al., 2022). Current approaches to menopause management broadly include pharmacological and non-pharmacological strategies.

Pharmacological options, such as hormone replacement therapy (HRT), remain a cornerstone of menopause management. HRT helps alleviate symptoms like hot flashes, night sweats, and vaginal dryness by supplementing declining hormone levels (Thomas et al., 2021). However, the potential risks of HRT, including an increased risk of breast cancer, stroke, and cardiovascular diseases, have led to a growing emphasis on non-pharmacological and preventive strategies (Naftolin et al., 2019).

Non-pharmacological strategies include lifestyle modifications and complementary therapies. Regular physical activity, stress management, and dietary adjustments have been shown to alleviate symptoms and reduce the risk of chronic diseases associated with menopause, such as osteoporosis and cardiovascular conditions (Bahri et al., 2019; Karimi et al., 2022). Complementary therapies, such as yoga, acupuncture, and herbal supplements, have gained popularity as alternatives, particularly for women seeking holistic approaches (Rees et al., 2020).

M-Health technologies are emerging as a supportive tool to enhance these non-pharmacological strategies (Lopez Burst et al., 2024). For instance, M-Health can guide users in implementing lifestyle changes, tracking their symptoms, and providing reminders for physical activities and dietary goals (Senette et al., 2018). Additionally, these applications can integrate evidence-based complementary therapies by offering tutorials, virtual consultations, and community forums to encourage adherence and provide psychosocial support.

Despite the availability of various interventions, challenges persist in addressing the diverse needs of menopausal women. These challenges include personalization, where many existing strategies fail to cater to the unique symptoms and health profiles of individual women. Research has shown that a one-size-fits-all approach reduces user satisfaction and adherence to interventions (Ghanvatkar et al., 2019). Additionally, limited access to healthcare resources and inadequate awareness about menopause management options hinder effective care, particularly in underserved regions (Paripoorani et al., 2023). Social stigma surrounding menopause further impacts women's emotional well-being, underscoring the need for psychosocial support in management strategies (Cronin et al., 2021). Furthermore, while M-Health technologies demonstrate potential, their full benefits remain untapped due to issues related to data security, trustworthiness, and usability (van Haasteren et al., 2019).

The integration of M-Health solutions offers a transformative approach to addressing these challenges. Applications enabling symptom tracking, virtual community support, and teleconsultation empower women to actively manage their symptoms and access healthcare resources remotely (Rafati et al., 2023). However, concerns about data privacy, the credibility of health information, and user engagement need to be addressed to ensure widespread adoption and efficacy (Alfawzan et al., 2022). While traditional and alternative approaches to menopause management have made significant progress, persistent gaps in personalization, accessibility, and technological integration call for innovative solutions. Notably, many existing approaches address these aspects in isolation rather than as an integrated system, limiting their effectiveness in supporting long-term menopause management. This study seeks to bridge these gaps by

proposing a comprehensive M-Health framework that incorporates advanced technologies, such as machine learning, alongside user-centered and persuasive design principles to enhance menopause management outcomes (Halttu et al., 2015; Lee et al., 2015).

2.2 The role of digital health and M-Health solutions in healthcare

The advent of digital health has revolutionized the healthcare industry by leveraging technology to enhance access, efficiency, and quality of care. Among these innovations, M-Health stands out as a pivotal tool, offering solutions that empower users and healthcare providers like (Matricardi et al., 2020).

M-Health refers to the use of mobile devices such as smartphones and tablets to facilitate healthcare delivery, encompassing applications for remote monitoring, teleconsultations, and health education (World Health Organization, 2011). By capitalizing on the widespread adoption of mobile devices, M-Health solutions offer unique advantages in addressing gaps in traditional healthcare systems.

One key role of M-Health is improving access to healthcare. In regions where healthcare facilities are scarce or inaccessible, M-Health provides a lifeline by offering remote consultations and real-time health monitoring (Müssener, 2021). This helps bridge disparities and ensures timely medical interventions (Müssener, 2021).

Additionally, M-Health enhances healthcare efficiency by streamlining processes like electronic health record management, symptom tracking, and patient follow-ups. This not only reduces the workload on healthcare providers but also enables proactive management of chronic conditions (Dendere et al., 2019).

M-Health also plays a vital role in patient engagement. Through interactive tools, fitness trackers, and personalized reminders, M-Health solutions encourage individuals to take an active role in managing their health, fostering autonomy and responsibility (Boadu et al., 2024). Furthermore, these technologies empower users with educational resources tailored to their specific health conditions, enabling informed decision-making (Raman et al., 2023).

Despite its benefits, M-Health faces challenges such as ensuring data security and privacy, which are critical for maintaining user trust. Concerns about sensitive health data being mishandled or exposed can deter individuals from adopting M-Health technologies (Chen et al., 2022). Developers must implement robust encryption standards and transparent data usage policies to address these concerns.

For menopausal women, M-Health applications offer specialized functionalities like symptom tracking, access to virtual communities, and tailored health advice, addressing both physical and emotional needs (Rafati et al., 2023). Studies have shown that mobile application-based self-care training can significantly enhance the quality of life and reduce the severity of menopausal symptoms, highlighting the transformative potential of M-Health in supporting women's health (AlSwayied et al., 2022).

M-Health is reshaping healthcare by making it more inclusive, efficient, and patient-centered. However, despite these advantages, many M-Health solutions remain generic and are not specifically tailored to the complex and evolving needs of menopausal women. This limits their effectiveness in delivering sustained engagement and meaningful health outcomes. By leveraging advanced technologies and incorporating user-centered design principles, M-Health solutions have the potential to better address condition-specific needs such as menopause and contribute to the broader goals of healthcare innovation.

2.3 Previous studies on M-Health frameworks and applications for menopausal support

M-Health frameworks and applications have emerged as critical tools for addressing the challenges faced by menopausal women. Previous studies highlight their potential in symptom tracking, lifestyle management, and providing educational resources tailored to the needs of this demographic.

2.3.1 Existing M-Health frameworks for menopause management

M-Health frameworks have been developed to address various healthcare needs, including women's health and chronic condition management. These frameworks serve as a foundation for understanding how digital health solutions can be designed to improve accessibility, personalization, and engagement. Below are five notable M-Health frameworks, along with their advantages and limitations, providing valuable insights for developing an effective menopause management framework.

(i) Framework by Lee et al. (2015)

This framework focuses on understanding women's needs during menopause by incorporating symptom tracking, personalized advice, and accessibility. Its strength lies in its user-centric application, addressing specific health concerns with tailored solutions. However, the framework lacks advanced technological integration, such as machine learning, to provide adaptive support, limiting its ability to cater to evolving user needs. Fig. 1 shows Lee et al. (2015) framework.

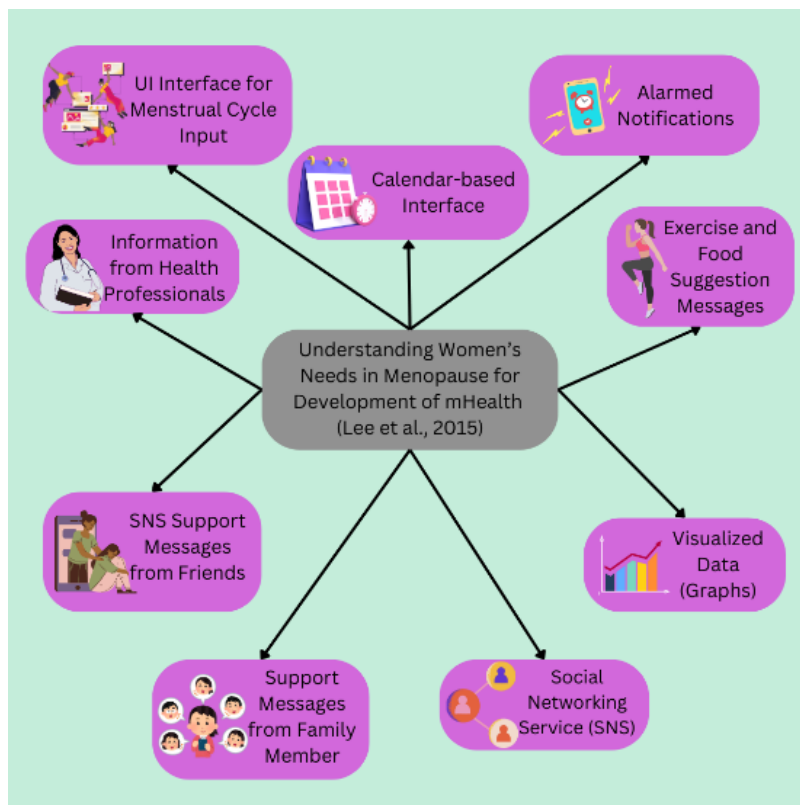


Fig. 1. Framework by Lee et al. (2015)

(ii) Framework by Halttu et al. (2015)

Halttu's framework integrates persuasive design elements to encourage user engagement and behaviour change. Features like reminders and gamification effectively sustain long-term use. Despite its strengths, the framework falls short in addressing data privacy and trustworthiness, which are critical for user

confidence, particularly in sensitive areas like menopause management. Fig. 2 shows Halttu et al. (2015) framework.

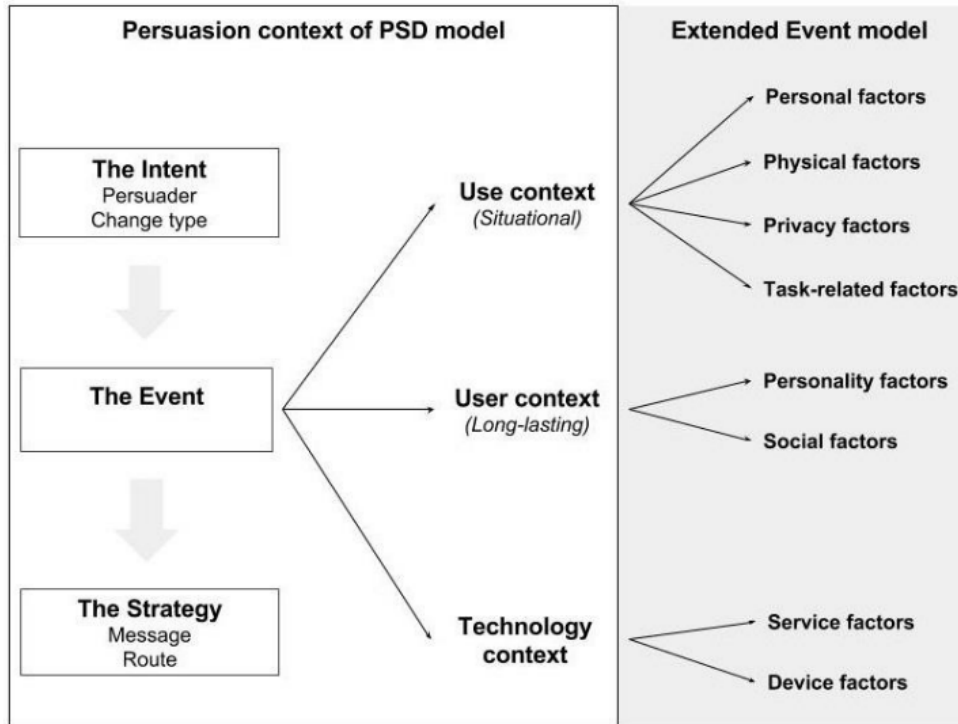


Fig. 2. Framework by Halttu et al. (2015)

(iii) Framework by Tutia et al. (2019)

Tutia's framework emphasizes human-computer interaction (HCI), offering an intuitive interface and age-inclusive design. This focus ensures usability for older adults, addressing cognitive and physical barriers to technology adoption. However, it lacks comprehensive features such as community support or telehealth integration, which are vital for holistic menopause management. Fig. 3 shows Tutia et al. (2019) framework.



Fig. 3. Framework by Tutia et al. (2019)

(iv) Framework by Burst et al. (2024)

Burst's framework incorporates a cultural sensitivity component, making it particularly relevant for diverse populations. Its advantage lies in its adaptability to different healthcare contexts. Nonetheless, its limitation is the absence of persuasive strategies, which are crucial for encouraging consistent user engagement and adherence to self-care practices. Fig. 4 shows Burst et al. (2024) framework.

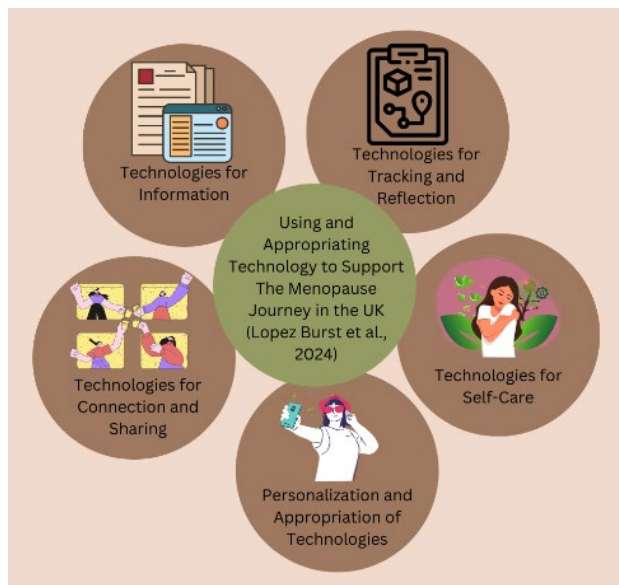


Fig. 4. Framework by Burst et al. (2024)

(v) Framework by Senette et al. (2018)

Senette's framework focuses on integrating wearable devices for real-time health monitoring and personalized feedback. Its strength lies in leveraging technology to provide users with actionable health insights. However, it lacks a virtual community component, which is essential for emotional support and shared learning among menopausal women. Additionally, while it prioritizes technological integration, it does not adequately address trustworthiness, a critical factor for adoption in health applications. Fig. 5 shows the Senette et al. (2018) framework.



Fig. 5. Framework by Senette et al. (2018)

The existing M-Health frameworks highlight the importance of personalization, accessibility, and cultural sensitivity in digital health solutions. However, a critical analysis reveals that these frameworks tend to address key elements such as persuasive strategies, trustworthiness, and user-centered design in isolation rather than in an integrated manner. This fragmentation limits their ability to support sustained user engagement and holistic menopause management. Therefore, developing a new M-Health framework for menopause management must prioritize the integration of these elements. This integration directly informs the design decisions of the proposed framework, where each component is systematically combined to enhance user engagement, build trust, and improve usability. This application will ensure a holistic, reliable, and impactful solution tailored to the needs of menopausal women.

Table 1 Comparative summary of existing M-Health frameworks for menopause management

Framework	Key Features	Strengths	Limitations	Gap Address by Proposed Framework
Lee et al. (2015)	Symptom tracking, personalized advice, accessibility	User-centric, tailored support	No machine learning, limited persuasive strategies, weak trust focus	Proposed framework adds persuasive strategies, trustworthiness and adaptive personalization
Halttu et al. (2015)	Persuasive design, reminders, gamification	Supports engagement and behavior change	Limited privacy and trust mechanisms	Proposed framework integrates trustworthiness and menopause-specific functions
Tutia et al. (2019)	HCI principles, age-inclusive interface	Good usability for older adults	Lacks community support and telehealth integration	Proposed framework incorporates social support and holistic functions
Burst et al. (2024)	Cultural sensitivity, adaptable design	Suitable for diverse populations	No persuasive mechanisms, limited engagement support	Proposed framework embeds persuasive strategies for sustained adherence
Senette et al. (2018)	Wearables, monitoring, personalized feedback	Strong technological integration	Lacks virtual community and trust dimension	Proposed framework combines monitoring, trust and community support

As summarized in Table 1, existing frameworks contribute valuable elements such as personalization, persuasive support, age-inclusive design, and monitoring capabilities. However, these frameworks tend to emphasize individual aspects in isolation rather than integrating persuasive strategies, trustworthiness, M-Health functions, and user-centered design into a unified structure. This comparative analysis reveals a research gap that motivates the proposed framework, which seeks to combine these complementary dimensions into a holistic menopause management solution.

2.4 Gaps in existing M-Health frameworks for menopause management

Based on the comparative analysis presented in Table 1, several gaps remain in existing M-Health frameworks for menopause management. Although prior frameworks address important aspects such as personalization, usability, and monitoring, these elements are often implemented in isolation rather than as an integrated solution. Three key gaps were identified: persuasive strategies, trustworthiness, and user-centered design (UCD).

2.4.1 Persuasive strategies

As observed in Table 1, only a limited number of frameworks incorporate persuasive strategies, and even then, these are often restricted to basic elements such as reminders or gamification. Many existing frameworks inadequately utilize persuasive strategies to engage users and promote sustained application use (Orji & Vassileva, 2023). Effective strategies, such as goal-setting, reminders, and gamification, are often underdeveloped or absent. Research highlights that incorporating these elements can enhance user motivation and adherence to self-care practices (Halttu et al., 2015). A lack of such strategies limits the ability of current frameworks to encourage long-term behavior change, an essential factor in menopause management.

2.4.2 Trustworthiness

The comparative analysis also indicates that trust-related elements are either underdeveloped or not explicitly addressed across most frameworks. The issue of trust remains a significant limitation in existing M-Health frameworks. Users often express concerns about data privacy, security, and the credibility of the information provided (Rafati et al., 2023). Frameworks that fail to implement robust encryption, transparent

data policies, and evidence-based content risk losing user confidence. Without trustworthiness, even the most advanced applications struggle to achieve widespread adoption and meaningful impact.

2.4.3. User-Centered Design (UCD)

While some frameworks demonstrate usability considerations, Table 1 shows that comprehensive user-centered design tailored to menopausal women remains insufficient. While some frameworks incorporate basic UCD principles, they often fail to address the diverse needs of menopausal women effectively. Features such as cognitive load reduction, inclusive design, and personalization are either limited or overlooked (Lee et al., 2015). Furthermore, many frameworks lack iterative feedback mechanisms, which are critical for refining functionalities based on real-world user experiences (Duran et al., 2023). Neglecting UCD elements reduces usability, particularly for older women who may face challenges in navigating digital health solutions.

Overall, the comparative findings highlight that existing frameworks tend to address persuasive strategies, trustworthiness, and user-centered design independently rather than as an integrated system. This fragmentation limits their effectiveness in supporting sustained engagement and holistic menopause management. Therefore, a significant research gap exists in developing a unified M-Health framework that systematically integrates these key components. Addressing this gap forms the foundation of the proposed framework, which aims to provide a comprehensive, user-centered, and trustworthy solution for menopause management.

3. METHODOLOGY

This study adopts a Design Science Research Methodology (DSRM) to guide the development of a conceptual M-Health framework for effective menopause management. The research involves iterative phases, ensuring the framework is systematically designed, tested, and refined based on empirical evidence and stakeholder feedback. Fig. 6 shows the overall DSRM model.

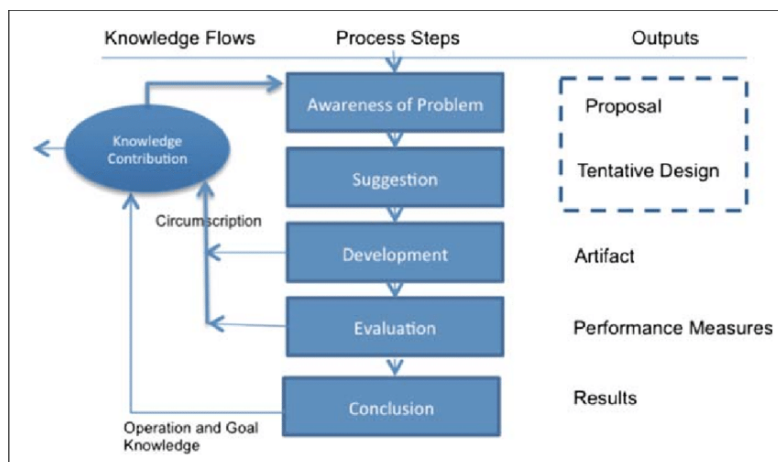


Fig. 6. DSRM model

3.1 Framework development process

3.1.1 Problem awareness phase

In the Problem Awareness phase, this study aims to identify and understand a specific problem through an extensive literature review. The researcher will define the problem, highlighting its significance and the motivation for addressing it. By analyzing gaps in current knowledge and practices, this phase lays the foundation for targeted research that aims to advance the field. The literature review will explore relevant methodologies, theories, and frameworks related to M-Health and effective menopause management, providing a basis for further investigation and comparison.

3.1.2 Suggestion phase

In the Suggestion phase, the research questions (RQs) and research objectives (ROs) are established to guide the study. These questions are developed based on the literature review to address the identified problem or opportunity. The RQs help shape the design and development of the conceptual framework for effective menopause management.

3.1.3 Development phase

In the Development phase, the researcher creates the design artefact, the M-Health conceptual framework for effective menopause management, which addresses the identified problem. This phase involves applying relevant theoretical frameworks to guide the design process and integrating a tailored conceptual framework to meet the specific challenges of menopause health management. Methodological rigour and systematic design principles are followed to ensure alignment with research objectives. The development includes comparative and content analysis to select the best components and applying a user-centered design (UCD) application approach to ensure the final framework is user-friendly and effective.

3.1.4 Evaluation phase

In the Evaluation phase, the effectiveness of the M-Health conceptual framework is assessed to determine how well it addresses the identified problem. This phase involves comparing the framework's objectives with observable outcomes from its use in context. The evaluation includes expert reviews, in-depth interviews (IDIs), and framework refinement. Experts from IT, Human-Computer Interaction, and medical fields will review the framework's usability, functionality, and health-related features, providing feedback for refinement. Data from the expert reviews will be analyzed using thematic analysis to identify areas for improvement. IDIs will further evaluate the framework's effectiveness by gathering detailed feedback from medical personnel, IT experts, and menopausal women. The insights will guide further adjustments to enhance the framework.

3.1.5 Conclusion phase

In the Conclusion phase, all stakeholders are informed about the problem and the proposed solution. The communication approach is tailored to the study's objectives and the audience, which may include professionals in the field. The phase includes data analysis and documentation activities. Data from the in-depth interviews will be analyzed using thematic analysis to identify key patterns and insights. Documentation involves compiling detailed records of the design process, including decisions, implementation, evaluations, and findings, ensuring transparency, replicability, and knowledge sharing.

3.2 Theories, principles and strategies for framework design

The proposed M-Health framework for menopause management draws on several established frameworks to ensure it incorporates persuasive strategies, trustworthiness, and user-centered design

(UCD). These frameworks provide foundational principles that guide the design and development of an effective, user-focused solution.

3.2.1 Persuasive technology model

The framework integrates concepts from the Persuasive Technology Model, which emphasizes techniques such as reminders, goal-setting, and gamification to sustain user engagement and encourage long-term behavior change (Guo et al., 2023). These strategies are crucial for motivating menopausal women to actively manage their health.

3.2.2 Trustworthiness

Building user trust is central to the framework's design. It incorporates robust data security measures, transparent policies, and evidence-based content inspired by frameworks like Senette et al. (2018), which emphasize the role of trust in fostering user confidence and application adoption.

3.2.3 User-Centered Design (UCD)

UCD is integral to the framework, ensuring it aligns with the needs and preferences of menopausal women. Features such as cognitive load reduction, intuitive interfaces, and iterative feedback mechanisms are informed by Lee et al. (2015), who highlight the importance of addressing usability challenges for aging populations.

The design of this M-Health framework is informed by established theories and models that prioritize persuasive strategies, trustworthiness, and UCD. By integrating these principles, the framework ensures accessibility, reliability, and meaningful engagement, addressing the unique challenges of menopause management.

3.3 Data collection methods used in the design process

The data collection methods employed in this study include expert reviews, in-depth interviews (IDIs), and model refinement. These methods ensure that the proposed M-Health framework is evidence-based, user-centered, and aligned with the needs of menopausal women.

3.3.1 Expert reviews

A panel of experts comprising healthcare providers, IT specialists, and human-computer interaction (HCI) professionals was engaged to evaluate the framework's functionality, usability, and effectiveness. Structured questionnaires with targeted questions allowed experts to assess the relevance and adequacy of each framework component.

3.3.2 In-Depth Interviews (IDIs)

Semi-structured IDIs were conducted with three key groups: menopausal women, healthcare professionals, and IT experts. These interviews provided qualitative insights into user needs, challenges, and preferences. The data gathered helped identify gaps and validate the proposed framework's features, such as symptom tracking, virtual community support, and teleconsultation.

3.3.3 Model refinement

Feedback from expert reviews and IDIs was analyzed to refine the framework iteratively. The refinement process focused on addressing usability issues, enhancing personalization, and integrating persuasive strategies to promote sustained engagement. This iterative approach ensured the framework's practical applicability and user satisfaction.

4. FRAMEWORK DESIGN

4.1 Key components of the M-Health conceptual framework

The M-Health Conceptual Framework for Effective Menopause Management is structured around four main components, each contributing to its overall effectiveness and user-centric approach. These components are briefly outlined as follows:

(i) Persuasive Strategies

Persuasive strategies form the core of the framework, guiding its design and functionality. This component ensures that users remain engaged and motivated to utilize the application effectively. By integrating key principles of persuasion, the framework encourages positive behavioral changes and long-term engagement.

(ii) Trustworthiness

Trustworthiness is critical for fostering user confidence and ensuring consistent system use. This component emphasizes creating a reliable and secure environment where users feel assured of their data's privacy and the credibility of the information provided.

(iii) M-Health Functions

This component provides a range of practical tools and features tailored for menopause management. These functions address various user needs, enabling efficient health monitoring, community interaction, and personalized insights to support well-being.

(iv) User-Centered Design (UCD) with Alignment to Aging

The framework adopts a UCD approach, ensuring inclusivity and accessibility for women aged 45 to 55. By aligning with aging-related needs, this component enhances usability and ensures that the framework remains relevant and adaptable to its target demographic.

These components form a cohesive framework that addresses the unique needs of menopausal women through a robust, engaging, and user-friendly M-Health solution.

4.2 Features and functionalities envisioned to support menopause management

The M-Health Conceptual Framework incorporates various features and functionalities designed to address the multifaceted needs of menopausal women. These include:

(i) Dashboard

A centralized interface provides an overview of key health indicators such as symptoms, activity levels, and medication schedules. The dashboard facilitates quick access to essential information and daily recommendations.

(ii) Virtual Community

An interactive space for users to connect, share experiences, and provide emotional support. This feature fosters a sense of community and reduces feelings of isolation.

(iii) User Profile

Personalization options allow users to input details such as the menopause stage, language preferences, and health goals. This feature ensures that the framework delivers tailored insights and recommendations.

(iv) Customized Health Information

Tailored advice on diet, exercise, emotional health, and symptom management. This feature empowers users to make informed decisions about their health.

(v) Calendar-Based Interface

A tool for tracking symptoms, medication adherence, and appointments. The calendar also allows users to export data for consultations with healthcare providers.

(vi) Notifications

Timely reminders for medication, health tips, and updates from the virtual community. Notifications ensure that users stay engaged and informed.

(vii) Tracking

Features to monitor menstrual cycles, symptoms, and overall health trends. Tracking provides users with valuable insights into their progress and well-being.

4.3 Initial design of M-Health conceptual framework for effective menopause

Fig. 7 depicts the initial design of the M-Health Conceptual Framework for Effective Menopause Management, which incorporates persuasive strategies as a core element. It also includes key components such as trustworthiness, M-Health functions, and UCD

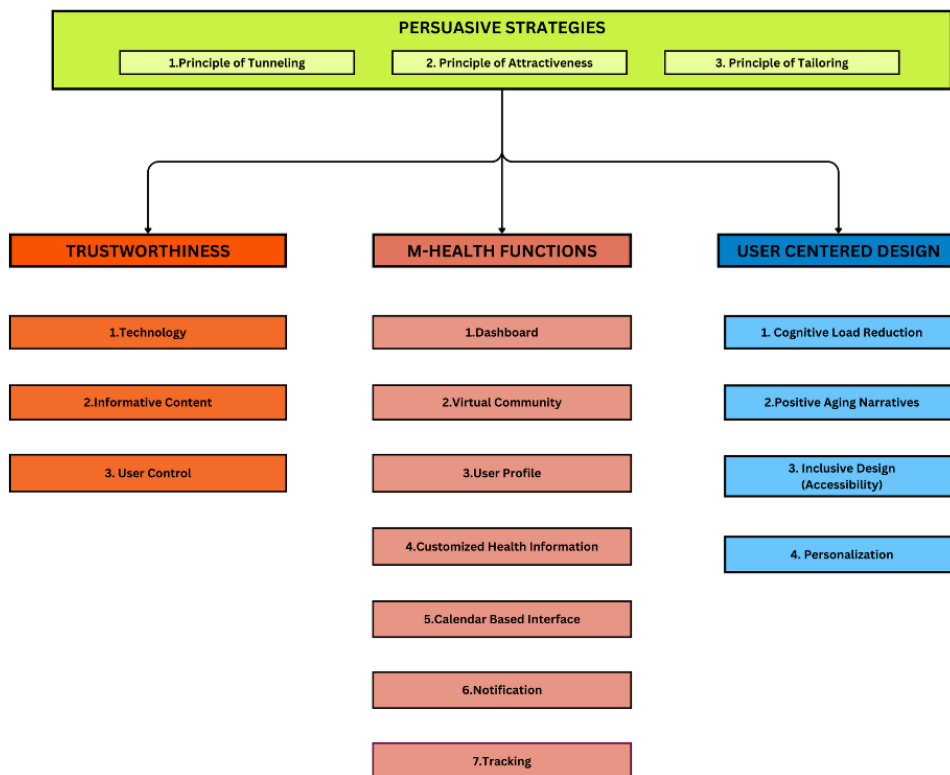


Fig. 7. Initial design of M-Health conceptual framework for effective menopause management

In this framework, persuasive strategies, namely tunneling, attractiveness, and tailoring, act as the driving mechanism that influences how users interact with the system and engage with its features. These strategies are embedded across the M-Health functions, guiding users through structured activities through tunneling, enhancing visual appeal and usability through attractiveness, and adapting content based on individual needs through tailoring.

The M-Health functions component serves as the operational layer of the framework, where features such as dashboards, virtual communities, personalized health information, and tracking tools support users in managing their menopausal symptoms. These functions are designed to work in conjunction with persuasive strategies to encourage continuous usage and self-management behaviours.

Trustworthiness underpins the entire framework by ensuring that users perceive the system as reliable and secure. Elements such as credible information, transparent technology, and user control contribute to building user confidence, which is essential for sustained engagement with sensitive health-related applications.

User-centered design (UCD) ensures that the system is accessible, intuitive, and tailored to the cognitive and emotional needs of menopausal women. Components such as cognitive load reduction, inclusive design, and personalization enhance usability and ensure that users can effectively interact with the system without unnecessary complexity.

These four components interact to support the overall user journey, beginning from initial engagement, through continuous interaction with system features, to long-term adherence and self-management. Persuasive strategies drive engagement, M-Health functions provide practical support, trustworthiness builds confidence, and UCD ensures usability, resulting in a cohesive and holistic framework for menopause management.

5. DISCUSSION

The proposed M-Health framework for effective menopause management will undergo an evaluation process with experts from various fields, including Information Technology (IT), Human-Computer Interaction (HCI), and medical practitioners. This evaluation will use structured questionnaires to assess the framework's usability, trustworthiness, and functionality. The feedback provided by these experts will play a crucial role in identifying areas for refinement, ensuring the framework aligns with both user needs and professional standards. Insights from this evaluation will contribute to an iterative development process, allowing the framework to evolve based on expert recommendations. Following the expert reviews, thematic analysis will be conducted to uncover key themes and patterns from the collected feedback. This analysis will highlight the framework's strengths, identify gaps, and provide actionable insights for improvement. In addition, in-depth interviews with IT specialists, HCI experts, and medical practitioners will offer qualitative perspectives on the framework's feasibility and practicality. These combined efforts aim to validate the proposed framework and enhance its relevance and effectiveness in addressing the complex challenges of menopause management.

6. CONCLUSION

The initial design of the M-Health Conceptual Framework for Effective Menopause Management represents an initial effort in addressing the multifaceted challenges faced by menopausal women. By integrating persuasive strategies, trustworthiness, and user-centered design elements, the framework is intended to provide a comprehensive approach for personalized and holistic care.

However, as this study is conceptual in nature, the proposed framework has not yet undergone empirical validation, and its effectiveness in real-world settings remains to be evaluated. The upcoming evaluations and interviews are expected to ensure that the framework is systematically tested and refined, contributing to its potential reliability and applicability.

This study is also subject to several limitations, including the absence of empirical data and reliance on existing literature for framework development. Despite these limitations, this research provides a foundational basis for future investigation and development. It highlights the potential role of M-Health technologies in supporting the quality of life for menopausal women and offers direction for future research and innovation in digital health solutions.

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8. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

9. AUTHORS' CONTRIBUTIONS

Nor Izzati Auni Mohd Jasni: Conceptualisation, methodology, framework design, formal analysis, investigation, data collection, and writing–original draft preparation; **Nadia Abdul Wahab:** Conceptualisation, methodology, validation, and writing–review and editing; **Aznoora Osman:** Conceptualization, validation, and writing–review and editing.

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