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Iterative Development of a Serious Game for Older Adults: The Usability-Informed Approach

Karuna Yampray[1*], Songphan Choemprayong[2,3] and Tatri Taiphapoon[4]

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ABSTRACT

This study presents the iterative usability evaluation of The Happy Cruise, a serious game specifically developed for older adults to support lifestyle-based market segmentation. Older adults represent a distinct user group facing usability challenges such as physical limitations, cognitive decline, and reduced digital engagement. To address these issues, the research adopted a problem–solution approach that integrated Nielsen's Usability Heuristics, Task Analysis, and the Serious Game Design Assessment (SGDA) Framework within an iterative design cycle. Twelve participants aged 60–75 completed expert reviews, task performance assessments, and user interviews. In the first iteration, eight participants experienced difficulties with navigation and input mechanisms. After implementing design modifications informed by heuristic evaluation and participant feedback, satisfaction improved substantially, with ten reporting positive experiences in the final iteration.

While ensuring data collection for market segmentation, findings highlight the importance of intuitive interfaces, adaptable difficulty levels, engaginggameplay, and social interaction features in developinginclusive gaming experiences for older adults. The study's novelty lies in demonstrating the rigorous integration of Nielsen's Heuristics, Task Analysis, and the SGDA Framework for designing serious games tailored to older adults.

Keywords: Usability Heuristic; Task Analysis; Serious Game Design Assessment Framework; Game Design; Older Adults

[1]Technopreneurship and Innovation Management Program, Chulalongkorn University, Bangkok, Thailand 10330
[2]Department of Library Science, Faculty of Arts, Chulalongkorn University, Bangkok, Thailand 10330
[3]Office of Academic Resources, Chulalongkorn University, Bangkok, Thailand 10330
[4]Faculty of Communication Arts, Chulalongkorn University, Bangkok, Thailand Chulalongkorn University, Bangkok, Thailand 10330
*Corresponding author e-mail: songphan.c@chula.ac.th

Introduction

Older adults are an increasingly significant segment of the gaming industry, now comprising 29% of U.S. video game players aged 50 and abovea notable rise indicating their growing interest in digital gaming [1]. Many seniors play not only for entertainment but also to remain cognitively and socially active, supported by game accessibility features and social interaction tailored to older users [2].

Market segmentation among older adults presents unique challenges and opportunities for researchers and marketers. Traditional lifestyle data collection methodssuch as surveys, interviews, and focus groupsface significant barriers when targeting this demographic. Older adults often experience survey fatigue more rapidly than younger populations, leading to incomplete responses or withdrawal from studies [3] Cognitive factors, including memory recall limitations and attention span variations, can compromise data quality [4,5].

Additionally, many seniors exhibit skepticism toward conventional market research approaches, viewing them as intrusive or irrelevant to their daily lives [6,7]. These methodological challenges result in underrepresented or inaccurate lifestyle profiles, limiting the effectiveness of age-appropriate product development and service delivery.

Game-based data collection offers a promising alternative by addressing these specific barriers. Interactive gameplay can maintain engagement for extended periods, reducing fatigue-related dropouts common in traditional surveys. Games naturally provide contextual cues and scenarios that support memory recall and decision-making processes. Furthermore, the entertainment value of games can transform data collection from a burdensome task into an enjoyable experience, potentially increasing participation rates and data completeness among older adults [8-13].

Despite this trend, there remains a clear research gap: no prior study has developed and evaluated a serious game explicitly designed to collect lifestyle data for market segmentation among older adults.

To address this gap, The Happy Cruise was developed as a serious game that engages older adults while simultaneously collecting lifestyle segmentation data. Its design was informed by interviews with older adults, psychologists, developers, and marketers, as well as prior marketing research on elderly lifestyles in Bangkok and surrounding areas. This integration of usability testing and market-oriented data collection represents the novelty of the study.

Given the dual goals of entertainment and segmentation, the usability assessment employed three complementary frameworks: Nielsen’s Usability Heuristics, Task Analysis, and the Serious Game Design Assessment Framework (SGDA) [14-16]. Prior research underscores the importance of usability for seniors, who face unique cognitive, physical, and sensory challenges. For example, Wang [17] applied Nielsen’s heuristics to compare

usability preferences between young and elderly users in brain-training games, while Pyae and Luimula[18] used the same framework to assess physical activity games for seniors, highlighting the importance of clear feedback and accessible mechanics.

Task Analysis has been used to break down player interactions and evaluate skills, tools, and environments [19]. Studies such as Gallagher et al. [20] and Vallejo et al. [21]demonstrate how task analysis can reveal problem-solving strategies and multitasking abilities. Meanwhile, the SGDA Framework, developed by Mitgutsch and Alvarado [22], evaluates games across six dimensionspurpose, content, mechanics, narrative, aesthetics, and framingshowing how coherence and impact can be assessed.

This research highlights that serious games targeting older adults must not only meet conventional usability standards and approaches [23-30] but also carefully balance simplicity, enjoyment, and accessibility.At the same time, these games must be capable of producing reliable lifestyle data, thereby serving both as engaging interventions and as effective tools for market segmentation and behavioral analysis.

The primary contribution of this study is to demonstrate how iterative usability-informed serious game design can improve engagement, navigation, and comprehension for older adultswhile pioneering the use of serious games as viable tools for lifestyle-based market segmentation in this demographic.

Methodology

The Happy Cruise was developed as an innovative marketing research tool aimed at capturing the complexity of older adults' lifestyles through a playful and accessible medium. Falling under the genre of serious games, its design prioritizes ease of playability while retaining the capacity to collect meaningful behavioral data. The core objective is to obtain lifestyle insights that are often difficult to capture through traditional surveys due to fatigue, disinterest, or hesitancy in self-reporting. By embedding data collection tasks within a fun and engaging narrative, The Happy Cruise aims to increase user motivation and interaction, thereby enhancing data quality and accuracy.

The overarching methodological framework for this study is design thinking, emphasizing iterative prototyping, testing, and refinement with continuous stakeholder feedback [31]. The development process followed a multi-phase, user-centered design. A prototype was created based on interviews with older adults, psychologists, and developers. The prototype included two main rooms (an exhibition room and a hobby room), each with two games and corresponding NPC interactions.

Participant Selection

Twelve participants aged 60–75 years were recruited from multiple senior centers and aging clubs acrossBangkokto enhance the diversity and better represent the

heterogeity of the older adult population.Inclusion criteria were established: participants must (1) reside in Bangkok or surrounding areas, (2) own and use a smartphone, (3) demonstrate basic digital literacy sufficient to install and operate mobile applications, and (4) maintain cognitive and physical functioningadequate for sustained gameplayactivites. These criteria ensure that findings can be applicable to community-dwelling older adults with baseline digital competency and experience.

In addition, the recruitment of participants also considered diverse backgrounds and life experiences. The participants included both men and women drawn from varied occupational groups such as retired government officials, teachers, state enterprise employees, housewives, and nurses. Using a purposive sampling technique, participants were intentionally selected to reflect diversity in gender, occupation, and life experience.

This approach ensured that the sample represented a cross-section of older adults in Bangkok aging clubs, capturing variations in lifestyle, prior work background, and social routines while still meeting inclusion criteria related to smartphone use, digital literacy, and cognitive/physical independence.

Iterative Process and Data Collection

The study applied three complementary frameworks across three iterations:

Iteration 1 – Usability Heuristics Testing

Older adults participated in structured gameplay tasks such as avatar customization, navigation, and NPC interaction. During gameplay, the research team observed interactions, noted challenges, and asked targeted questions to capture real-time opinions and feelings. Data collection combined think-aloud protocols, task completion rates, and error counts. This dual approach provided rich, experience-based feedback that informed initial design modifications, which were implemented before advancing to Iteration

Iteration 2–Task Analysis

Older adultsparticicants repeated core tasks such as avatar customization, settings configuration, room navigation, point exchange, and badge checking. The research team observed interactions, noted challenges, and asked targeted questions to capture real-time opinions and feelings. Data collection combined step checklists, task completion times, and observed difficulties. Findings showed that only 66.6% successfully completed point exchange and badge checking, highlighting usability gaps. Feedback from this iteration guided refinements to the reward and badge mechanisms and informed the expansion to 22 subgames.

Iteration 3 – SGDA Framework Evaluation

Older adults participants assessed all subgames using the Serious Game Design Assessment (SGDA) Framework, which evaluates six dimensions: purpose, content, mechanics, narrative, aesthetics, and framing. The research team observed interactions,

noted challenges, and asked targeted questions to capture real-time opinions and feelings. Based on participant feedback, refinements included a redesigned badge dashboard with social media sharing, streamlined item exchange processes, accuracy checks for in-game questions, simplified narratives, and a centralized lobby. These iterative improvements, validated through both qualitative methods (interviews, think-aloud, observations) and quantitative measures (task completion time, error rates, satisfaction levels), demonstrated clear gains in usability and engagement.

Game Mechanics

The final game casts players as global tourists aboard a cruise ship, with features including daily login rewards, avatar customization, and 11 lifestyle-based activity rooms. Motivational elements such as heart tokens for correct answers encouraged sustained engagement. These features were created to make the game easy to use and welcoming for everyone, while also collecting useful and accurate information about different lifestyles for market research.

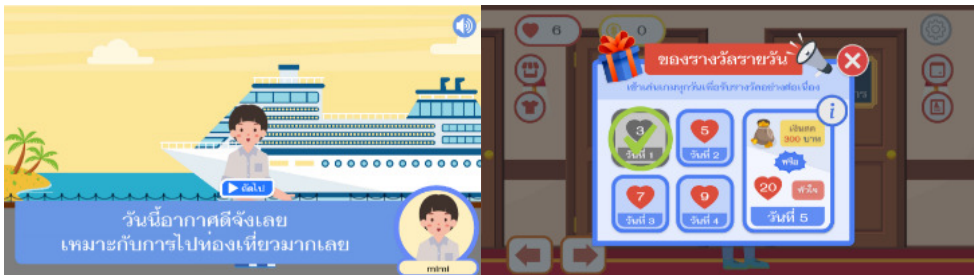

Figure 1 Gameplay Narrative and Daily Engagement Mechanism in The Happy Cruise

The figure illustrates the core gameplay structure of The Happy Cruise. Players take on the role of world-traveling tourists aboard a cruise ship, progressing through lifestylethemed activities that mirror real-world decisions. A daily login reward system encourages consistent participation, reinforcing habitual engagement. This mechanism sustains longterm interaction and ensures the collection of behaviorally rich, ecologically valid lifestyle data from older adult participants.

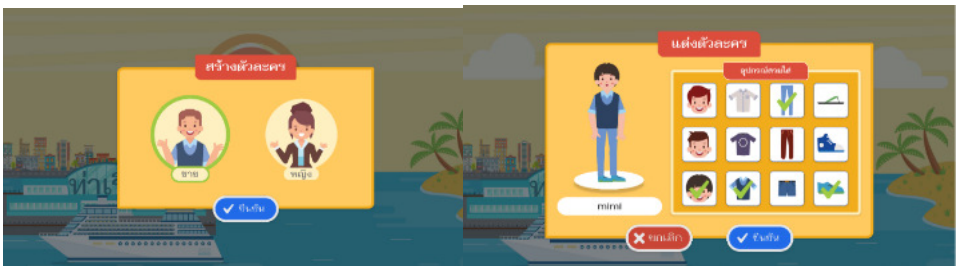

Figure 2 The player can select their gender and customize costumes according to their preferences.

The figure shows the personalization options in The Happy Cruise, allowing players to choose gender and customize costumes. These features strengthen engagement by enabling older adults to create avatars that reflect their identity, fostering immersion and a more enjoyable gameplay experience.

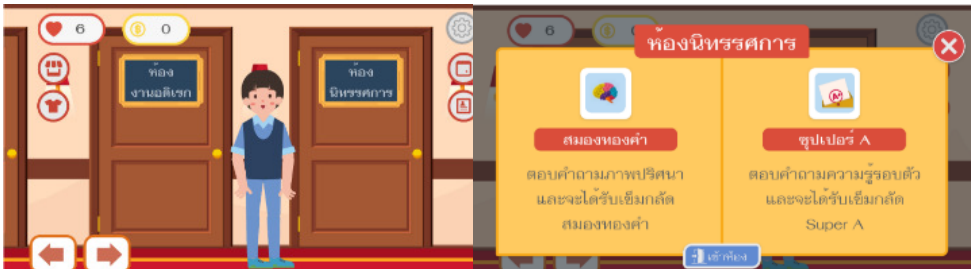

Figure 3 The game introduces players as world-traveling tourists aboard a cruise ship.

The figure illustrates the daily login process that promotes habitual interaction and sustained engagement. The game offers 11 lifestyle-based activities, organized into subrooms within the cruise ship's main room. Each sub-room is clearly labeled, allowing players to freely choose activities according to their interests. This open-ended design supports autonomy, personalization, and deeper immersion in gameplay.

Figure 4 The game room reflects an optimistic lifestyle theme and features the Golden Brain game.

The figure shows the Golden Brain game, set in an optimistic lifestyle-themed room. Players select the correct letters to form meaningful words, an activity designed to promote cognitive engagement and support vocabulary recall among older adults.

Figure 5 The game includes motivational features that encourage players to interact with in-game content.

The figure highlights motivational design elements that encourage active interaction. Players earn two heart tokens for correctly answering NPC questions. These tokens serve as in-game currency, unlocking additional features and reinforcing sustained engagement.

Results

The usability evaluation of The Happy Cruise with 12 older adult participants generated the following findings across three design iterations.

Iteration 1 – Usability Heuristics Testing

Evaluation findings

Feedback revealed several areas requiring improvement. Ten participants (83.3%) suggested enhancing flexibility and efficiency of use, while eight (66.6%) reported issues with

the system's alignment to real-world tasks. Six participants (50%) expressed a preference for recognition rather than recall, diagnosis, and error recovery. Areas least identified as problematic included user control and freedom, consistency, error prevention, and help/documentation, each cited by only two participants (16.6%). Overall, participants found the initial interface confusing, navigation menus complex, and the rewards system unclear.

Design Improvements

The initial evaluation revealed three major usability challenges: a confusing interface, complex navigation menus, and an unclear rewards system. Based on Nielsen's Usability Heuristics, the design team introduced the following improvements:

1. Simplification of the Initial Interface

The layout was streamlined by reducing visual clutter and restructuring menu hierarchies.Clearer labels and larger icons were introduced to support visibility and recognition.A tutorial overlay was added to provide step-by-step instructions before gameplay, ensuring that older adults could understand the basic mechanics without cognitive overload.

2. Navigation Enhancement

Arrowheads were added to facilitate left–right character movement, replacing dragbased controls that many participants found difficult.A consistent navigation bar was introduced across all game rooms to maintain familiarity and reduce disorientation.Redundant or nested menu options were removed, creating a more direct pathway for accessing key features.

3. Rewards System Clarification

The rules for earning and redeeming rewards were simplified and explicitly explained through both text and visual cues.The number of required actions for earning rewards (e.g., answering five questions) was reduced to make goals more attainable. A feedback message was added after each task to confirm the points or tokens earned, reinforcing recognition rather than recall.

These design improvements directly addressed the barriers identified during the heuristic evaluation, leading to greater interface clarity, smoother navigation, and increased transparency in the reward structurekey factors in enhancing usability for older adult players.

Iteration 2 – Task Analysis

Evaluation findings

Task completion data showed strong performance in several areas: all 12 participants (100%) successfully configured settings, subscribed through available methods, and customized avatars. All participants also engaged with NPCs and completed mini-games. However, only 8 participants (66.6%) successfully exchanged points for items or checked

badges. These tasks took longer to complete and were associated with higher error rates, indicating that reward and badge mechanisms were less intuitive than other game functions.

Design Improvements

Task analysis revealed that only 8 of 12 participants (66.6%) successfully completed tasks involving point exchange and badge checking, indicating confusion with these mechanics.

To address this, several design improvements were implemented:

1.Point Exchange Simplification

The redemption process was reduced to fewer steps, with large buttons and sequential prompts.Confirmation pop-ups clearly showed the item obtained and automatically equipped (e.g., shoes), ensuring players did not need to recall or recheck.

Figure 6 The redemption processof The Happy Cruise game

Figure 6 shows the simplified redemption process for exchanging points for shoes. The redesign provides immediate, visible confirmation of success, reducing reliance on memory and supporting older adults who may face attention or cognitive limitations.

2.Badge System Clarification

A dedicated badge dashboard was created to display collections with icons, progress bars, and short text labels.Tooltips explained badge purposes in plain, concise language.Linking badges to tangible benefits increased motivation and made abstract features easier to understand.

Figure 7 The badge dashboard of The Happy Cruise game

Figure 7 shows the simplified steps for claiming badges. The redesign transforms an abstract system into a concrete, visual, and reward-based experience, helping older adults better understand badge functions and stay motivated despite cognitive limitations.

Iteration 3 – SGDA Framework Evaluation

Evalutation Findings

The SGDA assessment showed that all participants (100%) understood room differences and the use of collected hearts, but only 2 participants (16.6%) understood the significance of badges. Eight participants (66.6%) rated the storyline as realistic, while four (33.3%) felt that some questions and answers were poorly aligned with context. Narrative organization was positively received, with 10 participants (83.3%) affirming coherence between events and character activities. Aesthetics were rated highly, as all participants (100%) found the graphics, colors, and audio appropriate; however, only 6 participants (50%) considered the questions appropriate. Two-thirds of participants (66.6%) reported overall satisfaction with the gameplay, though suggestions were made to simplify mechanics and add more tutorials.

Participants demonstrated high success rates in completing basic tasks such as configuration, subscription, and avatar customization, with all 12 participants (100%) performing these activities successfully. However, persistent challenges emerged in more complex interactions, particularly in point exchange and badge functions, where only 8 out of 12 participants (66.6%) completed the tasks effectively.

While participants valued the coherence of the storyline and the overall aesthetic quality of the game, they reported lower satisfaction with the clarity of in-game questions and the badge system. Overall, two-thirds of the participants (66.6%) expressed satisfaction with the gameplay experience and indicated their willingness to reply, highlighting both the strengths of the game and the areas requiring further refinement.

Design Improvements

The SGDA evaluation revealed that while participants appreciated the storyline coherence, aesthetics, and activity variety, many struggled to understand the reward system and found it confusing. Feedback also suggested that rewards should be offered more frequently and in smaller increments to maintain motivation.To address these issues, the design team implemented three major improvements:

1.Simplified Rewards System

The reward mechanism was redesigned to provide smaller, more frequent rewards with clear explanations.Visual cues and confirmation messages were introduced to ensure transparency and reduce confusion.This approach reinforced motivation while lowering the cognitive load for older adults.

2.Enhanced Interactivity

Additional interactive elements were added to create a more engaging experience, including responsive feedback during gameplay and progress indicators. These features supported sustained attention and helped older players better understand their progress.Additional interactive elements were added to create a more engaging experience, including responsive feedback during gameplay and progress indicators.These features supported sustained attention and helped older players better understand their progress.

3.Streamlined Game Flow

Redundant mechanics were simplified, and a centralized lobby was introduced to make navigation more intuitive.This improvement reduced complexity and supported smoother transitions between activities.

Overall, these refinements improved both usability and participant satisfaction, demonstrating the value of the iterative design process. By directly linking SGDA feedback to specific adjustments, The Happy Cruise became more engaging, motivating, and accessible for older adult users.

Table 1 Gameplay Mechanics Used analysis

Topic	Details of SGDA Framework Testing	Average	Data range
Gameplay mechanics used	Number of games completed successfully.	79	19-105
	Total time spent playing the game (in seconds).	2629	853-5058
	Time spent playing each game (in seconds).	46.5	35-57

The gameplay mechanics analysis (Table 1) provides further evidence of how older adults engaged with The Happy Cruise. On average, participants successfully completed 79

games, though the wide range (19–105) reflects individual differences in pace and persistence. The mean total playtime of 2629 seconds (≈44 minutes) indicates that older adults were willing to remain engaged for extended periods, surpassing typical survey completion times. Furthermore, the average of 46.5 seconds per game, with relatively narrow variation (34–57 seconds), suggests that each task was appropriately scoped for sustained attention without overwhelming cognitive load.

These findings reinforce the study's iterative improvements, showing that the integration of simplified interfaces, clearer rewards, and interactive feedback enabled older adults to engage more consistently and meaningfully. Importantly, such consistent engagement demonstrates the game's potential not only to provide enjoyable experiences but also to serve as a practical tool for collecting ecologically valid lifestyle dataan outcome rarely achieved through traditional surveys.

Discussion

Iterative Usability-Informed Design for Older Adults

This study demonstrates how iterative, usability-informed design can significantly enhance the accessibility and effectiveness of serious games for older adults. By applying three complementary frameworksNielsen's Usability Heuristics, Task Analysis, and the Serious Game Design Assessment (SGDA) Frameworkdesign decisions were systematically guided and validated across three development cycles. Each iteration not only addressed immediate usability issues but also contributed to the broader objective of positioning The Happy Cruise as both a meaningful leisure activity and an innovative tool for lifestyle-based market segmentation.

Usability Heuristics: Reducing Cognitive Load

The first iteration highlighted that older adults experienced confusion with interface complexity, menu hierarchies, and unclear reward structures. These findings are consistent with Nielsen's principles of visibility of system status and recognition rather than recall [14], which are especially critical for populations facing age-related declines in memory and processing speed [17,18,34,36]. Streamlining the interface, adding consistent navigation, and clarifying the reward system directly reduced cognitive load and improved comprehension.

Prior research confirms that simplifying menus, enlarging fonts, and reducing trial-and-error learning barriers are essential for older adults to develop confidence and autonomy in early gameplay[35].

Task Analysis: Supporting Stepwise Learning

The second iteration revealed that while participants could successfully configure settings and customize avatars, many struggled with multi-step processes such as point

exchange and badge checking. Task analysis uncovered these bottlenecks by breaking down player actions into discrete sequences [19,20].The redesign, which simplified redemption processes and introduced a badge dashboard with visual progress cues, reflected principles of error prevention and progressive disclosure [21].These changes were especially significant for older adults, whose working memory limitations make multi-step interactions challenging. This aligns with user-centered design studies that show older adults prefer incremental task complexity, guided tutorials, and supportive feedback to avoid frustration and abandonment [31,35].

SGDA Framework: Enhancing Engagement and Coherence

The third iteration, guided by the SGDA framework [22], underscored that while narrative coherence and aesthetics were well received, abstract mechanics such as badges remained poorly understood. The introduction of smaller, more frequent rewards, interactive feedback, and a centralized lobby exemplified the mechanics and framing dimensions of SGDA, aligning game design with older adults' motivational needs. By grounding abstract features in tangible outcomes, the redesign enhanced both usability and sustained engagement, ensuring that older adults perceived gameplay as meaningful rather than confusing. This refinement is supported by prior work emphasizing that older adults value clear reward structures, narrative relevance, and scaffolding to sustain motivation [33,36]. The interplay of usability and narrative coherence illustrates how engagement for older adults requires both functional clarity and emotional resonance.

Implications for Serious Game Design for Older Adults

Synthesizing these findings, several design principles emerge as guidelines for future serious games targeting older populations:

1.Simplicity and consistency in interface design to reduce cognitive barriers [17,23,34,35].

2.Stepwise task structuring and immediate feedback to accommodate working memory constraints [31,32].

3.Frequent, tangible rewards and interactive elements to sustain motivation [18,22,36].

4.Contextually meaningful narratives and activities to align with older adults' real-life experiences and values [2,25,33].

5.Transparent dashboards and progress indicators to reinforce a sense of achievement and autonomy [26,35].

These principles highlight that designing for older adults requires not only usability enhancements but also motivational scaffolding that supports long-term interaction.

Linking Usability Improvements to Lifestyle Segmentation

The iterative refinements also directly advance the study's market research objective: to gather ecologically valid lifestyle data from older adults. By enabling effortless navigation and meaningful interactions, the game embedded data collection within

engaging experiences. Daily login frequency provided insight into routines, choice of activity rooms reflected leisure preferences, and avatar customization revealed self-expression patterns. This approach mitigates the fatigue and disinterest often associated with traditional surveys [34].Prior usability studies confirm that embedding data collection within playful contexts increases ecological validity and the reliability of lifestyle insights [35].

Limitations and Implications

This study acknowledges several limitations that should be considered when interpreting the results of the usability evaluation of The Happy Cruise.

1. Sample Access

Participant recruitment was constrained by the COVID-19 outbreak, which restricted gatherings at adult schools and community centers. Although online delivery was explored, it was not feasible for many older adults lacking sufficient technology familiarity. Consequently, the sample was drawn from a limited pool, affecting representativeness.

2. Technical Limitations

Although the game was designed for compatibility with major web browsers, certain mobile operating system versions (e.g., iOS 15.4) produced display errors such as screen vibration. Participants were required to update their systems (e.g., to iOS 15.4.1) to ensure proper gameplay, highlighting potential barriers in device optimization.

3. Internet Restrictions

As a web-based application, the game required constant internet connectivity. Some participants lacked stable access, limiting their ability to engage fully with the game and underscoring the importance of considering connectivity barriers when designing for older adults.

4. Design Complexity

The game was developed to capture lifestyle data across 11 segmentation patterns, requiring the creation of 22 subgames. This level of complexity increased development and testing time and necessitated robust database management to store behavioral data, posing resource challenges for future scalability.

5. Need for Periodic Updates

Because older adults' lifestyles evolve with technological and societal changes, the game requires regular updates to remain relevant. This continual redesign increases development costs and demands ongoing investment in usability testing.

6. Integration with External Systems

The game employed Facebook's API for subscription and login, ensuring compliance with PDPA requirements. However, reliance on third-party systems raises risks, such as policy changes or API modifications, which could affect access or functionality. Although

the current design avoids direct payment integration, future expansions may require careful planning to balance usability, privacy, and security.

These limitations offer important implications. Future studies should recruit from more diverse populations to enhance generalizability, optimize cross-platform performance, and develop offline or low-bandwidth modes to improve accessibility. Modular game structures may reduce design complexity while preserving data richness. Adaptive content should be prioritized to reflect changing lifestyles of older adults, and integration with external systems must balance usability with ethical and data privacy considerations.

Addressing these issues will support the development of more resilient, inclusive, and adaptable serious games that both engage older adults and generate high-quality lifestyle data for research and policy.

Conclusion

This study demonstrates that usability-informed iterative design is essential for developing serious games tailored to older adults. By applying Nielsen's Heuristics, Task Analysis, and the SGDA Framework in an integrated process, The Happy Cruise achieved measurable improvements in navigation, comprehension, and reward transparency. The primary contribution lies in reframing usability barrierssuch as installation difficulty, interface confusion, and abstract systems like badgesnot as insurmountable limitations, but as design challenges that can be systematically resolved through iterative refinement.

Beyond improving gameplay, the study highlights the broader role of serious games as tools for lifestyle-based market segmentation. By embedding data collection within engaging play, The Happy Cruise generates behaviorally rich insights while enhancing older adults' physical, cognitive, and social engagement. This dual function positions serious games at the intersection of entertainment, research, and marketing innovation.

For future research, broadening participant recruitment, enhancing cross-platform accessibility, and considering cultural contexts will be critical. By continuously refining usability and engagement strategies, researchers and developers can ensure that serious games not only entertain but also empower older adults while producing actionable data for industry and policy.

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