

Determinants of Elderly Users' Satisfaction and Engagement with Senior-Focused Puzzle Applications: Evidence from User-Generated Content

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Abstract:

Purpose: This study investigates the drivers of elderly users' satisfaction and engagement with a senior-focused puzzle application using large-scale marketplace reviews to examine post-adoption experience domains relevant to age-related needs.

Methodology: English language reviews of Vita Jigsaw for Seniors were collected from the Google Play Store (53,800 reviews). After screening, 36,853 reviews were retained, and deep cleaning produced 17,216 analysis-ready reviews. A mixed-methods design combined sentiment analysis and LDA topic modelling to derive experience dimensions and map them to eight theory-grounded constructs. Three experts validated the keyword to construct the mapping. Confirmatory testing used PLS regression with a Random Forest robustness check.

Findings: PLS results showed that system quality, information quality, service quality, accessibility, perceived enjoyment, and flow experience were positively and significantly associated with satisfaction across polarity and subjectivity specifications ($R^2 = 0.952$ and 0.793 , respectively). Satisfaction was positively and significantly associated with engagement, although explained variance was modest ($R^2 = 0.080$ and 0.078). Random Forest importance rankings highlighted accessibility and system quality as the most influential predictors of satisfaction.

Originality: The study contributes a validated, theory-grounded, review-based measurement approach that links senior app experience dimensions to satisfaction and engagement using longitudinal marketplace data.

Practical implications: Designers should prioritize accessibility for seniors and reliable performance while supporting enjoyable, immersive gameplay to enhance satisfaction and engagement among older users. For policymakers and digital inclusion stakeholders, the results provide evidence-based criteria for evaluating and promoting senior-friendly apps to support older adults' digital well-being.

Keywords

Elderly users; Senior-focused puzzle applications; User satisfaction; User engagement; Information systems success; User-generated content

1. Introduction:

Older adults are increasingly using digital technologies for everyday activities and leisure (Y. Zhang et al., 2025). Puzzle and brain-training applications for seniors fall into an exceptional category because they combine fun activities with exercises that improve memory, concentration, and visuospatial skills (Barnard et al., 2013; Chen & Chan, 2014). The number of older people using these tools is growing worldwide due to global aging, the rise of smartphones, and public digital-inclusion programs (Kebede et al., 2022). Maintaining satisfaction and continued use remains a challenge (Chen & Chan, 2014). In practice, many users discontinue after limited trial experiences, particularly when interaction effort, clarity, or stability becomes a barrier for older adults. Even though senior puzzle apps spread quickly, users are occasionally inconsistent with them; many stop using them after a few tries. Previous research has focused on acceptance and usability rather than on post-adoption experience, leading to deficiencies in evaluation, emotion, and perseverance (Gomez-Hernandez et al., 2023). As a result, evidence remains limited on which experience dimensions in real-world use are most strongly associated with older adults' satisfaction and engagement in senior-focused puzzle applications. Conventional information systems models rarely emphasize accessibility or cognitive limitations, hence diminishing their explanatory efficacy for this demographic. Accordingly, clearer integration is needed between functional quality, age-aligned accessibility, and experiential immersion in a post-adoption setting.

To address this gap, the study integrates three complementary theoretical lenses, which are consolidated in the Literature Review section before hypothesis development. First, the Information Systems (IS) Success model posits that system, information, and service quality shape post-adoption evaluations such as satisfaction and continued use intentions (DeLone & McLean, 2003). Second, Human-Computer Interaction (HCI) research on aging highlights accessibility as a contextual requirement for older users, including perceptual clarity, cognitive simplicity, and interaction designs that reduce effort and error costs (Hawthorn, 2007; Sayago & Blat, 2009). Third, hedonic-use perspectives and Flow Theory emphasize perceived enjoyment and flow experience as immersion-related states that can strengthen favorable evaluations in leisure technologies (Babin et al., 1994; Helal et al., 2024; Venkatesh et al., 2012). Engagement is conceptualized as a review-expressed post-adoption outcome reflected in continued-

involvement language, and the satisfaction–engagement link is examined as a predictive association in observational review data. The study is guided by the following research questions:

RQ1: Which functional quality, accessibility, and experiential factors are associated with elderly users' satisfaction with senior-focused puzzle applications?

RQ2: To what extent is satisfaction associated with elderly users' engagement expressions in senior-focused puzzle applications?

This research delineates and substantiates the determinants of pleasure and engagement among aged users of senior-oriented puzzle applications. It employs a mixed-methods exploratory–confirmatory framework and draws on findings from Vita Jigsaw for Seniors. The objectives are: (1) to identify latent experiential and functional themes in user-generated reviews; (2) to correlate these themes with dimensions from IS success, HCI accessibility, and flow theories; and (3) to evaluate interrelationships by predictive modeling. A two-phase design is applied. The exploratory phase utilizes topic modeling and sentiment analysis on app-store evaluations to uncover experiential dimensions and quality indicators in natural language (Archak et al., 2011; Tirunillai & Tellis, 2014). The confirmatory phase uses Partial Least Squares (PLS) regression to construct a structural prediction model and Random Forest regression to test its robustness. This allows for comparing theory-guided routes with non-parametric prediction in real-world situations. The mixed-methods design is explicitly structured into an exploratory phase (construct identification and mapping) and a confirmatory phase (prediction-oriented hypothesis testing).

In theory, the IS Success model is extended by incorporating accessibility, perceived enjoyment, and flow, tailoring success logic to elderly-focused hedonic–utilitarian systems and clarifying satisfaction–engagement associations (DeLone & McLean, 2003; van der Heijden, 2004). We provide helpful guidance for developers and policymakers on creating accessible, emotionally engaging experiences. This includes ensuring that text is easy to read, allowing for quick mistake correction, reducing interaction costs, and adding adaptive personalization that helps people feel comfortable and stay interested. The other sections are organized as follows: Section 2 reviews the work and identifies any gaps. Section 3 describes how the research will be done. Section 4 presents exploratory

findings. The model and hypotheses are developed in Section 5. Section 6 presents an analysis confirming the results. Section 7 addresses the implications and limitations. Section 8 concludes.

2. Literature review

2.1. Digital inclusion and senior-focused applications

Digital inclusion means having access to technology, knowing how to use it, and feeling confident in its use (Kebede et al., 2022). Adoption is still unequal and depends on how useful, easy, and helpful people perceive it to be (Venkatesh et al., 2012). Mobile cognitive applications, such as puzzle, memory, and logic games, provide low-risk, repetitive tasks that can enhance attention, working memory, and positive affect (Amouzadeh et al., 2025; De Schutter, 2010; Silva et al., 2024). As people get older, their inherent cognitive load increases. Interfaces with many features and non-linear navigation make mistakes more expensive, while simpler flows and gradual information revelation make them less costly (Arning & Ziefle, 2007). Usability challenges, such as small touch targets, low contrast, and unclear icons, make learning and feeling confident more difficult (Mitzner et al., 2010). Most previous research focuses on adoption intentions and one-time usability (Akdin et al., 2022; Wang et al., 2022). Post-adoption experiences, ongoing satisfaction, and continuing usage are insufficiently explored in senior environments, despite their significance in IS continuation models (Bhattacharjee, 2001). For cognitively oriented mobile games, the design should maintain enjoyment and reduce friction while validating anticipated advantages through explicit progress feedback. Despite the growth of senior-focused puzzle applications, there is limited empirical evidence on how older users' post-adoption satisfaction and engagement are reflected in real-world marketplace use and feedback.

2.2. User experience and quality perspectives in elderly digital contexts

Based on the IS Success tradition, older users' satisfaction and continued usage of senior puzzle applications can be understood as post-adoption outcomes associated with perceptions of system, information, and service quality (Bhattacharjee, 2001; DeLone & McLean, 2003). Quality factors forecast satisfaction and retention in e-services, e-learning, and FinTech (Parasuraman et al., 2005; Sun et al., 2008; Zhou, 2013). However, this

research seldom addresses age-related sensory and cognitive constraints that influence hedonic experiences. Accordingly, quality conceptualization in elderly digital contexts benefits from explicit attention to accessibility-related requirements. Information quality involves breaking things down and pacing; system quality emphasizes stability and error correction; and service quality focuses on providing care and nudges that help people maintain their independence. Changes in eyesight, motor control, and working memory that happen with age make these aspects have an even bigger effect on satisfaction and continuance (Vaportzis et al., 2017). Existing IS quality frameworks provide limited specificity regarding sensory, cognitive, and accessibility requirements in older-adult hedonic applications, motivating context-sensitive extensions in senior puzzle settings.

2.3 Accessibility, enjoyment, and flow in senior interaction design

Accessibility enhances system quality beyond its fundamental functions and makes it more inclusive (Kim & So, 2022). In HCI, accessibility means that the interface is easy to read, the type is scalable, there is enough contrast, the touch targets are big enough, and the visuals are simple (Gomez-Hernandez et al., 2023). Larger font sizes and typography make text easier to read, which helps people who read slowly or whose eyesight changes with age (DYSON & HASELGROVE, 2001; Hawthorn, 2007). Touch accuracy increases with larger targets and greater spacing, reducing motor variability (Park et al., 2017), although less visual complexity and standard layouts enhance orientation (Tuch et al., 2012). These design choices can reduce errors and cognitive effort, which is particularly relevant for older users. In addition to accessibility, subjective enjoyment and flow are important states of experience that maintain immersion and satisfaction. Research in IS indicates that hedonic motivation and cognitive absorption, a flow-like state, facilitate adoption and persistence (Agarwal & Karahanna, 2000; Helal et al., 2024; van der Heijden, 2004; Venkatesh et al., 2012) however, suggests that holistic experiences with technology as captured in constructs such as enjoyment and flow are potentially important explanatory variables in technology acceptance theories. In this paper, we describe a multi-dimensional construct labeled cognitive absorption and defined as a state of deep involvement with software. Cognitive absorption, theorized as 'Cynthia Beath was the accepting senior editor for this paper. being exhibited through the five dimensions of temporal dissociation, focused immersion, heightened enjoyment,

control, and curiosity, is posited to be a proximal antecedent of two important beliefs about technology use: perceived usefulness and perceived ease of use. In addition, we propose that the individual traits of playfulness and personal innovativeness are important determinants of cognitive absorption. Based on the conceptual definition of this construct, operational measures for each dimension are developed. Using the World Wide Web as the target technology, scale validation indicates that the operational measures have acceptable psychometric properties and confirmatory factor analysis supports the proposed multi-dimensional structure. Structural equation analysis provides evidence for the theorized nomological net of cognitive absorption. Theoretical and practical implications are offered. Keywords: "author": {"dropping-particle": "", "family": "A garwal", "given": "Ritu", "non-dropping-particle": "", "parse-names": false, "suffix": ""}, {"dropping-particle": "", "family": "Karahanna", "given": "Elena", "non-dropping-particle": "", "parse-names": false, "suffix": ""}, {"container-title": "MIS Quarterly", "id": "ITEM-1", "issue": "4", "issued": {"date-parts": [{"2000", "12"}]}, "page": "665", "title": "Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage", "type": "article-journal", "volume": "24"}, {"uris": ["http://www.mendeley.com/documents/?uuid=4e6e21d7-d1194-b9d-b8495-a12c3469a71"], {"id": "ITEM-2", "itemData": {"DOI": "10.230725148660/", "ISSN": "02767783", "abstract": "[This paper studies the differences in user acceptance models for productivity-oriented (or utilitarian. When challenges and skills are balanced, attention is concentrated, and time seems to fly by, flow happens (X. Yang, 2023). This gives people intrinsic pleasures that make them want to keep playing games and using mobile services. In puzzle apps for seniors like Vita Jigsaw for Seniors, users may enjoy the game less as it gets harder, but more because the interactions are easy to understand and forgiving, making them feel comfortable, independent, and competent. Nevertheless, most information on enjoyment and flow comes from general gaming or mobile contexts involving younger adults, with little contextualization for older adults (Mitzner et al., 2010). For older adults, flow may rely on seamless onboarding, regular feedback, and steady pacing instead of challenge loops. There is a lack of empirical integration of accessibility with hedonic-motivational antecedents in models of senior satisfaction and continuance (H. Yang et al., 2023; Y. Zhang et al., 2025). This gap motivates an integrated perspective in which accessibility, enjoyment, and flow are examined jointly in relation to post-adoption satisfaction in senior-focused puzzle applications.

2.4. Engagement as a post-adoption outcome

Engagement is the level and degree of a person's involvement with an activity, product, or situation (Nakagomi et al., 2025) potentially offering cognitive, social, and physical benefits. However, its broader impact on health and well-being, particularly in real-world settings, remains unclear. Objective: This study aimed to evaluate the multidimensional effects of digital gaming on health and well-being among older adults, using data from the Japan Gerontological Evaluation Study conducted in Matsudo City, Chiba, Japan. Methods: Data were drawn from 3 survey waves (2020 prebaseline, 2021 baseline, and 2022 follow-up). Engagement in senior-oriented puzzle applications constitutes a persistent cognitive and behavioral commitment to the program, evidenced by repeated usage, favorable sentiment, advocacy, and loyalty-like behaviors (Brodie et al., 2011; Hollebeek, 2011). In IS and marketing, satisfaction frequently serves as a mediator in the transition from usage to engagement or loyalty by validating expectations and reinforcing attitudes, hence stabilizing continuance (Anderson & Srinivasan, 2003; Bhattacharjee, 2001; Oliver, 1999). Additionally, habit and experiencing value can transform fulfilled intentions into actual re-engagement over time (Kumar et al., 2010; Limayem et al., 2007) this assumption may not be as readily applicable to continued IS usage behavior since it ignores that frequently performed behaviors tend to become habitual and thus automatic over time. This paper is a step forward in defining and incorporating the "habit" construct into IS research. Specifically, the purpose of this study is to explore the role of habit and its antecedents in the context of continued IS usage. Building on previous work in other disciplines, we define habit in the context of IS usage as the extent to which people tend to perform behaviors (use IS). For older adults who utilize Vita Jigsaw for Seniors, engagement is more than just completing puzzles. It also includes psychological connection, meaning, and satisfaction. Previous research indicates that older persons continue using technology when the design fosters simplicity, confidence enhancement, and socio-emotional benefits (Barnard et al., 2013).

Game studies indicate that older players prioritize relaxation, enjoyment, and self-affirmation over competition, hence correlating involvement with hedonic benefits (Babin et al., 1994; De Schutter, 2010). In senior puzzle circumstances, engagement signifies a persistent attachment that integrates cognitive effort, habitual behavior, and emotional resonance, rather than simply task efficiency. However, engagement

is frequently operationalized using survey or behavioral log measures, whereas marketplace reviews primarily provide narrative expressions of ongoing involvement rather than verified usage intensity (e.g., frequency or duration). This limitation motivates conceptual clarification of engagement as “review-expressed engagement” in review-based studies, and cautious interpretation of the satisfaction–engagement relationship as associational.

Empirical work remains limited in explaining how post-adoption mechanisms generalize to senior-focused puzzle applications. Continuance studies commonly emphasize utilitarian quality and satisfaction, while consumer-oriented models highlight hedonic motivation and habitual behavior. HCI research on older adults documents enduring perceptual, cognitive, and motor constraints in mobile interaction, while service research emphasizes affective and sensory experiences as determinants of satisfaction and loyalty (Barnard et al., 2013; Molinillo et al., 2022). Senior puzzle application research has only partially integrated these streams, leaving limited evidence on how IS quality, age-aligned accessibility, and experiential states (enjoyment and flow) jointly relate to post-adoption satisfaction and review-expressed engagement.

Evidence from related mobile contexts underscores confirmation and pleasure, but often lacks age-specific accessibility considerations (Oghuma et al., 2016). and accessibility research frequently prioritizes compliance over practical usability (Kosztýánné Mátrai, 2018).

3. Research design:

This study uses a two-stage mixed-analyses design to explain how elderly users evaluate senior-focused puzzle applications and how these evaluations translate into engagement. The research relies on naturally occurring user-generated content, specifically public reviews posted on major mobile app stores, because such reviews capture experience-based assessments formed during real use (Ahmed et al., 2026; Al-Sharafi et al., 2026).

In the first stage, an exploratory analysis is conducted to identify recurring experience patterns in the review texts and to organize them into the study’s conceptual dimensions. This stage applies sentiment analysis and LDA topic modelling to surface salient experience themes and to support construct specification. This stage supports

theory-informed construct specification by linking review themes to quality and experiential factors and by clarifying how elderly users describe satisfaction-related experiences. The variables in the conceptual model are identified through a structured construct-specification procedure that integrates theory with empirical evidence from the exploratory outputs. Specifically, candidate constructs are defined based on prior IS, HCI, and experiential-use literature; their empirical presence is verified using the most coherent and interpretable LDA topics and sentiment patterns; construct-level keyword sets are then derived from topic-word evidence through independent coder mapping and reconciliation; and the resulting mapping is evaluated by domain experts before confirmatory testing.

In the second stage, the resulting constructs are operationalized as review-level variables and used to evaluate the proposed relationships in the conceptual model. The analysis focuses on estimating the effects of the antecedent dimensions on elderly users' satisfaction and then assessing how satisfaction relates to engagement with senior-focused puzzle applications. Confirmatory testing is conducted using PLS regression, and a Random Forest model is used as a robustness check to examine whether predictor importance remains consistent under a nonlinear specification. Model checks are performed to ensure that a single analytical choice does not drive conclusions.

Across both stages, the study follows a consistent data-handling protocol, including review screening, text preparation, and anonymized, aggregated reporting. Since the data are publicly available and no user identification is attempted, the study presents results in a way that minimizes traceability while preserving evidentiary support through brief, non-identifying examples where needed. Figure 1 summarizes the overall research process and illustrates how the two stages connect, from review-based exploration to model testing and interpretation.

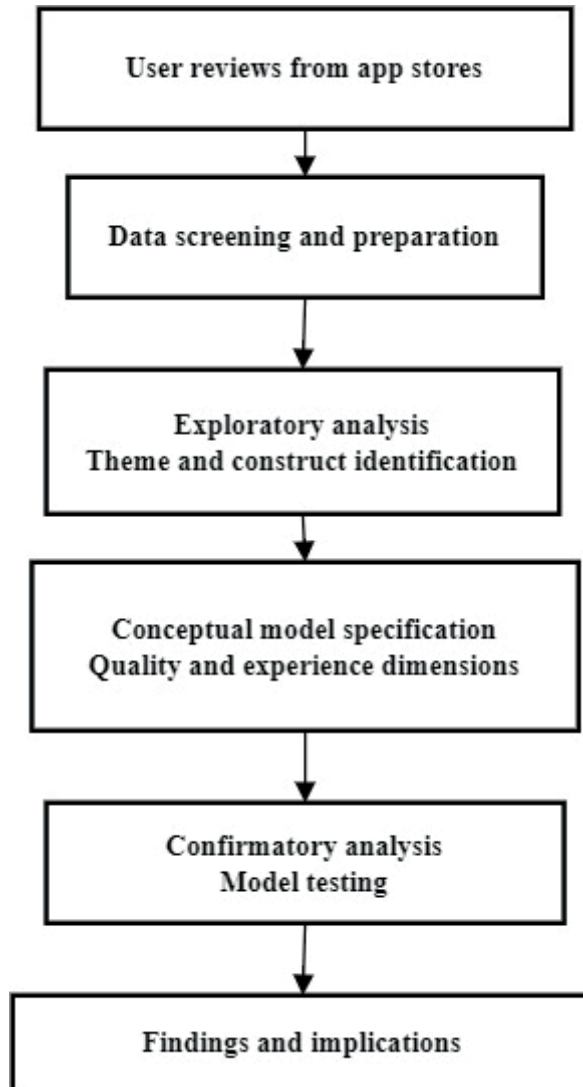


Figure 1. Overview of the research design and analysis workflow

4. Exploratory study:

The exploratory study aims to reveal how elderly users describe their experiences with senior-focused puzzle applications using naturally occurring app store reviews. This phase is intended to surface the most salient experience patterns in users' narratives and organize them into conceptually meaningful dimensions that align with the study framework. The insights

generated here guide the specification of the constructs and inform the variables used in the subsequent confirmatory analysis.

4.1: Data collection and text preprocessing

The dataset was compiled from the Google Play Store and restricted to English language reviews associated with the application Vita Jigsaw for Seniors. Reviews posted between July 1, 2024, and August 27, 2025, were retrieved and organized as a corpus. In total, 53,800 reviews were collected, including 42,600 from Android phones and 11,200 from Android tablets. Along with review text, the dataset retained essential metadata available from the platform, enabling device-level segmentation and time-based tracking of user feedback.

Given the well-documented vulnerability of app store environments to spam, coordinated manipulation, and automated posting, an integrity screening step was applied before any textual modeling. The study used an unsupervised detection strategy designed to flag suspicious reviews using multi-signal logic that leverages irregular statistical patterns and linguistic redundancy, without requiring labeled training data. A key component of this screening was near-duplicate identification based on character n-gram TF-IDF representations and cosine similarity, which detects highly similar review texts that may indicate templated or repeated submissions. After screening the entire corpus, 16,947 reviews (31.5%) were flagged as suspect and excluded, leaving 36,853 reviews (68.5%) for subsequent processing.

Text preprocessing was then conducted to transform the retained reviews into a clean and consistent corpus suitable for computational analysis. A deep cleaning pipeline was implemented to reduce noise and standardize linguistic content. This pipeline consisted of twelve operations covering case normalization, Unicode standardization, removal of emojis and non-English scripts, filtering of URLs and other identifiers, removal of long numeric strings, normalization of repeated characters, restriction to alphabetic content, whitespace normalization, removal of stopwords including app-specific terms, and token length filtering to retain meaningful terms. Following this preprocessing, 17,216 cleaned reviews were retained, representing 46.7 percent of the screened genuine set. The resulting cleaned corpus was stored in a structured file and served as the standardized textual input for the study's subsequent analyses. The word cloud in Figure 2 highlights the most salient terms appearing across reviews, with prominent words reflecting both the core activity and experiential tone, such as puzzle, game, relaxing, easy, and fun.

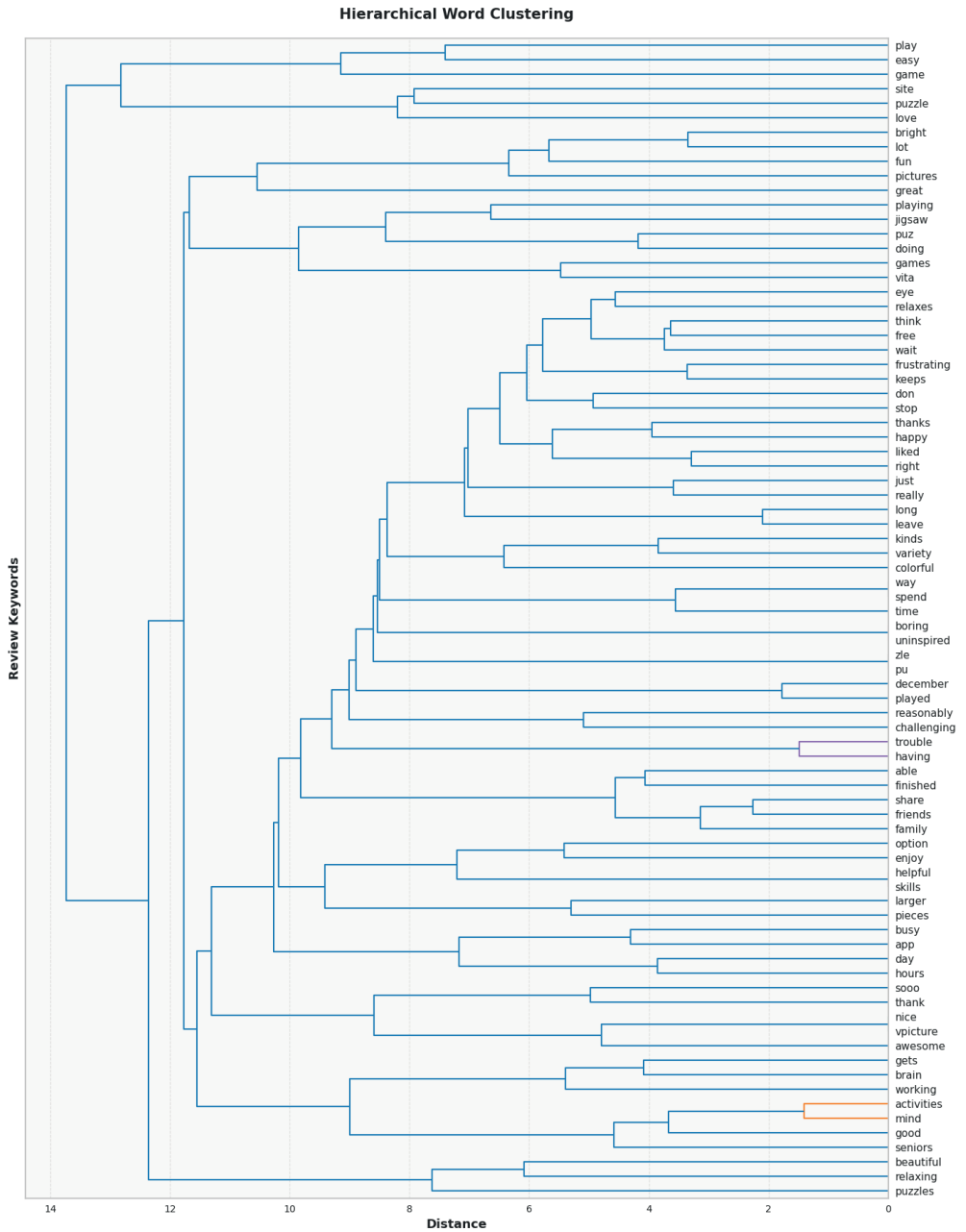


Figure 3. Hierarchical clustering dendrogram of frequent review keywords

4.3. Topic modeling :

To uncover the dominant experience themes expressed in Vita Jigsaw for Seniors reviews, this study applied Latent Dirichlet Allocation (LDA), a probabilistic topic modeling technique that represents each review as a mixture of latent topics and each topic as a distribution over words (Blei et al., 2003). The LDA models were estimated using Gensim's parallelized LdaMulticore implementation, with the cleaned review corpus represented as a bag-of-words representation after tokenization and bigram detection to preserve meaningful multiword expressions (e.g., common phrase-like combinations). Model selection was guided by the C_v coherence metric, which evaluates semantic interpretability by combining normalized pointwise mutual information and cosine similarity, making it suitable for identifying coherent, human-interpretable themes in large-scale user-generated content. Following an initial extraction of 100 topics, the topics were ranked by coherence, with scores ranging from 0.4275 to 0.9913, enabling the study to prioritize the most semantically meaningful themes for interpretation and construct mapping. The final solution retained 88 topics, achieving an overall coherence of 0.521. The model was estimated with 10 passes and 100 iterations, using symmetric Dirichlet priors for both the document-topic and topic-word distributions to support stable topic discovery across the corpus.

4.4. Keyword to construct mapping and expert validation

The topic modeling outputs were converted into theory-consistent constructs through a structured keyword-to-construct mapping procedure, followed by expert validation to strengthen content validity. Candidate keywords were first drawn from the most coherent and interpretable topics and then organized into construct-level keyword sets that reflected the conceptual definitions in the proposed research model. The guiding principle was that keywords should be assigned based on their meaning within the topic context rather than as isolated terms, ensuring that each construct captures a distinct and interpretable domain of elderly users' experiences. Appendix A reports the construct-to-topic-to-keyword mappings, including the representative topics and the finalized keyword sets for each construct. Given the use of marketplace reviews, the resulting constructs are treated as review-expressed indicators of experience domains rather than as direct psychometric measurements of latent psychological states. Because no matched survey data are available for the same reviewers, expert validation

and transparent reporting are used to support content validity, while convergent validity against psychometric benchmarks is left for future multi-source studies.

Two members of the research team independently performed the mapping. For each construct, the coders reviewed the representative topics. They inspected the highest-probability words within those topics to determine which construct best matched the terms' use in the review narratives. For example, System Quality incorporated terms such as «clear», «page», «design», «update», «load», «stop», «wifi», and «black» because these words commonly co-occurred with interface layout and technical functioning topics, reflecting usability and performance. Information Quality included words such as «text», «graphic», «image», «audio», «display», and «vision_problem» because they relate to the clarity and usefulness of visual and auditory information. Service Quality was characterized by support-oriented terms such as «support», «help», «reinstall», «troubleshoot», «option», and «screenshot», which are typical of assistance and issue-resolution contexts. Accessibility was identified through age-related expressions, including «easy_eye», «senior», «dementia», «concentrate», «brain», «calm», and «focus», indicating the accommodation of age-related needs. Perceived Enjoyment was represented by affective and pleasure-oriented terms such as «love», «fun», «happy», «calming», «peace», and «music». Flow Experience captured immersion and persistence through challenge-related terms such as «challenge», «persistence», «keep_interested», «finish», «continue», «try», «hard», «busy», and «playing». Satisfaction was expressed through endorsement-oriented terms such as «highly recommend», «thank», «excellent», «favorite», «appreciate», «enjoyable», and «gratitude». Engagement, as the outcome, was represented by continuity and repeated involvement language such as «continue», «longer», «week», «daily», «play», «reopen», «keep», «time», and «constantly». After independent mapping, the coders compared their allocations and resolved disagreements through discussion, producing a consolidated mapping with clear construct boundaries. This refinement step focused on reducing overlap, removing redundant expressions, and ensuring that each keyword set remained interpretable and aligned with its operational definition. Appendix A (Table A1) provides the operational definitions and theoretical grounding used to guide construct boundaries, supporting transparency in the alignment between topic contexts and theory.

Three domain experts then assessed the consolidated mapping. Experts evaluated each construct's keyword set on relevance and clarity using a five-point scale and provided optional qualitative comments. Relevance reflected the degree to which the keyword set represented the intended construct domain, while clarity reflected how unambiguous the keywords were as indicators of that construct. Across constructs, expert ratings indicated strong support for the mapping: mean relevance scores ranged from 4.00 to 4.67, and mean clarity scores ranged from 4.00 to 4.67 (on a five-point scale), with the lowest average support observed for System Quality and Service Quality. Appendix B (Table B1) reports the expert validation results in full, including construct-level relevance and clarity ratings for each expert and the corresponding mean scores. Across constructs, expert ratings indicated strong support for the mapping, with high average scores for both relevance and clarity. Expert feedback was used to fine-tune wording where necessary, address potential boundary ambiguity between closely related constructs, and confirm that the final keyword sets were suitable for representing the theoretical constructs in the subsequent model testing. Because heterogeneous reviews may constrain measurement accuracy for intricate experiential constructs, interpretations of Perceived Enjoyment and Flow Experience are considered surrogate indicators based on recurring linguistic patterns rather than direct inferences about individual psychological states.

5. Conceptual framework and hypotheses development:

Drawing on the validated keyword to construct mapping, the study defines eight experience dimensions as the core constructs of the conceptual framework. These constructs reflect recurring, theory-consistent patterns in review narratives and represent distinct domains of elderly users' experiences with senior-focused puzzle applications.

5.1 Conceptual Model

This study's conceptual model integrates ideas from IS, HCI, and psychology to fully explain why seniors continue to use puzzle apps like Vita Jigsaw. The model asserts that user satisfaction, a recognized proximal indicator of IS Success, is influenced by unique yet synergistic aspects of user experience. The new IS Success model has three main dimensions that show functional quality: system quality, information quality, and service quality (Petter et al., 2012). These basic parts ensure that the application

is dependable, the puzzle content is clear and acceptable, and any help is valuable. At the same time, the model includes experiential and emotional aspects that are very important for older people. Based on HCI and Flow Theory, we include accessibility, which is how easy it seems to get past physical and mental barriers that come with age; enjoyment, which is the pleasure that comes from the interaction itself (Xiao et al., 2021); and flow, which is the state of deep, effortless concentration that happens during gameplay (Csikszentmihalyi, 2014). In this concept, satisfaction serves as the essential mechanism, transforming the impacts of these functional and experiential antecedents into a lasting behavioral consequence. We view this result not only as a desire to continue but also as an active, rich state of engagement that includes extensive and focused usage sessions (O'Brien et al., 2018). The concept posits that a senior user's engagement with the application is fundamentally influenced by their satisfaction, which is fostered by a robust, entertaining technical experience tailored to their requirements. The proposed research model is shown in Figure 4.

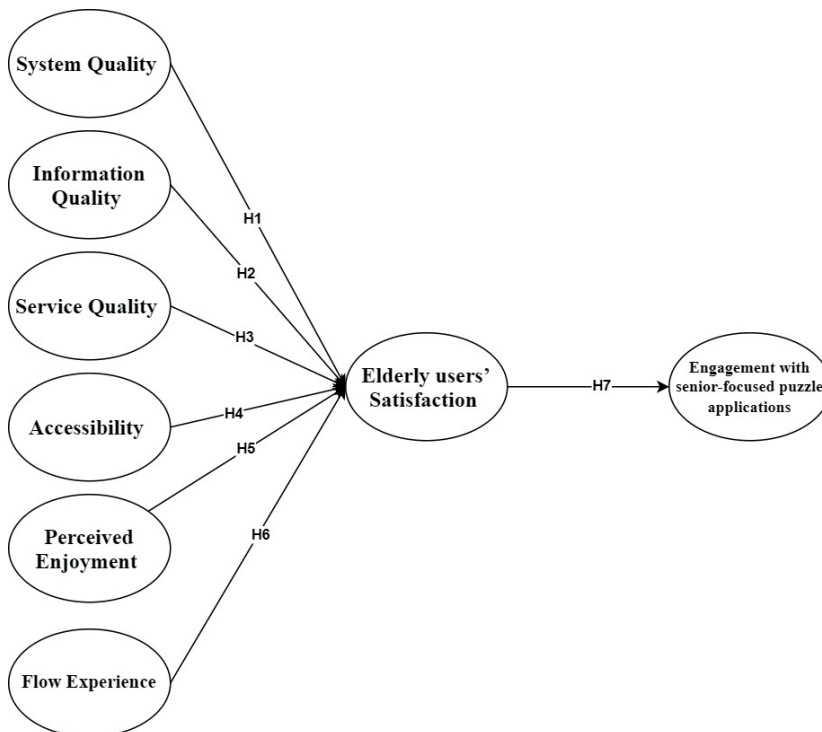


Figure 4. research model

5.2. Hypotheses Development

5.2.1. System quality and satisfaction

System quality is the extent to which an IS consistently provides the functions users need, with as few errors and problems as possible (Nazifi et al., 2025). System quality captures an app's reliability, usability, responsiveness, and technical performance (Helal et al., 2024). For example, puzzle apps aimed at seniors include clear interfaces, consistent sessions, low-latency interactions, and forgiving mistake handling. The IS Success stream asserts that enhanced system quality elevates user satisfaction by diminishing effort and uncertainty in job execution (DeLone & McLean, 2003; Rai et al., 2002). Evidence indicates that navigational ease, perceived control, and interface responsiveness influence satisfaction and subsequent retention (Wixom & Todd, 2005). For older persons, age-related perceptual and motor impairments increase the importance of features such as clear targets, consistent design, and strong performance, which reduce friction and cognitive burden (Chen & Chan, 2014; Hawthorn, 2007). In hedonic-utilitarian systems such as puzzle applications, seamless interaction dynamics facilitate immersion, hence enhancing satisfaction. In general, previous research shows that users rate the experience more highly when a senior puzzle app has reliable features, easy-to-read controls, and predictable responses across devices and sessions. This increases satisfaction after adoption and sets the stage for engagement and continued use. Accordingly, we hypothesize:

H1. System quality positively influences elderly users' satisfaction.

5.2.2. Information quality and satisfaction

Information quality indicates how accurate, relevant, clear, and timely the content and feedback provided to users are (Gorla et al., 2010). In puzzle apps for seniors, high-quality information includes clear instructions, easy-to-read labels, difficulty levels that adjust based on the player's skill level, clear progress indicators, and helpful suggestions to reduce confusion. The IS Success literature correlates enhanced information quality with increased user satisfaction by ensuring system outputs are congruent with users' tasks and cognitive expectations (DeLone & McLean, 2003; Seddon, 1997). Empirical research substantiates that correctness, completeness, and format quality serve as significant predictors of satisfaction in both company and consumer settings (Gorla

et al., 2010; Nelson et al., 2005). For older persons, who may face deficits in working memory, vision, and processing speed, readability and conceptual clarity are crucial to keeping cognitive load manageable and preventing irritation (Chen & Chan, 2014; Czaja & Lee, 2006). In hedonic systems, clear, useful feedback increases perceived value and strengthens intrinsic motivation, which makes people happier (Helal et al., 2024; van der Heijden, 2004). For Vita Jigsaw for Seniors, consistent naming, simple onboarding, and context-sensitive assistance should make users feel understood and in control, leading to higher satisfaction ratings and a greater willingness to continue using the app. Accordingly, we hypothesize:

H2. Information quality positively influences the satisfaction of elderly users.

5.2.3. Service quality and satisfaction

Service quality in mobile applications includes reliability, responsiveness, assurance, and empathy, which are conveyed through the app's user interface (UI) and support system (Ahmed et al., 2026; Helal et al., 2024). In technology-enabled services, enhanced service quality amplifies the confirmation of expectations and emotional responses, therefore increasing customer satisfaction (DeLone & McLean, 2003; Parasuraman et al., 2005). The quality of information systems services has been demonstrated to influence satisfaction by diminishing perceived performance risk, enhancing trust, and enabling effortless problem resolution (Lin & Hsieh, 2011; Pitt et al., 1995). When older individuals play cognitive games, responsiveness (such as quick loading and timely hints), reliability (such as crash-free play), and empathy (such as a courteous tone and age-appropriate support) are critical because they help ease worries about making mistakes and forgetting things. Evidence from HCI indicates that when service touchpoints reduce effort and offer constructive feedback, older users have increased enjoyment and confidence, hence enhancing satisfaction (O'Brien & Toms, 2008; Sonderegger & Sauer, 2010). In puzzle apps aimed at seniors, the quality of service demonstrates credibility and concern for users' dignity, adding perceived value beyond the main function. Accordingly, we hypothesize:

H3. Service quality positively influences the satisfaction of elderly users.

Accessibility refers to how easy it is for users with age-related changes in vision, motor function, and cognition to see, use, comprehend, and rely on an application (Khamaj & Ali, 2024). HCI research advocates "designing for dynamic diversity," emphasizing the need for flexible input/output, redundancy, and error tolerance to accommodate diverse older populations. Research indicates that enhancing target size, contrast, and language clarity improves performance and reduces irritation among older users, facilitating smoother task flow and a greater sense of control, which are precursors to happiness (Hawthorn, 2007; Kurniawan, 2008). From an IS point of view, accessibility is determined by perceived ease of use and effort expectancy. When the cost of contact decreases, positive feelings and perceived value increase, making people happier (Venkatesh & Bala, 2008). In mobile cognitive games, accessibility also enhances self-efficacy and diminishes fear of failure, which is particularly important for seniors dealing with memory lapses or dexterity limitations (Chen & Chan, 2014). Features like adjustable difficulty, readable font, large touch targets, and easy error recovery not only make the game easier to play but also enhance its quality and overall fun. Accordingly, we hypothesize:

5.2.4. Accessibility and satisfaction

H4. Accessibility positively influences the satisfaction of elderly users.

5.2.5. Perceived enjoyment and satisfaction

Perceived enjoyment refers to how fun, pleasant, or amusing it is to use a system, regardless of any results or performance gains (Won et al., 2023) the study examined the influences of app system success dimensions and TAM determinants on branded sport app usage intention. Moreover, the current study examined the gender differences regarding the relative importance of the drivers and predictors of usage intention. Design/methodology/approach: Data collection (n = 256. Perceived enjoyment signifies the inherent pleasure obtained from utilizing an application; in hedonic circumstances, it supersedes cognitive assumptions in shaping post-use evaluations (van der Heijden, 2004). Research in game and entertainment research indicates that when play is perceived as pleasurable, people evaluate outcomes more positively and express more satisfaction with the overall service (Hsu & Lu, 2004). Consumer information technology models similarly identify hedonic motivation as a fundamental factor influencing

positive affect and evaluative judgments, especially regarding non-work technologies (Venkatesh et al., 2012). Pleasure also involves achieving well-defined objectives, receiving prompt feedback, and engaging in visually appealing challenges that reduce perceived effort and enhance post-use contentment. For older people who enjoy playing puzzles, the experience is even more important because mild, relaxing play can help with cognitive fatigue and boost perceptions of competence, making them happier. Accordingly, we hypothesize:

H5: Perceived enjoyment positively influences the satisfaction of elderly users.

5.2.6. Flow experience and satisfaction

Flow is a concentrated, intrinsically rewarding condition that happens when tasks and talents are properly matched, and feedback comes right away (Strohmeier & Röhrs, 2017). In digital contexts, flow encompasses profound engagement and temporal disconnection, resulting in positive post-use assessments (Novak et al., 2000). Cognitive absorption, a concept closely related to flow, has been associated with increased satisfaction and favorable responses to technological experiences within IS (Finneran & Zhang, 2003). Flow means that interaction design aspects like timing, feedback, and challenge calibration are working together to make things easier and more valuable, which should make people happier after a session (Schaffer & Fang, 2022). For puzzle apps aimed at seniors, well-calibrated jigsaw complexity and seamless interactions can help them focus without getting tired, making them feel competent and independent. These emotions ought to enhance post-session enjoyment. Empirical studies in e-commerce, online gaming, and virtual communities indicate that flow, or cognitive absorption, serves as a positive predictor of evaluative outcomes, such as satisfaction (Nakagomi et al., 2025; Novak et al., 2000)

"type": "article-journal", "volume": "19", "uris": ["http://www.mendeley.com/documents/?uuid=8fa420c8-d3c847-d9-b7ba-4c7419da6bbb"], {"id": "ITEM-2", "itemData": {"DOI": "10.219669080/", "ISSN": "14388871", "PMID": "39869904", "abstract": "Background: Digital gaming has become increasingly popular among older adults, potentially offering cognitive, social, and physical benefits. However, its broader impact on health and well-being, particularly in real-world settings, remains unclear. Objective: This study aimed to evaluate the multidimensional effects of digital gaming on health and well-being among older adults, using data from the Japan

Gerontological Evaluation Study conducted in Matsudo City, Chiba, Japan. Methods: Data were drawn from 3 survey waves (2020 prebaseline, 2021 baseline, and 2022 follow-up). For Vita Jigsaw for Seniors, a more intense flow experience, characterized by high levels of focus, control, and temporal distortion, should lead to positive satisfaction ratings. Accordingly, we hypothesize:

H6: Flow experience positively influences the satisfaction of elderly users.

5.2.7. Satisfaction and engagement

Satisfaction, as a cumulative evaluative judgment, serves as a crucial antecedent by bolstering positive emotion and trust, encouraging more profound connection, investigation, and advocacy (Vivek et al., 2012) this study explores the nature and scope of customer engagement (CE). In digital environments, content users are more inclined to devote attention and engage in value co-creation, demonstrating vigor, absorption, and activation characteristics of engagement (Laukka et al., 2024). Research on IS continuation demonstrates that satisfaction leads to post-adoption behaviors, suggesting a strategy for maintaining interaction (Bhattacharjee, 2001). Engagement is a multidimensional concept that includes behavioral, affective, and cognitive facets; however, these facets are not fully observable in marketplace reviews. Accordingly, engagement is operationalized here as review-expressed engagement, captured through language indicating continued involvement and repeated use (for example, "daily," "continue," "reopen," or similar expressions). This operationalization reflects engagement-related expressions in narratives rather than direct behavioral intensity, such as frequency or duration of use. For puzzle apps aimed at seniors, being happy with previous sessions should encourage them to return, play longer, and explore new features (such as choosing a difficulty level or sharing achievements), thereby increasing their mental and behavioral engagement. Research on interactive media indicates that favorable assessments predict greater engagement, with satisfaction correlating with engagement trajectories (Calder et al., 2009; O'Brien & Toms, 2008). In games research, immersive and enjoyable experiences have been correlated with prolonged engagement, hence endorsing satisfaction-to-engagement frameworks (Jennett et al., 2008). Therefore, with Vita Jigsaw for Seniors, increased satisfaction should lead more people to continue playing the puzzles and using the features more. Accordingly, we hypothesize:

H7: Elderly users' satisfaction positively influences engagement with senior-focused puzzle applications.

6. Confirmatory study

6.1. Methodology

The confirmatory study evaluated the proposed hypotheses by estimating predictive relationships among the model constructs using review-derived indicators. Partial Least Squares regression was used as the primary technique because it is appropriate when predictors are correlated and the goal is to obtain stable, interpretable coefficients to explain an outcome (Abdi, 2010; Goodhue et al., 2012). This article is categorized under: Statistical Models > Linear Models Algorithms and Computational Methods > Least Squares, author: [{"dropping-particle": "", "family": "Abdi", "given": "Hervé", "non-dropping-particle": ""}, {"parse-names": false, "suffix": ""}], container-title: "WIREs Computational Statistics", id: "ITEM-1", issue: "1", issued: {"date-parts": [{"2010", "1", "1"}]}, page: "97-106", publisher: "John Wiley & Sons, Ltd", title: "Partial least squares regression and projection on latent structure regression (PLS Regression). Two parallel specifications were estimated for each dependent construct using polarity and subjectivity signals as alternative operationalizations. Statistical uncertainty for coefficients and model fit was assessed using bootstrap resampling, a well-established approach for approximating sampling variability without strong distributional assumptions. To mitigate overfitting concerns, predictive performance was evaluated under strict train–test separation, with all performance metrics reported on the held-out test set in addition to in-sample estimates. Predictive performance was evaluated using a train-and-test split aligned with cross-validation principles for statistical prediction. As a robustness check, Random Forest regression was applied to the Satisfaction model to capture potential nonlinearities and provide a feature-importance-based view of predictor influence (Saura et al., 2023; L. Zhang et al., 2014) and outliers almost always exist. Random forest (RF) Convergent results across PLS regression and Random Forest provide cross-model validation, reducing the likelihood that conclusions reflect a single modeling specification.

6,2 Results

PLS regression results support the proposed antecedents of Satisfaction across both operationalizations. As shown in Table 1, all six predictors exhibit positive, statistically significant effects on Satisfaction in both the polarity-based and subjectivity-based models. In the polarity specification, Perceived Enjoyment shows the strongest effect ($R^2 = 0.323$), followed by System Quality ($\beta = 0.253$) and Information Quality ($\beta = 0.193$). In the subjectivity specification, the strongest effects are observed for Service Quality ($\beta = 0.165$), Flow Experience ($\beta = 0.162$), and Perceived Enjoyment ($\beta = 0.151$).

Table 1. Hypotheses testing results for Satisfaction (PLS regression)

Predictor	Polarity [95% CI], SE	.Sig	Subjectivity [95% CI], SE	.Sig
System Quality	0.009, [0.267, 0.239] 0.253	Yes	0.007, [0.024, 0.001] 0.010	Yes
Information Quality	0.007, [0.203, 0.184] 0.193	Yes	0.010, [0.129, 0.098] 0.112	Yes
Service Quality	0.006, [0.162, 0.144] 0.153	Yes	0.008, [0.178, 0.156] 0.165	Yes
Accessibility	0.007, [0.026, 0.006] 0.014	Yes	0.007, [0.105, 0.085] 0.093	Yes
Perceived Enjoyment	0.008, [0.340, 0.316] 0.323	Yes	0.009, [0.168, 0.140] 0.151	Yes
Flow Experience	0.006, [0.177, 0.159] 0.167	Yes	0.010, [0.179, 0.150] 0.162	Yes

Model fit and predictive performance are summarized in Table 2. The polarity-based model explains a substantial proportion of variance in Satisfaction (bootstrap $R^2 = 0.952$) and shows consistent generalization in the test split (test $R^2 = 0.957$). The subjectivity-based model also demonstrates strong predictive performance (bootstrap $R^2 = 0.793$) with comparable test performance (test $R^2 = 0.800$). In this regression-based, prediction-oriented setting, R^2 is interpreted primarily as an index of out-of-sample predictive performance rather than as a causal explanation. Accordingly, interpretation emphasizes test-set performance and coefficient stability based on bootstrap confidence intervals. Overall, the results provide consistent evidence that the six experience dimensions significantly shape elderly users' Satisfaction, and the model achieves strong predictive performance across both sentiment-based operationalizations.

Table 2. Model fit and predictive performance for Satisfaction (PLS regression)

Metric	Polarity	Subjectivity
(R ² (bootstrap	0.952	0.793
F statistic	993.464	483.629
Train R ²	0.952	0.792
Test R ²	0.957	0.800

Using common guidelines in IS and social science modeling, R² values around 0.75, 0.50, and 0.25 are typically interpreted as substantial, moderate, and weak model performance respectively; therefore, the Satisfaction results indicate substantial in-sample and out-of-sample predictive performance across both specifications (Hair et al., 2021). Table 3 reports the hypothesis test for Engagement. Satisfaction positively and significantly predicts Engagement in both polarity and subjectivity specifications, supporting the proposed link between evaluative experience and subsequent engagement.

Table 3. Hypothesis testing results for Engagement (PLS regression)

Predictor	Polarity β [95% CI], SE	.Sig	Subjectivity β [95% CI], SE	.Sig
Satisfaction	,[0.063 ,0.039] 0.056 0.007	Yes	,0.001] 0.019 0.008 ,[0.027	Yes

In contrast, the Engagement R² values (approximately 0.08) indicate weak explained variance, suggesting that satisfaction alone captures only a limited portion of engagement expressions and that additional antecedents are likely required for stronger prediction. Table 4 reports the model fit for Engagement. The explained variance is modest (R² = 0.080 for polarity and 0.078 for subjectivity), indicating that the current specification provides only a partial account of engagement. This pattern is consistent with engagement being multidimensional (behavioral, affective, and cognitive), whereas marketplace reviews mainly capture self-expressed involvement rather than direct behavioral intensity such as usage frequency or duration. Engagement is operationalized as review-expressed engagement; therefore, limited explained variance is consistent with the likelihood that additional drivers (for example, habit cues,

personalization, social features, health-related constraints, or broader user context) are not fully observable in short marketplace reviews.

Table 4. Model fit summary for Engagement (PLS regression)

Metric	Polarity	Subjectivity
(R ² (bootstrap	0.080	0.078
F statistic	210.162	182.563
Train R ²	0.080	0.078
Test R ²	0.081	0.078
Test MAE	0.066	0.060

The Random Forest analysis provides a complementary nonlinear perspective on the relative influence of predictors on Satisfaction. As shown in Table 5, Accessibility and System Quality emerge as the most influential predictors, followed by Perceived Enjoyment, Flow Experience, and Service Quality. Information Quality shows the lowest relative importance. The consistency between Random Forest importance patterns and PLS regression results supports robustness and reduces concerns that the high Satisfaction R² reflects model-specific artifacts. Overall, the ranking reinforces the central role of age-appropriate interaction design and technical reliability in shaping satisfaction with senior-focused puzzle applications.

Table 5 Random Forest feature importance for predicting Satisfaction (sorted).

Rank	Predictor	(Importance (SE
1	Accessibility	(0.018) 0.213
2	System Quality	(0.009) 0.210
3	Perceived Enjoyment	(0.020) 0.183
4	Flow Experience	(0.006) 0.160
5	Service Quality	(0.010) 0.156
6	Information Quality	(0.004) 0.078

7. Discussion and implications:

This study examines predictive associations between elderly users' satisfaction and engagement with a senior-focused puzzle application by integrating functional quality and experiential drivers derived from longitudinal app reviews. Key findings can be summarized as follows. First, satisfaction is strongly associated with both functional quality and experiential factors: system quality, information quality, service quality, accessibility, perceived enjoyment, and flow experience all show positive and significant effects. Second, across complementary analyses, accessibility and system quality emerge as particularly influential, indicating that age-aligned usability and reliable performance represent foundational conditions for favorable evaluations. Third, satisfaction is positively associated with engagement expressions, but the explained variance for engagement remains modest, suggesting that engagement is likely shaped by additional factors beyond satisfaction alone.

Overall, the confirmatory results are consistent with the conceptual model and support the hypotheses that system quality, information quality, service quality, accessibility, perceived enjoyment, and flow experience are positively associated with satisfaction, and that satisfaction is positively associated with engagement. Because the evidence is based on observational, self-selected reviews, the discussion focuses on associations and predictive patterns rather than causal mechanisms.

First, the positive and significant effects of system quality, information quality, and service quality on satisfaction align with the Information Systems Success logic, which posits that quality perceptions are core antecedents of user satisfaction (DeLone & McLean, 1992, 2003; Petter et al., 2012). System quality showed a comparatively strong effect in the polarity model and ranked among the most influential predictors in the Random Forest results, indicating that reliability and smooth interaction are foundational for elderly users. This is consistent with IS success research suggesting that performance and usability are essential for favorable evaluations, particularly in contexts where interaction effort can be a barrier (DeLone & McLean, 2003; Petter et al., 2012). Information quality and service quality were also significant, with service quality especially salient in the subjectivity specification, suggesting that when reviews are more opinionated, support and problem resolution weigh more heavily in satisfaction judgments (DeLone & McLean, 2003).

Second, perceived enjoyment emerged as one of the strongest predictors of satisfaction across specifications, reinforcing the role of intrinsic motivation in hedonic systems. This finding is consistent with prior IS research that conceptualizes enjoyment as a key driver of favorable attitudes and outcomes in technology use beyond utilitarian benefits. In a senior puzzle context, enjoyment likely reflects relaxation, pleasure, and emotional comfort, which can be central to seniors' continued interest in leisure technologies.

Third, flow experience significantly predicted satisfaction, supporting Flow Theory's argument that deep concentration and absorption enhance positive evaluations when challenge and skills are balanced (Csikszentmihalyi, 2014). The presence of flow effects suggests that seniors' satisfaction is shaped not only by what the app provides but also by how the interaction feels during play, particularly in terms of persistence, focus, and a sense of progress. This pattern complements rather than replaces enjoyment, indicating that both affective pleasure and immersive involvement contribute to seniors' overall appraisal.

Fourth, accessibility was significant in PLS and ranked highest in Random Forest importance, highlighting the centrality of age-aligned design. This is consistent with gerontechnology and HCI for aging, which emphasizes visual clarity, interaction simplicity, and reduced cognitive burden as factors associated with older adults' ability to benefit from digital systems (Chen & Chan, 2014; Czaja & Lee, 2006). The discrepancy between the smaller linear coefficient and higher nonlinear importance suggests that accessibility may operate as a constraint or threshold. When accessibility needs are not met, satisfaction may be limited, regardless of enjoyment or content quality, while improvements in accessibility may enable the benefits of enjoyable, immersive features.

Finally, satisfaction significantly predicted engagement, consistent with post-adoption perspectives where positive evaluations are linked to deeper involvement (Bhattacharjee, 2001). The modest variance explained by engagement suggests that satisfaction is necessary but not sufficient to account for engagement expressions in review narratives fully. This is compatible with engagement scholarship that treats engagement as a multidimensional state shaped by factors beyond satisfaction alone, including sustained attention, involvement, and context-dependent motivations (Calder et al., 2009; O'Brien & Toms, 2008).

For senior puzzle apps, additional drivers may include habit cues, a variety of content, personalization, and pacing features that sustain interest over time. Taken together, the findings extend IS success reasoning to a senior-focused hedonic application by showing that functional quality and experience quality jointly shape satisfaction, while engagement reflects broader involvement that is only partly explained by satisfaction.

For designers and providers, the results imply that improving accessibility and technical reliability is a prerequisite, while enjoyment and flow-oriented features can further strengthen satisfaction and support deeper engagement.

7.1. Theoretical implications:

This study advances understanding elderly users' digital experiences by showing that an integrated set of functional quality and experiential mechanisms is associated with satisfaction and engagement in senior-focused puzzle applications. The findings reinforce that a purely technical view of app success is insufficient in hedonic senior contexts. While system, information, and service quality remain important, perceived enjoyment and flow-related immersion are equally central in predicting how older users evaluate senior-oriented leisure applications. This supports an expanded view of IS success in hedonic settings where cognitive stimulation and emotional comfort are core motives for use.

A key theoretical implication is the elevated role of accessibility. The results indicate that accessibility is not a peripheral design attribute but a primary experience dimension that conditions overall system evaluation. The discrepancy between the relatively smaller linear effects and the high non-linear importance suggests a constraint mechanism: when accessibility needs are not met, satisfaction may be capped even if other experience factors are favorable. This provides a stronger rationale for modeling accessibility as a distinct construct rather than embedding it within general usability. In senior-focused applications, accessibility captures a unique combination of age-related interaction requirements, perceptual clarity, and cognitive effort management.

The study also clarifies the conceptualization of engagement in older adults' leisure technologies. Engagement is not merely continuance intention but a richer state of sustained involvement, persistence, and focused interaction. The modest variance explained by satisfaction suggests that engagement is multi-determined and may

depend on additional mechanisms such as habit formation, perceived cognitive benefit, content novelty, and routine integration. Accordingly, future extensions should model engagement as an outcome shaped by satisfaction alongside direct experiential drivers, particularly those related to immersion and stimulation.

Methodologically, the study demonstrates how longitudinal user-generated content can be translated into theory-aligned constructs through structured keyword mapping and expert validation. This strengthens confidence that the constructs reflect how users naturally articulate experience rather than being derived solely from researcher-imposed survey measures. The high mapping coverage further indicates that app review corpora can represent broad construct domains when operational definitions and keyword boundaries are carefully specified. Finally, the combined use of linear modeling and non-linear feature importance enhances robustness and theoretical insight. The convergence and divergence between PLS coefficients and Random Forest rankings help distinguish average linear effects from threshold-like or interaction-sensitive influences. This mixed analytical lens is transferable to other apps and platform contexts where predictors are correlated, and user experience relationships may not be strictly linear.

7.2. Practical implications :

The findings offer actionable guidance for designers, publishers, and digital inclusion stakeholders seeking to enhance the satisfaction and sustained engagement of elderly users with senior-focused puzzle applications. Because accessibility and system quality emerged as the most influential predictors of satisfaction, practical priorities should begin with age-aligned interaction design and dependable performance, followed by experience features that strengthen enjoyment and flow. Accessibility should be treated as a primary product objective, not an optional enhancement. This includes readable typography, strong contrast, adjustable visual settings, clear iconography, and predictable navigation. Interaction design should minimize fine motor demands by using larger touch targets and reducing precision requirements. Cognitive simplicity is also crucial. Interfaces should reduce clutter, avoid overwhelming menus, and provide consistent patterns so that users do not need to relearn functions. Tutorials and help cues should be simple, skippable, and available on demand.

System reliability is another foundational requirement. Seniors' satisfaction is sensitive to crashes, loading delays, freezes, and connectivity issues. Developers should prioritize performance optimization, cross-device stability, and graceful error handling. Features like autosave, stable progress tracking, and quick resume support can reduce frustration and may support longer sessions. Enjoyment and flow features are key levers once accessibility and stability are ensured. To support enjoyment, apps should provide pleasing aesthetics, calming audio options, and rewarding feedback that reinforces accomplishment. Flow can be supported through adaptive difficulty, gradual progression, and clear goals that match users' skill levels. Challenge needs to be balanced so the experience remains stimulating without becoming frustrating. Progress cues, gentle hints, and optional assistance can help maintain immersion.

Service and support should be senior-friendly. When issues occur, older users benefit from clear troubleshooting steps, simple contact options, and fast resolution. In-app help content should be easy to read, and support pathways should avoid complex technical language. Because service quality is associated with satisfaction, especially in strongly opinionated reviews, improving support responsiveness can reduce negative experiences that disproportionately shape perceptions.

Engagement-oriented design should focus on sustainable routines rather than aggressive retention tactics. Seniors may engage more when the app supports consistent daily use with gentle reminders, personalized content, and meaningful goals. Content variety, seasonal themes, and new puzzle packs can sustain interest, but they should be introduced without confusing interface changes. Consistency across updates matters to preserve confidence.

Senior-focused puzzle apps are often used for relaxation, cognitive stimulation, and daily structure. Caregivers and health practitioners can use the findings to identify what makes these tools usable and engaging for older adults. When recommending apps, emphasize accessibility features, stability, and the availability of supportive guidance. Organizations supporting digital inclusion can also use these insights to develop evaluation checklists for senior-friendly apps and to advocate for accessibility standards in commercial leisure products.

App publishers should monitor engagement signals not only through ratings but also through narrative themes related to accessibility and stability. Product roadmaps should allocate resources to accessibility and performance improvements alongside new content releases. App store platforms could also improve discovery and transparency by highlighting accessibility features that are senior-friendly, making it easier for older adults and caregivers to select appropriate apps.

7.3 Limitations and future research

A first limitation is that the evidence base is limited to English-language Google Play reviews, which may not reflect the experiences of iOS users. In addition, the analysis focuses on a single senior-focused puzzle application, and transferability to other senior-oriented app categories (for example, health or finance applications) should be made cautiously. Future work should replicate the study using Apple App Store reviews and additional app categories to examine whether the relative importance of quality and experience dimensions varies across platforms and cultural contexts.

A second limitation relates to self-selection. Posting an app review is voluntary, so the dataset may overrepresent users with extreme experiences while underrepresenting silent users. This participation structure may also bias the sample toward more digitally literate and expressive older adults and underrepresent less literate or less vocal groups. Future research can triangulate review analytics with usage telemetry, where feasible, and with complementary methods (for example, surveys or interviews). Future research can triangulate review analytics with usage telemetry, where feasible, to confirm whether the identified determinants generalize to the broader population of elderly users.

A third limitation is that constructs such as satisfaction and engagement are operationalized through review language, keywords, and sentiment-based signals. Although this approach is scalable and grounded in user narratives, it may not fully capture the multidimensional nature or intensity of these constructs. Future studies should develop richer multi-indicator measures that combine linguistic features with star ratings and additional behavioral proxies and examine measurement reliability across alternative operationalizations.

A fourth limitation is that engagement is modeled as an outcome predicted solely by satisfaction, yielding modest explained variance and suggesting that important drivers remain outside the current specification. Future work should extend the framework by incorporating additional antecedents, such as habit, perceived cognitive benefits, content variety, personalization, monetization frictions, and update-related changes, and test alternative structures in which selected experience dimensions also directly predict engagement.

A fifth limitation concerns interpretive subjectivity in topic interpretation and construct boundary decisions. Even with expert validation, some keywords may plausibly relate to more than one construct, and alternative mappings could produce slightly different construct representations. Future research can strengthen robustness by triangulating multiple topic modeling approaches, formally assessing inter-rater reliability, and evaluating alternative mapping techniques, such as embedding-based clustering or supervised classification using expert-labeled samples.

A sixth limitation concerns convergent validity. Because the design relies on marketplace reviews and does not include matched survey measures from the same users, direct convergent validity tests against established psychometric scales cannot be conducted in this study. Future research should pair review analytics with survey instruments to confirm that older adults are using the same application and to examine the alignment between review-derived construct scores and validated survey-based measures. Where feasible, combining surveys with usage logs would provide stronger triangulation across narrative, perceptual, and behavioral indicators.

A seventh limitation is that, although the dataset is time-stamped, the current analysis does not explicitly model temporal dynamics. Future research can leverage the longitudinal nature of review streams to examine changes in experience dimensions over time, compare early- and later-reviewer cohorts, and assess pre- and post-update patterns when update windows can be reliably identified from version histories or release notes. Such extensions can deepen insight into the evolution of experience while remaining consistent with an associational interpretation.

A final limitation is the absence of verified demographic information about reviewers. While the application targets seniors, the review corpus may include caregivers or

younger users commenting on behalf of older adults. Future research should separate senior and caregiver narratives using linguistic cues and available metadata and validate the findings through targeted data collection from confirmed elderly users.

8. Conclusion:

This study examined the determinants of elderly users' satisfaction and engagement with a senior-focused puzzle application using English-language Google Play reviews of Vita Jigsaw for Seniors in the United States. A mixed-methods design combined sentiment analysis and topic modeling to map review language onto eight theory-grounded experience dimensions, supported by expert validation and broad construct coverage across the corpus. Confirmatory results showed that system quality, information quality, service quality, accessibility, perceived enjoyment, and flow experience significantly and positively predicted satisfaction across both polarity and subjectivity specifications. Satisfaction also significantly predicted engagement, although the explained variance for engagement was modest. A Random Forest robustness check highlighted accessibility and system quality as the most influential predictors of satisfaction. Overall, the findings indicate that successful senior puzzle experiences depend on reliable performance and age-aligned accessibility, complemented by enjoyable and immersive gameplay. Future work can extend the model by incorporating additional engagement drivers, such as habit, content variety, and personalization, to better explain sustained involvement among older users.

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Appendix A. Review-based construct operationalization

Table A1. Constructs, representative topics, keywords, and Construct definitions

Construct	# Topics	Operational Definition	Representative Keywords
System Quality	35 ,39 ,42 19 ,44 ,88 ,47	The extent to which the puzzle application performs reliably, is easy to navigate, stable, and technically efficient in supporting user interaction	design, piece, fix, support, update, load, stop, wifi, open, instruction
Information Quality	17 ,5 ,12	The degree to which the application's visual, textual, and auditory information is clear, accurate, and useful for elderly users	look, star, text, graphic, image, show, audio, center, pressure, detail, proper, display, picture
Service Quality	9 ,39	The perceived responsiveness and support provided by the application, including troubleshooting, reinstall options, and problem resolution	support, help, reinstall, solv, option, screenshot, memory, troubleshoot, device_info, run, reinstall, process
Senior Accessibility	98 ,61 ,85	The extent to which the application accommodates age-related needs, including visual clarity, cognitive simplicity, and ease of interaction for elderly users	easy_eye, senior, dementia, concentrate, brain, calm, focus, recommend, age, slow, horse, type, crossword, eye
Perceived Enjoyment	16 ,8 ,2 ,0 ,1 66	The degree of fun, relaxation, and intrinsic pleasure experienced by elderly users while interacting with the puzzle application	love, addictive, bright_color, calming, patience, happy, music, fun, brainer, peace, joy, accomplishment, enjoyment
Flow Experience	23 ,73 ,6 ,82 76	A state of deep absorption and focused involvement that occurs when puzzle challenges balance elderly users' abilities, leading to persistence and immersion	persistence, keep_interested, joy, finish, continue, try, playing, boost, flow, focus, immersion, absorb
Satisfaction	56 ,26 ,11 ,53	The overall positive evaluation of the puzzle application experience reflects the fulfillment of elderly users' expectations and needs	highly_recommend, thank, excelente, excellent, stay_focused, important, recommend, favorite, appreciate, accomplishment, happy, enjoyable, gratitude, satisfaction
Engagement	30 ,69 ,68	The degree of active, sustained involvement of elderly users with the puzzle application is reflected in repeated, meaningful interactions	continue, longer, week, daily, coin, play, multiple, reopen, keep, time, constantly, love, start

Appendix B. Expert validation of construct keyword sets

Experts rated each construct keyword set on relevance and clarity using a 5-point scale (1 = very low, 5 = very high).

Table B1. Expert ratings for relevance and clarity

Construct	Relevance (E1, E2, E3)	Relevance means	Clarity (E1, E2, E3)	Clarity means
System Quality	4, 5, 3	4	5, 5, 3	4.33
Information Quality	5, 5, 4	4.67	5, 5, 4	4.67
Service Quality	4, 5, 3	4	4, 5, 3	4
Accessibility	4, 5, 4	4.33	4, 5, 4	4.33
Perceived Enjoyment	4, 5, 4	4.33	4, 5, 4	4.33
Flow Experience	5, 5, 4	4.67	5, 5, 4	4.67
Satisfaction	5, 5, 4	4.67	4, 5, 4	4.33
Engagement	5, 5, 4	4.67	5, 5, 4	4.67