ISSN 2409-2665
Journal of Logistics, Informatics and Service Science
Vol. 13 (2026) No. 2, pp.116-133
DOI:10.33168/JLISS.2026.0207

Market Demand and Service Innovation as System-Level Constraints in Digital Elderly Care Services: A Qualitative Study from the Beijing–Tianjin–Hebei Region

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Abstract. This study examines how market demand and service innovation shape the transformation outcomes of digital elderly care services, from a service system and informatics perspective. Focusing on the Beijing–Tianjin–Hebei (BTH) region of China, the research investigates why large-scale investments in digital intelligence technologies have produced uneven transformation effects across elderly care service systems.

Adopting a qualitative research design, the study draws on in-depth interviews and focus group discussions with 15 key stakeholders, including elderly users, family caregivers, service practitioners, and policymakers. Data were analyzed using reflexive thematic analysis to uncover system-level mechanisms through which digital applications are translated—successfully or unsuccessfully—into service value.

The findings reveal three interrelated mechanisms. First, digital intelligence applications generate significant efficiency potential at the system level, yet frequently fail to improve service outcomes at the user level. Second, service innovation operates as a critical mediating process; when innovation is implemented through technology-driven, top-down service redesign, it constrains rather than enables transformation. Third, market demand functions as a socially embedded system constraint, shaped by trust networks, cultural norms, and user adaptability, which moderates the effectiveness of digital service systems.

By reconceptualizing market demand and service innovation as structural conditions within digital service systems, this study contributes to service science and informatics research by explaining why digital transformation outcomes diverge from intended policy and operational objectives. The findings offer practical implications for the design, governance, and evaluation of digital elderly care service systems in aging societies.

Keywords: Healthy Elderly Care Services, Digital Intelligence Application; Service Innovation, Market Demand, Transformation Effect, Qualitative Research.

1.Introduction

Digital transformation has become a central strategy for improving the efficiency, coordination, and sustainability of service systems in aging societies (Wang et al., 2023). In the context of elderly care, digital intelligence technologies—such as smart monitoring devices, integrated service platforms, and data-driven management systems—are increasingly adopted to address rising service demand, labor shortages, and resource allocation challenges. From a service science perspective, these technologies are expected to enhance service delivery efficiency, enable cross-organizational coordination, and improve overall system performance.

China's Beijing–Tianjin–Hebei (BTH) region represents a critical case for examining digital transformation in elderly care service systems. As one of the most economically developed and densely populated regions in China, BTH faces pronounced population aging—with residents aged 60 and above exceeding 19.6% across all sub-regions, surpassing the national average (National Bureau of Statistics of China, 2021)—alongside strong policy-driven investment in digital elderly care infrastructure. Government-led initiatives have promoted the deployment of smart service platforms and digital management systems with the expectation of improving service quality and operational efficiency at scale.

However, despite substantial technological investment, the realized transformation effects of digital elderly care services remain uneven (Xia & Chen, 2024). While prior quantitative studies have identified statistical relationships between digital technology adoption, service innovation, and performance outcomes, empirical evidence suggests that expected efficiency gains and service improvements do not consistently materialize in practice. This discrepancy raises an important service science question: why do digital service systems with strong technological capacity fail to generate corresponding transformation outcomes?

Existing research in logistics, informatics, and service science has largely conceptualized digital transformation as a function of technology deployment and organizational capability. Market demand and user adaptation are often modeled as exogenous moderators or contextual variables (e.g., Qin & Li, 2025). Such approaches, while analytically useful, provide limited insight into how service systems actually operate when digital technologies encounter the complex reality of elderly care—a reality where factors like trust, cultural norms, and even individual health anxieties actively shape what "demand" means and how it constrains or enables transformation. This points to a critical qualitative gap in understanding the interactive mechanisms and the socially constructed nature of market demand as a dynamic force within service systems.

To address this gap, this study shifts the analytical focus from technology adoption outcomes to service system transformation mechanisms. Specifically, it adopts a qualitative paradigm to examine how digital intelligence applications are translated into service value through service innovation processes, and how market demand operates as a system-level constraint that shapes transformation outcomes. Using qualitative evidence from multiple stakeholder groups in the BTH elderly care service ecosystem, the study offers a process-oriented, experience-based explanation of digital transformation beyond variable-based models.

By doing so, the research responds directly to calls within service science and informatics for deeper understanding of the socio-organizational mechanisms that condition digital service system performance. Integrating insights from Service Innovation and Market Orientation theories, the findings contribute to ongoing debates on why digital transformation initiatives succeed or fail in complex service environments and provide practical insights for designing more resilient and adaptive digital elderly care service systems.

2.Literature Review

2.1 The Quantitative Foundation of Digital Transformation in Elderly Care

The academic literature on digital intelligence in health and elder-care is predominantly quantitative, focusing on measuring outcomes, testing hypotheses, and modeling relationships (Zhao & Li, 2024). This body of work has established key value drivers such as process automation and data analytics, and has identified significant barriers like low technology acceptance among the elderly (Yusif et al., 2016; Peek et al., 2014). Theoretical lenses such as the Resource-Based View, Technology Acceptance Model, and Stewardship Theory have been applied to explain adoption and effectiveness.

2.2 The Problematized Role of Market Demand

A critical consensus emerging from this literature is the pivotal yet problematic role of market demand. Li et al. (2022) theorized that market demand negatively moderates the relationship between digital intelligence application and transformation effect. This finding is often attributed to the mismatch between technological complexity and elderly users' adaptability (Li et al., 2022). However, this research stream typically operationalizes "Market Demand" and "Transformation Effect" as latent variables measured by scales, potentially stripping away context, meaning, and process.

2.3 Identified Gaps for Qualitative Inquiry

A significant qualitative gap emerges here. First, while factors like "user-unfriendly design" are noted, there is limited deep-dive into what constitutes "friendliness" from the elderly's phenomenological perspective their sensory perceptions, cognitive patterns, and emotional responses. Second, the process of service innovation, how ideas are generated, designed, and implemented within institutions---remains a black box in quantitative studies. It is treated as a mediating variable rather than a social practice (Aksoy et al., 2019). Third, the concept of "Market Demand" is often abstracted from its social moorings. Qualitative inquiry is needed to explore how demand is formed through interpersonal trust, family dynamics, community narratives, and cultural attitudes towards aging and technology.

In summary, while quantitative research has effectively mapped the landscape of digital transformation in elderly care, revealing "what" relationships exist, it leaves the 'how' and 'why' of these relationships—as lived and negotiated by people—largely uncharted. This study positions itself to explore this lifespace, providing the depth and nuance needed to complement and explain the broader quantitative patterns.

3.Conceptual Framework and Research Questions

This study is guided by a qualitative conceptual framework designed to explore the phenomena identified in the quantitative literature through an interpretative lens. The framework integrates the same core theoretical foundations—Service Innovation Theory, Market Orientation Theory, and Technological Empowerment Theory—but repositions them to guide an in-depth investigation of processes, meanings, and lived experiences (Figure 1).

The framework posits digital intelligence application as the central technological phenomenon under study, transformation effect as the multidimensional outcome perceived by stakeholders, service innovation as the critical mediating process that translates technology into service value, and market demand as the pervasive contextual condition that shapes all interactions within the ecosystem. This structure mirrors the quantitative model's logic but shifts from testing variable relationships to understanding their substantive enactment and social construction.

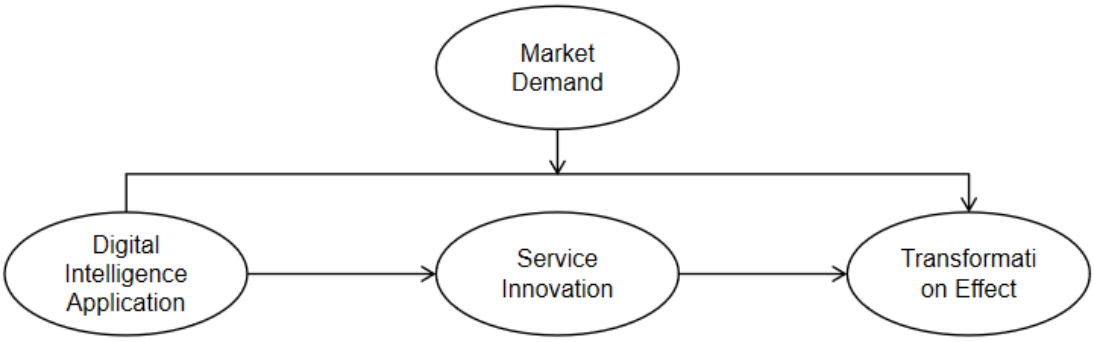

Fig.1: Conceptual Framework of the Study

Drawing on this framework, the study formulates specific research questions to systematically explore how the relationships between these constructs are realized in practice. The development of each research question is grounded in the relevant theoretical perspective and addresses a specific gap in understanding the "how" and "why" behind established quantitative correlations.

RQ1: How do different stakeholders perceive and experience the role of digital intelligence applications in shaping elderly care services, and what meanings do they attribute to this technological integration?

This question is primarily informed by a sociotechnical perspective on technology and social inclusion (e.g., Warschauer, 2004). Moving beyond a view of technology merely as a tool for optimizing processes, this perspective emphasizes how the integration of digital tools is experienced, interpreted, and given meaning within specific social contexts. RQ1 thus examines whether and how these applications are perceived as facilitators of access, participation, and empowerment for caregivers and recipients, or conversely, as sources of new complexity, dependency, or exclusion. By focusing on the subjective perceptions and attributed meanings of diverse stakeholders, this inquiry aims to uncover the lived mechanisms through which technology fosters inclusion or alienation in elderly care practices, thereby providing essential context to complement quantitative findings on the application's impact.

RQ2: How is the process of service innovation enacted within organizations providing digital elderly care, and how does this process mediate stakeholders' experiences of transformation?

This question is centrally supported by service innovation Theory. The theory suggests innovation is a key mechanism for value creation (Lusch & Nambisan, 2015). RQ2 probes the nature of this mechanism as a process. It investigates how innovations in service design, delivery, and support are conceived, implemented, and negotiated in real-world settings. It further explores how these enacted processes—whether user-centric or technology-driven—directly shape the lived experience of change for elderly users and caregivers, thereby addressing the critical gap in understanding the mediating role of Service Innovation between technological adoption and perceived Transformation Effect.

RQ3: In what ways does the social context of market demand, encompassing acceptance, adaptability, and culturally-shaped needs, enable or constrain the relationship between digital applications and realized transformation outcomes?

This question draws directly on Market Orientation Theory. The theory emphasizes that external market conditions shape strategic effectiveness. Quantitative studies indicate market demand exerts a moderating influence (Kohli & Jaworski, 1990). RQ3 seeks to qualitatively unpack this moderation by investigating its social and cultural mechanics. It explores how factors like trust built through social networks, familial expectations, community norms, and the practical realities of elderly users' digital literacy collectively create a context. This context either facilitates the effective use of technology or renders it ineffective. This question aims to move beyond the "what" of moderation to explain the "how" of its operation in daily life.

This structured approach ensures the qualitative inquiry is theoretically anchored. It systematically addresses the core components of the conceptual framework and provides a coherent exploration of the complex dynamics underpinning digital transformation in elderly care.

4. Method

This study employed a qualitative research design to investigate the influence of digital intelligence applications and market demand on the transformation effects of healthy elderly care services in the Beijing-Tianjin-Hebei region, with service innovation as a mediating variable. The qualitative approach was selected to enable an in-depth, interpretative exploration of the meanings, processes, and contextual factors underlying the relationships among constructs, providing rich, nuanced understanding that complements and explicates quantitative findings (Lim, 2025). Data collection was conducted between May and June 2025.

4.1 Methodological Approach

This study adopts a qualitative research design employing Reflexive Thematic Analysis (RTA) as the primary analytical method, informed by an interpretative phenomenological orientation (Braun & Clarke, 2006, 2022). RTA provides a flexible yet systematic framework for identifying, analyzing, and reporting patterns (themes) across the dataset. The interpretative phenomenological orientation guides our engagement with the data, ensuring a focus on understanding the subjective, lived experiences of stakeholders—how they make sense of technology, innovation, and care within their lifeworlds.

This approach differs from a pure Interpretative Phenomenological Analysis (IPA), which typically involves a smaller, more homogeneous sample and an intensive case-by-case analysis focused on individual lived experience. Given our aim to capture and compare shared and divergent experiences across a purposively diverse sample of 15 stakeholders from four groups, RTA with a phenomenological lens is the more appropriate methodological choice. It allows us to move beyond pure description to achieve an interpretative engagement with data, guided by phenomenological sensitivity to meaning and context.

4.2 Data Collection and Translation Procedures

All interviews and focus group discussions were conducted in Mandarin. The complete audio recordings were transcribed verbatim in Mandarin. The transcripts were then translated into English by a senior translator at Etrans Intelligent Information Technology Co., Ltd. (Beijing).Holds a CATTI translation certification and has extensive experience in translating social science research. To ensure conceptual and semantic accuracy, a translation verification procedure was employed, involving back-translation of key excerpts by an independent bilingual researcher to cross-check consistency with the original meanings.

4.3 Sample Size Rationale and Data Saturation

In qualitative research, the sample size is not determined by statistical power but by the principle of achieving "information saturation" or "theoretical saturation," meaning that newly collected data no longer generate new analytical insights or themes (Creswell & Poth, 2018). The final sample size in this study (N=15) was determined based on this principle. During the iterative process of data collection and concurrent analysis, we observed that after interviewing the 13th participant, the new codes and themes generated became extremely sparse.

Subsequent interviews with the 14th and 15th participants, along with data from the two focus group discussions, primarily served to confirm and enrich the already established themes, without introducing any new core categories. This phenomenon indicates that information saturation was achieved. Previous qualitative methodological research also notes that for studies employing thematic analysis aimed at exploring shared patterns, a sample size of 12-15 participants is typically sufficient

and common (Guest et al., 2006; Morse, 2000). Even with the inclusion of minor subgroup variations within the sample, the achievement of data saturation at 15 participants reinforces that the variability present was sufficiently captured within the framework of thematic analysis, aligning with Guest et al.'s (2006) underlying principle that sample size adequacy is determined by thematic coverage rather than strict numerical thresholds. Therefore, the current sample size is adequate to provide an in-depth and nuanced understanding of the research questions.

4.4 Ethical Approval and Informed Consent

This study has been reviewed and approved by the Research Ethics Committee of Rattana Bundit University (Approval No.: RBAC-EC-BUS-0-005/68). All participants provided fully informed consent prior to data collection. We provided a detailed informed consent form in Chinese, explaining the research purpose, procedures, confidentiality and anonymity measures, as well as the rights to voluntary participation and withdrawal at any time. All interviews and focus group discussions were conducted in private settings agreed upon by the participants. Sessions were audio-recorded in full, and transcripts were anonymized and stored securely with encryption.

4.5 Participants

The study recruited 15 participants from the healthy elderly care service ecosystem in the Beijing-Tianjin-Hebei region. Purposive sampling was employed to ensure the inclusion of information-rich cases that provide deep insights into the research questions across key stakeholder groups: five (33.33%) were elderly users, four (26.67%) were family caregivers, four (26.67%) were service practitioners, and two (13.33%) were policymakers and administrators. The sample exhibited diversity in experiential context. The elderly user group comprised individuals with varying levels of digital literacy, all of whom had used at least one community-based or digital care service.

The family caregiver group consisted of primary decision-makers involved in daily care coordination. Among the five elderly users, three (60%) were aged 71–75 and two (40%) were aged 66–70. Participants were drawn from areas with medium (eight, 53.3%), high (four, 26.7%), and low (three, 20.0%) levels of economic development within the region, ensuring contextual diversity. Regarding technological familiarity, among all participants, six reported average familiarity, five were relatively familiar, two were very familiar, and two reported low familiarity. The detailed process is presented in Table 1.

Table 1. Participant Composition and Characteristics (N=15)

Stakeholder Category	n	%	Primary Role / Context	Sub-group Detail (n)	Gender (n)	Avg. Experience/Usage
Elderly Users	5	33.33 %	Direct recipients of elderly care services; varied digital literacy.	Age: 71-75 (3), 66-70 (2)	3F,2 M	4.0 yrs service use
Family Caregivers	4	26.67 %	Primary family decision-maker/supporter for elderly relative.	Spouse (2), Child (2)	2F,2 M	5.5 yrs caregiving
Service Practitioners	4	26.67 %	Professionals delivering/managing elderly care services.	Community Center (2) Institutional Care (1) Digital Platform (1)	2F,2 M	10.8 yrs industry
Policymakers & Administrators	2	13.33 %	Officials involved in policy formulation &	Civil Affairs (1)	1F,1 M	13.5 yrs in role

			implementation.	Health Planning (1)
Total	15	100%		

4.6 Instrument

Digital intelligence application was explored using a semi-structured interview guide developed with reference to the conceptual dimensions of the quantitative scale. The guide comprised three thematic sections. Perceived User Alignment (3 core questions) explored fit with elderly needs and habits (e.g., "Can you describe how digital services match or fail to match the daily routines and preferences of the elderly?"). Perceived Policy and Institutional Environment (3 core questions) examined contextual support (e.g., "What supports or barriers exist in the current policy or organizational environment for digital elderly care?"). Observed Resource Investment (3 core questions) assessed the deployment of digital infrastructure (e.g., "From your observation, are sufficient resources---training, equipment, funding---dedicated to digital systems?").

Service innovation was explored using a guide adapted from service innovation literature (Bitner et al., 2008), comprising three sections. Experiences of Service Design Innovation (3 core questions) addressed novelty in service concepts (e.g., "Can you give an example of a significantly new or changed service offering? What was innovative about it from your perspective?"). Processes of Service Delivery Innovation (3 core questions) examined changes in service provision (e.g., "How is the service delivered or accessed now compared to before? What is different in the process?"). Adequacy of Service Support Innovation (3 core questions) evaluated novel support mechanisms (e.g., "What kind of help, guidance, or follow-up is available when using new services? Is it effective?").

Market demand was explored using a guide informed by technology acceptance and adaptation theories (Venkatesh et al., 2007), comprising three sections. Perceived Adaptability to Changing Demands (3 core questions) assessed responsiveness to needs (e.g., "How well and how quickly do services adapt to the varying demands of different elderly individuals?"). Personal and Observed Adaptability (3 core questions) measured adjustment capacity (e.g., "How do you or the elderly you know adapt to new digital care services? What facilitates or hinders this?"). Perceived Acceptance Level (3 core questions) evaluated market reception (e.g., "How readily are new service formats accepted in your community or family? What factors most influence this acceptance or resistance?").

Transformation effect was explored using a guide focusing on perceived outcomes, comprising three sections. Perceived Changes in Service Quality (3 core questions) assessed improvements in care standards (e.g., "In what tangible or intangible ways has the quality of care been affected by digital tools?"). Observed Changes in Operational Efficiency (3 core questions) measured process gains (e.g., "Have you noticed changes in how efficiently care tasks or services are managed? Please describe."). Perceived Shifts in Market or Community Position (3 core questions) evaluated competitive or social standing (e.g., "Has the adoption of digital services changed how the service or organization is perceived within the community or sector?").

Additionally, interview guides included opening questions about participant background and concluding questions for overall reflections. All guides were translated into Mandarin Chinese and pilot-tested with 4 stakeholders (1 from each group) to ensure cultural appropriateness, clarity, and logical flow. Adjustments were made to question phrasing and sequencing based on pilot feedback.For instance, in the guide for elderly users, the initial technical term “user interface (UI)” was replaced with the more accessible phrase “the look and feel of the screen or buttons” based on a participant’s confusion. Furthermore, the sequence of questions for service practitioners was reordered to first explore observed challenges in adoption before discussing their innovation processes, creating a more natural narrative flow from problem recognition to solution design.

4.7 Data Collection

Data were primarily collected through 15 semi-structured in-depth interviews and 2 focus group discussions (one with elderly users and one with mixed service providers). The interviews averaged approximately 75 minutes in length, while the focus groups lasted around 120 minutes, generating approximately 24 hours of audio recordings. After transcription, this resulted in over 200 pages of textual data. We integrated data from both sources in the analysis, with attention to their complementary nature: interview data deeply revealed individual experiences and inner feelings, while focus group data were particularly useful for capturing social norms and consensus emerging from group interactions (especially discussions related to "social trust"). In presenting the results, we synthesized insights from all data sources and indicated when citing expressions that particularly reflected group dynamics.

4.8 Analysis Process

Data analysis followed the six-phase framework of reflexive thematic analysis proposed by Braun & Clarke (2006, 2022), assisted by NVivo 14 software. The process included: 1) immersion in the data; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) defining and naming themes; and 6) writing the report. The analysis was consistently guided by an interpretative phenomenological perspective, aiming to understand the meaning behind experiences.

4.9 Measures to Ensure Rigor

To enhance the study's credibility, dependability, and confirmability, the following measures were implemented: Inter-coder reliability check: After completing unified training, two researchers independently conducted open coding on 30% of randomly selected transcripts (5 documents). We calculated the percentage of coding agreement; the initial agreement was 78%, which falls within the expected range for first-round coding of complex qualitative data involving interpretive latitude (Campbell et al., 2013). Subsequently, all discrepancies were discussed in a consensus meeting, leading to the revision and formation of a unified coding manual. Based on this manual, a second independent coding of another randomly selected transcript achieved an agreement rate of 95%, indicating that the coding standards were clear and reliable. Finally, one researcher completed the coding of all data using the final manual. The detailed process is presented in Table 2.

Table 2. Inter-coder Reliability Check Process

Step	Description	Result
Step One: Independent Coding	Two researchers independently coded 5 randomly selected transcripts (P03, P05, P08, P11, P14).	Initial agreement percentage = 78%
Step Two: Consensus Meeting	Discussed each discrepancy line by line, clarifying code definitions with reference to the original context.	Formed a revised coding manual.
Step Three: Reliability Verification	Conducted a second independent coding of P07 using the revised manual.	Secondary agreement percentage = 95%
Step Four: Full Coding	Researcher A completed the analysis of all data using the final manual.	Ensured the reliability of the coding process.

Member checking (participant validation): After preliminary themes were formed, we invited 4 participants from different groups (P03 – elderly user, P08 – family caregiver, P11 – service provider, P13 – policymaker) for validation. We provided them with personalized analysis summaries and solicited their feedback. Participants generally confirmed that the analysis "hit the mark" and offered minor refinements in wording (e.g., placing greater emphasis on "the difficulty of repeated learning

due to system updates"). This feedback was incorporated into the final analysis, enhancing the authenticity and resonance of the findings.

Negative case analysis: During theme development, we actively sought and examined data that did not fit the preliminary thematic framework. For example, a service provider from a high-end elderly care community (P12) described an iterative design process within their institution that included user testing. This case did not negate the dominant theme of "innovation as imposition" but helped define its boundaries: it suggests that under conditions of sufficient resources and a genuinely user-centered organizational culture, the "imposition" model can be overcome. This added depth and explanatory power to our analysis.

Audit trail: We systematically maintained a complete audit trail archive, including: all raw data and transcripts; different versions of the codebook along with revision logs; mapping records from raw statements to codes and then to themes; memos from analysis meetings; and researchers' reflective notes. This archive ensures that every analytical decision from data to conclusion is transparent and traceable.

Data collection employed a multi-method approach to ensure depth and triangulation. Primary data came from in-depth, semi-structured interviews conducted face-to-face with all 15 participants in private settings conducive to conversation. Supplementary data were collected through two focus group discussions (FGDs) to capture group dynamics and interactive dialogue: one with elderly users, and one with mixed service practitioners, generating approximately 24 hours of audio recordings.

All sessions were audio-recorded with prior informed consent and transcribed verbatim, resulting in over 200 pages of textual data. The high level of data richness was achieved through collaboration with local community and administrative partners for participant recruitment, multiple contact points to build rapport, and scheduling at times convenient for participants. Standardized protocols for interviewer training, ethical introduction, neutral facilitation, and data handling were maintained across all researchers and settings. The detailed process is presented in Table 3.

Table 3 Core Thematic Areas in Interview and FGD Guides

Stakeholder Group	Core Thematic Areas (Examples of Guiding Questions)
All Groups	Perceptions of "digital/ smart" elderly care. Personal experiences with relevant technologies/services. Views on changes in service quality and delivery. Daily interaction with devices/platforms (ease, frustration).
Elderly Users	Feeling of control, dignity, or anxiety. Trust in technology and service providers.
Family Caregivers	The role of technology in sharing the care burden. Challenges in helping parents adopt tech. Perceived impact on family relationships.
Service Practitioners	Internal process of adopting/designing new digital services. Training and support for users. Measured vs. perceived outcomes.
Policymakers	Policy objectives vs. on-ground realities. Assessment of market readiness and demand. Cross-regional coordination challenges.

4.10 Data Analysis

Data analysis followed the systematic, iterative six-phase process of reflexive thematic analysis as outlined by Braun and Clarke (2006, 2022), conducted from an interpretative phenomenological orientation. Transcripts were imported into NVivo 14 software for management and coding. The six phases included: (1) Familiarization: Repeated reading of all transcripts and listening to audio recordings to immerse in the data. (2) Generating Initial Codes: Systematic coding of interesting

features across the entire dataset, focusing on semantic content and latent meaning related to the research questions. (3) Searching for Themes: Collating codes into potential themes, gathering all data relevant to each potential theme. (4) Reviewing Themes: Checking themes against the coded extracts and the entire dataset to ensure they form a coherent pattern. This involved iterative refinement. (5) Defining and Naming Themes: Ongoing analysis to refine the specifics of each theme and the overall story of the analysis. (6) Producing the Report: Selecting vivid, compelling extract examples, final analysis of selected extracts, and relating the analysis back to the research questions and literature.

Throughout this process, the interpretative phenomenological orientation guided the analysis. This meant the coding and theme development were not merely descriptive but sought to interpret the participants' lived experiences—how they perceived, felt, and made sense of digital transformation. Attention was paid to language, metaphor, emotion, and contradiction as windows into their phenomenological world. For example, codes like "Emotional Distress (Feeling Incompetent)" emerged from this dual focus on pattern (thematic) and meaning (phenomenological).

Preliminary analysis involved repeated reading of transcripts for deep familiarization, followed by open coding to identify significant statements, narratives, and concepts related to the research framework. Codes were then clustered into potential themes through an iterative process of comparison and refinement.

The core analysis utilized a structured approach to identify patterns related to the four main constructs. For the construct of digital intelligence application, analysis focused on identifying themes related to perceived utility, integration challenges, and contextual facilitators. For service innovation, analysis examined narratives around the process of innovation, its drivers, and its immediate impacts on users and providers. For market demand, analysis sought themes related to the social construction of need, acceptance determinants, and adaptive behaviors. For transformation effect, analysis identified perceived outcomes, both intended and unintended, across service, operational, and community dimensions.

Inter-coder reliability was established through analyst triangulation, where two researchers independently coded a subset of transcripts and discussed discrepancies to refine the coding framework. Credibility was enhanced through member checking, where preliminary interpretations were shared with a subset of participants for feedback. Particular attention was paid to understanding the mediating processes of service innovation and the moderating role of market demand as experienced and described by participants. The coding structure evolved from initial open codes to final themes, as exemplified in Table 4.

Table 4 Example of Coding Process: From Raw Data to Themes

Raw Data Excerpt (Translated)	Initial Open Code	Axial Code	Final Theme
"The app has dozens of buttons. I just want to call a nurse. My fingers tremble, I always press the wrong one… It makes me feel stupid." (Elderly, 78, Beijing)	UI Complexity Physical Barrier Emotional Distress (Feeling Incompetent)	Design-User Mismatch	Theme 2: Innovation as Imposition
"We launched the new system after a vendor demo. The staff got a 2-hour training. We assumed the elderly would learn from their kids." (Manager, Community Center, Tianjin)	Top-down Implementation Inadequate Staff Training Assumption of External Support	Insufficient Implementation Support	Theme 2: Innovation as Imposition
"I don’t care what the brochure says. If Sister Li next door says it’s good and safe, and she shows me, then I’ll try it." (Elderly, 71, Hebei)	Distrust of Official Promo Peer Recommendation Trust Need for Demonstrative Learning	Trust via Social Proof	Theme 3: Market Demand as Social Trust

4.11 Researcher Reflexivity Statement

This study employs Reflexive Thematic Analysis, which acknowledges the researcher's role in knowledge construction. The primary researcher is a PhD candidate in Business Administration with approximately three years of prior research experience in digital health and elderly care services. This investigation was conducted under the close guidance and regular critique of two senior supervisors, ensuring the work was continually challenged from multiple academic perspectives. The researcher (aged 29, male) entered the field as an external academic without prior personal or professional ties to the Beijing-Tianjin-Hebei region or its elderly care community. This outsider status was consciously leveraged to ask fundamental questions, but it also required diligent effort to build rapport and contextual understanding. It is acknowledged that his identity as a young male researcher and an external student may have influenced participant responses—potentially leading elderly users to offer more simplified explanations of technology use, or prompting service providers to emphasize formal, policy-aligned outcomes during interviews.

The research team approached the study with an interdisciplinary stance, believing in the potential of digital technologies for elderly care while critically questioning technologically deterministic implementations. Prior expectations, informed by quantitative literature, were consciously bracketed during data collection and analysis. To operationalize this bracketing and trace the influence of the researcher's subjectivity, a reflexive journal was maintained throughout the research process to document assumptions, emotional reactions, and decision-making rationales after each field interaction and analytical session. The emergence of themes such as "innovation as imposition" prompted explicit reflection on potential pro-innovation biases, leading to active searching for disconfirming cases.

Throughout interviews and analysis, the team adopted a learner's stance, used non-technical language to bridge generational gaps, and subjected interpretations to team scrutiny to mitigate individual bias. A specific practice of structured post-interview debriefing with supervisors was implemented to critically examine interaction dynamics, such as the potential for social desirability bias when interviewing policymakers or the risk of interpretive authority when analyzing the narratives of less technologically articulate elderly participants. This statement clarifies that the findings represent a theoretically informed interpretation of participant narratives, rigorously shaped and validated through these sustained reflective practices.

5. Results

This study conducted a systematic thematic analysis of interviews and focus group discussions with 15 key stakeholders from the Beijing-Tianjin-Hebei (BTH) region. The stakeholders included elderly individuals, family caregivers, service practitioners, and policymakers. The aim was to uncover the underlying experiences and key contradictions in the digital transformation of healthy elderly care services. Guided by the integrated interpretative phenomenological and reflexive thematic analysis approach, the analysis involved open coding, theme condensation, and interpretation of meanings. This culminated in the identification of three core themes that constitute critical dimensions for understanding current transformation practices. These themes collectively provide a nuanced response to the three research questions. They illuminate how digital intelligence applications are experienced (RQ1), how service innovation processes mediate transformation (RQ2), and how market demand as a socio-cultural context shapes outcomes (RQ3). The structure and core meaning of these themes are summarized in Table 5.

Table 5 Summary of Qualitative Themes and Core Insights

Theme	Core Concept	Key Dimensions (Sub-themes)	Representative Quote
The Paradox of Potential	Dissonance between macro-level promise and micro-level experience.	Enthusiasm from Policy/Provider Side Daily Frustration & Alienation The "Strict Nurse" Phenomenon	"It feels like a strict nurse on my wrist, not a helper." (Elderly User, 74, Beijing)
Innovation as Imposition	Service innovation as a top-down, tech-centric process lacking user empathy and support.	Design Disconnect (Complex UI, misaligned logic) Support Void (Lack of sustained guidance) Process Exclusion (Users not involved in design)	"Where is the 'simple lunch' button?" (Family Caregiver, Tianjin)
Market Demand as Social Trust & Cultural Readiness	Demand is constructed through social networks and cultural norms, not just product features.	Trust Over Features (Peer influence > official marketing) Cultural Hesitance (Familial duty vs. digital outsourcing) Community as Gatekeeper Negative: Replacing/Complicating Interaction (e.g., automated kiosks) Metric of Success: Relational Quality	"I won't use it unless my neighbor tries it first and shows me." (Elderly User, 71, Hebei)

Theme 1: The Paradox of potential

Participants universally acknowledged the theoretical potential of digital intelligence. Policymakers spoke of "leapfrog development" and "smart integration," with one official stating, "The strategic goal is to build a seamlessly integrated, smart elderly care ecosystem." Service providers highlighted efficiency gains. However, this enthusiasm was sharply tempered by the daily experiences of elderly users and caregivers. The technology was often experienced as alien and frustrating, as articulated by a caregiver: "Every update adds more buttons; it's like they're solving a problem we don't have, while the one we do gets worse." This created a significant gap between promise and lived reality. This theme directly addresses RQ1 by revealing how stakeholders perceive digital intelligence applications not merely as tools for efficiency, but as sources of ambivalence simultaneously promising yet alienating. This enriches our understanding of the "meanings" attributed to technological integration in elderly care.

Theme 2: Innovation as imposition

Service innovation was frequently described not as a user-centered process but as a top-down imposition of technology. The mediating role of innovation was visible, but often negatively. Criticisms focused on overly complex designs that ignored physical and cognitive limitations, embodied in a user's question: "Why does the 'emergency call' require three steps and a password? In an emergency, I can't remember all that!", and a critical lack of ongoing, empathetic support after deployment. A community worker noted, "After the devices were handed out, the hotline was only for technical faults, not for teaching how to use them. People just gave up." This left users feeling abandoned. This theme responds to RQ2 by illustrating how service innovation is enacted in practice: not as a co-creative, value-adding process, but as an imposed, technology-driven rollout. This failure to mediate positive transformation explains why innovation can negatively shape stakeholder experiences. Notably, the dominant pattern of "innovation as imposition" was contextual. A negative case (P12, a high-end elderly care community) outlined an alternative pathway. Here, an iterative design process incorporating user testing was described. This case did not invalidate the theme but crucially helped define its boundaries. It suggests that under specific conditions—namely, sufficient resource allocation and a deeply embedded, genuinely user-centered organizational culture—the top-down "imposition" model can be overcome. The inclusion of this case adds analytical rigor and depth by explicitly demonstrating the circumstances under which the predominant finding may not hold, thereby strengthening the explanatory power of the analysis.

Theme 3: Market demand as social trust and cultural readiness

Market demand emerged not as an abstract economic force but as a fabric woven from trust, social influence, and cultural attitudes. Willingness to adopt was less about a service's features and more about personal or community endorsement. An elderly participant explained, “My son bought me this health monitor. I use it only because he checks on the app. If it were just for me, I wouldn’t bother.” Furthermore, cultural hesitance about replacing human care with digital tools posed a significant barrier, reflecting deeper values about family responsibility. A middle-aged child caregiver expressed this tension: “Relying on an app to check on my mother feels like I’m shirking my duty. What will the neighbors think?” Here, the findings engage with RQ3 by demonstrating that market demand operates as a socio-cultural moderator. Adoption is enabled or constrained not by features alone, but through trust networks, peer influence, and cultural norms. This explicates the "how" behind its moderating role.

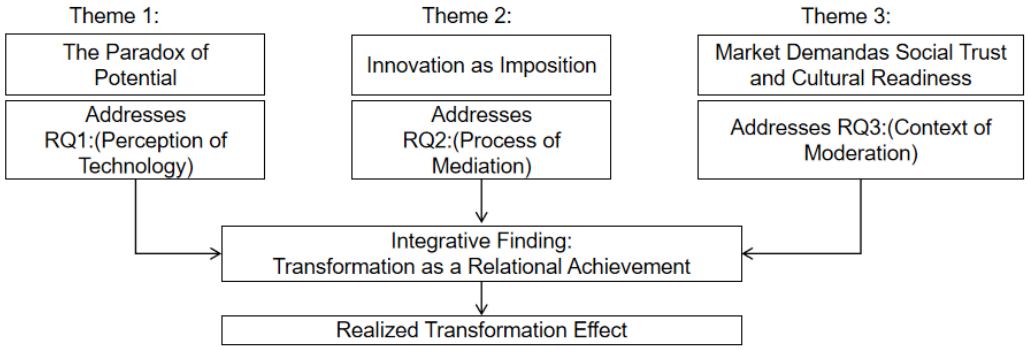

Fig.2: The Pathway to Realized Transformation Effect in Digital Elderly Care

Integrative Finding: Transformation as a relational achievement

The synthesis of the preceding three themes leads to a core integrative finding: the ultimate outcome of digital transformation is defined by its capacity to achieve a relational achievement （Figure 2）, whether it strengthens or weakens human connections within the care ecosystem. Success was embodied in stories of technology facilitating connection (e.g., family video calls). Failure was epitomized by technology that replaced or complicated warm human interaction. The ultimate metric of transformation was relational quality---feelings of dignity, autonomy, and connection. Therefore, this study concludes that successful digital transformation in elderly care is ultimately realized and evaluated as a relational achievement. It synthesizes the influences of technology perception (Theme 1), innovation process (Theme 2), and socio-cultural context (Theme 3), placing human connection and dignity at the core of assessing transformative success, thereby providing a unified answer to the research questions.

6. Logical Structure and Integrative Framework of the Themes

The four core themes identified above do not exist in isolation; rather, they are interrelated and interact dynamically, collectively forming an integrative explanatory framework for understanding the complexity of digital transformation in healthy elderly care. To clarify their internal structure and pathways of influence, this study presents the logical relationships between the themes through systematic analysis.

The analysis first demonstrates—by examining the coverage proportion of core categories—that service innovation, digital intelligence application, and transformation effect occupy the most central and frequently discussed positions. This empirically confirms that they constitute the key action dimensions for driving and measuring the transformation process. These three elements form the basic “action triangle” of transformation: digital intelligence application serves as the technological input and primary driver. It must undergo value translation and implementation through the crucial

mediating process of service innovation, with the ultimate value output reflected in the multidimensional transformation effect.

However, this linear "technology–innovation–effect" logic is fraught with tension in practice. Further hierarchical analysis clarifies that the entire transformation process is consistently moderated by a deeper, more pervasive contextual force—market demand—which is embodied in the qualitative findings as social trust and cultural preparedness.

The framework indicates that both the introduction of technology and the choice of innovation models are profoundly filtered by localized trust networks, family ethics, and community cultural norms. This explains why service innovation that is detached from this context—often appearing as a form of "imposition"—encounters strong resistance, leading to the observed "paradox" between technological potential and user experience.

Ultimately, the direction of all efforts and the criterion for success or failure are anchored to the final dimension of relational achievement. This signifies that the fundamental measure of transformation effect transcends the optimization of efficiency and functionality. The framework underscores that this humanistic value goal is not an automatic outcome, but rather a core objective requiring proactive design and continuous moderation.

In summary, this integrative model reveals that healthy aging digital transformation is a complex socio-technical process: it originates from technology-driven impetus, undergoes translation through an innovation process often marked by disembedded risks, is continuously moderated by the socio-cultural context throughout, and ultimately aims to achieve humanistic relational value. This conceptual framework not only deepens the understanding of each isolated theme but also connects them into a coherent narrative, fundamentally explaining why digital transformation proves challenging in practice and where strategic efforts should be directed.

7.Discussion

7.1 Synthesis of Key Findings

This qualitative study delves into the lived experiences and social processes underlying the digital transformation of elderly care in the Beijing-Tianjin-Hebei region. Our findings offer a nuanced, mechanism-based understanding that complements and extends the prior quantitative phase of our research program (Tian et al., 2025). This qualitative study constitutes the explanatory phase of a sequential mixed-methods design, building directly upon the initial quantitative findings. By foregrounding the interpretive depth of stakeholder narratives, this research addresses the three core questions systematically, revealing the underlying social and procedural dynamics of the "technology—innovation—market" interplay in digital transformation. The methodological choice of reflexive thematic analysis, informed by an interpretative phenomenological orientation, allowed us to capture both the richness of individual lived experience and the broader thematic patterns across stakeholder groups. This approach preserves the complexity of the phenomenon without reducing it to variable-based abstractions.

First, the study illuminates how service innovation operates as a mediating process—an aspect often obscured in quantitative models. Where prior quantitative findings indicated a negative association with service innovation, our qualitative analysis refines this understanding: the adverse effect stems not from innovation itself, but from its predominant enactment as an imposition, a top-down process that overrides embedded user routines and trust networks. Notably, the contrast with a negative case (P12, a high-end community practicing iterative co-design) crucially defines the boundary of this pattern. It demonstrates that the imposition pathway is not a necessity but a prevalent outcome shaped by common constraints in resources and organizational culture. Thus, the perceived negative effect is attributable to this specific implementation mode, rather than to service innovation intrinsically. When innovation is driven primarily by technological capability rather than

user-centered co-creation, it results in designs misaligned with elderly users' cognitive and physical realities, coupled with a critical absence of sustained, empathetic support. This process failure engenders frustration, alienation, and disengagement, thereby negatively shaping the perceived transformation effect. Thus, the present findings provide a procedural explanation for why and how service innovation can hinder rather than facilitate positive change.

Second, this research unpacks the socio-cultural constitution of market demand—a construct frequently operationalized in quantitative studies as an aggregate moderator. In the lived reality of stakeholders, market demand manifests not as an abstract economic metric, but as a tapestry woven from social trust, peer influence, and cultural norms regarding care and familial responsibility. Adoption decisions are filtered through localized networks of trust and values, rather than through mere feature assessment. Consequently, even well-intentioned digital applications may falter if they lack social legitimacy or conflict with deeply held cultural expectations. This qualitative explication clarifies in what ways market demand operates as a contextual force that enables or constrains the transformation pathway—by shaping the very conditions of acceptance and meaningful use.

Finally, the data refine the conceptualization of transformation effect itself. Beyond quantitatively measured dimensions such as service quality or operational efficiency, stakeholders consistently evaluated transformation in terms of relational achievement—whether technology enhanced human connection, preserved dignity, and supported autonomy, or instead replaced or complicated warm interpersonal interaction. This relational criterion emerges as the ultimate yardstick against which digital transformation is judged. It integrates insights across all three research questions: transformation as experienced (RQ1), as mediated by innovation processes (RQ2), and as moderated by socio-cultural context (RQ3). This suggests that quantitative indicators of transformation gain full meaning only when understood in light of their contribution to relational well-being.

7.2 Theoretical Contributions

This study makes three key theoretical contributions.

First, the study reconceptualizes market demand from a service system perspective. Rather than treating demand as an external or static moderator, the findings demonstrate that market demand operates as an active, socially constructed force—a socially embedded system constraint actively shaped by trust networks and cultural norms, which collectively define local "cultural readiness." This perspective extends existing service science models by explaining how these socially constituted demand conditions actively structure the effectiveness of digital service systems.

Second, the study advances understanding of service innovation as a mediating mechanism in digital transformation. The findings show that service innovation does not automatically enhance transformation outcomes; instead, its effect depends on how innovation processes are organized and governed as a socio-technical practice. We reveal a critical "imposition vs. co-creation" dichotomy: Technology-driven, top-down (imposed) innovation can constrain system performance, while user-aligned (co-created) innovation pathways enable more effective value realization and positive transformation effects. This insight contributes to service innovation research by highlighting governance and implementation mode as critical determinants of system-level outcomes.

Third, the study contributes a process-oriented explanation of digital transformation failure and divergence in elderly care service systems. By integrating digital intelligence application, service innovation, and market demand into a unified qualitative and integrated socio-technical framework, the research explains why investments in digital technologies may fail to translate into expected service improvements. This framework provides a dynamic, process-oriented lens that moves beyond static components, centering on the enactment of innovation and the critical role of context-sensitive factors like "relational achievement." This contribution is particularly relevant for informatics and service system scholars seeking to bridge the gap between technological capability and realized service performance.

7.3 Practical Implications

The findings translate into actionable recommendations for key stakeholders. For service providers and technology developers, the primary imperative is to shift from a technology-centric to a user-centric innovation model. This entails instituting formal co-design mechanisms, such as permanent elderly user panels for iterative feedback, and prioritizing investment in the "human stack"—dedicated, continuous support roles like community-based "digital navigators" to address the post-deployment guidance void.

For policymakers, strategies should focus on cultivating an enabling ecosystem that aligns with the socio-cultural nature of market demand. This can be achieved by designing subsidy programs and procurement standards that favor technologies adhering to evidence-based, age-friendly design principles, such as a minimum font size of 14 points, high-contrast color schemes, and simplified single-task screens to reduce cognitive load (Czaja et al., 2019). Further, funding should target community-anchored, peer-to-peer digital literacy programs modeled on successful initiatives like “Digital Companions,” which leverage existing social trust networks. Such programs, akin to Singapore’s Seniors Go Digital campaign, utilize trained older-adult volunteers to foster acceptance and skill transfer among peers.

For community organizers and families, the recommended action is to actively facilitate trust-building and adaptation. Communities can serve as launchpads for new services through "social proof" pilots involving respected local champions, while families can be integrated into technology design and use as remote assistants, thereby framing digital tools as bridges for familial connection rather than replacements for care.

7.4 Limitations and Future Research

This study provides an in-depth qualitative exploration of how market demand shapes the digital transformation of elderly care services in the Beijing-Tianjin-Hebei (BTH) region. While it offers contextualized insights, the findings must be interpreted with consideration of the following limitations, which concurrently chart a course for subsequent scholarly inquiry.

The first cluster of limitations pertains to the boundaries of context and time. The deliberate focus on the BTH region, a distinct socio-economic and policy entity, grounds the study in specificity but necessarily constrains its generalizability. The significant regional disparities across China in terms of economic development, digital infrastructure, and cultural norms around aging imply that the identified mechanisms may not translate directly to other contexts, such as the Yangtze River Delta or less developed central-western provinces. Furthermore, the cross-sectional design captures a static snapshot of perceptions and relationships. Consequently, the study cannot delineate the temporal dynamics or causal sequences through which market demand influences digital adaptation over time, a process that is inherently evolutionary.

The second limitation concerns the scope and diversity of the qualitative sample. Although the experiences of 15 key stakeholders yielded rich, nuanced data, this sample size cannot fully encompass the heterogeneity within the vast BTH region itself. Perspectives from critically relevant subgroups—such as the oldest-old, rural elderly, individuals with low digital literacy, or migrant family caregivers—may be underrepresented, potentially leaving certain dimensions of demand or barriers to transformation less explored.

Finally, the study's analytical framework could be further refined in its granularity. Treating "service innovation" and "market demand" as broad, holistic constructs was instrumental for an exploratory analysis. However, this approach may obscure differential effects. A more disentangled examination—distinguishing, for instance, between product, process, and organizational innovation, or between functional, emotional, and social dimensions of demand—would likely yield a more precise understanding of their specific interactions and impacts.

These limitations, however, construct a meaningful agenda for future research. To enhance external validity, comparative studies across strategically selected regions (e.g., Pearl River Delta vs. central-western provinces) are imperative to test and refine the influence of contextual factors. To address the temporal constraint, longitudinal designs are needed to trace the evolution of trust, adaptation, and innovation outcomes. Expanding and strategically diversifying samples to include the voices of the digitally marginalized, frontline care workers, and technology architects would provide a more complete ecosystem perspective. Conceptually, future work should decompose macro-constructs to investigate their sub-dimensions and mechanisms with greater specificity. Moreover, as technologies like generative AI and IoT permeate care, qualitative inquiries into their real-world implementation, ethical dilemmas, and perceived value are urgently needed. Methodologically, employing embedded mixed-methods or participatory action research could powerfully bridge the depth of qualitative insight with broader validation, strengthening both the theoretical and practical contributions of this field.

8. Conclusion

This qualitative exploration confirms that the digital transformation of elderly care is a fundamentally socio-technical process. The powerful direct effect of digital intelligence application is contingent upon passing through the crucial filter of user-centric service innovation and is further moderated by the socio-cultural fabric of market demand. The transformation effect itself is ultimately judged on a relational scale. Therefore, achieving a positive transformation requires a paradigm shift from a technology-push model to a relationship-centric pull model. Future research should continue to prioritize the voices of elderly users themselves, ensuring that the accelerated digitalization of care services remains accountable to those it claims to serve.

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