Technology Empowerment and Virtual-Real Integration: Innovative Pathways of Elderly Care Models from the Perspective of the Metaverse

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Abstract: With the continuous growth of China's elderly population, the demand for elderly care is gradually shifting from basic survival needs to higher-level developmental needs. Based on Maslow's hierarchy of needs and social support theory, the characteristics of this transitional process reveal a structural contradiction in traditional elderly care models, particularly in their ability to meet spiritual and cultural needs and provide support for social participation. To address this contradiction, there is an urgent need to construct a theoretical framework for a metaverse-empowered elderly care model, utilizing virtual-real fusion technology. This model aims to effectively break through the spatio-temporal limitations of traditional elderly care services through a closed-loop system encompassing demand capture via smart terminals, resource integration on a metaverse platform, collaborative provision by multiple entities, and a feedback and guarantee service mechanism. Although metaverse technology shows significant advantages in applications such as remote medical rehabilitation, virtual social interaction, and immersive education for the elderly, its development still faces potential challenges, including an infrastructure access gap, the risk of digital addiction, and the lack of a regulatory system. Accordingly, an optimized path forward is proposed, focusing on improving digital infrastructure, clarifying the boundary between the virtual and real, and strengthening institutional design to further advance the digital transformation of an aging society.

Keywords: Metaverse; Elderly Care Model Innovation; Elderly Care Demand; Virtual-Real Integration

1. Introduction

As China's population ages, elderly care has emerged as a critical societal concern. According to the China Statistical Yearbook 2024, the proportion of the population aged 65 and above has risen to 15.4% (Liu, 2024). The State Council's 2025 Opinions on Deepening the Reform and Development of Elderly Care Services explicitly state that advancing this reform is an urgent requirement for implementing the national strategy to actively address population aging. It constitutes a vital task for safeguarding and improving people's livelihoods, impacting the well-being of hundreds of millions of citizens and the stability of social harmony. Currently, traditional elderly care models have achieved some success in meeting the basic physiological and safety needs of the elderly. However, they fall significantly short in addressing higher-level needs such as social belonging, respect, and self-actualization. This imbalance between supply and demand in elderly care poses challenges in fulfilling the higher-level needs of the elderly within care services.

In recent years, the emergence of metaverse technology has opened new possibilities for optimizing elderly care models. Leveraging the integration of virtual and real worlds and employing multiple cutting-edge technologies, the metaverse breaks through the constraints of time and space to provide immersive services for medical rehabilitation, daily care, social interaction, and educational learning, thereby addressing the shortcomings of traditional models. However, applying the metaverse to elderly care services may encounter multiple risks and challenges. Therefore, how to fully leverage the enabling role of metaverse technology in exploratory practices to build a sustainable "metaverse" elderly care model has become a critical issue requiring urgent resolution.

This paper draws upon Maslow's Hierarchy of Needs and social support theory as its theoretical foundation. It conducts an in-depth

analysis of the current state of elderly care demand in contemporary China and the causes of the imbalance between demand and supply. Building upon this analysis, it explores implementation pathways for optimizing elderly care models through metaverse empowerment and proposes relevant countermeasures and recommendations to address potential risks and challenges encountered during metaverse application.

2. Analysis of Contemporary Elderly Care Needs in China

Maslow's Hierarchy of Needs posits that human requirements evolve dynamically from basic survival to higher-level aspirations (Yang, 2024). This framework equally applies to elderly care. Integrating social support theory reveals that deficiencies in both formal and informal support networks within elderly care systems hinder the fulfillment of seniors' higher-level needs. Currently, China's elderly population has largely met their physiological safety needs, yet structural challenges persist in addressing their higher-level spiritual and cultural requirements.

2.1 Basic Fulfillment of Physiological and Safety Needs

At the basic livelihood security level, the social security system and aging-friendly renovation projects (Lin, 2024) have largely covered the needs of the elderly population. However, structural contradictions persist due to disparities in pension standards between urban and rural areas (Bian, 2017). In the medical care sector, the integration of medical treatment and elderly care (Jiang&Zheng, 2014) and the tiered diagnosis and treatment system have progressively improved the service framework. Nevertheless, service provision still has shortcomings. For instance, community healthcare focuses more on disease treatment than chronic disease prevention (Jiang&Zheng, 2014), and there are insufficient convenient services such as home-visit medical care (Huang, 2013).

2.2 Difficulties in Meeting Spiritual and Cultural Needs

Traditional eldercare models show significant inadequacies in meeting the higher-level needs of the elderly.

First, social needs are difficult to fulfill. The trend toward nuclear family structures (Yao,

2001), intergenerational residential separation (Chen&Zhang, 2023), and the empty-nest phenomenon have led to the shrinking of older adults' social networks. Simultaneously, the homogenization of community recreational activities (Niu&Mi, 2019) fails to meet personalized needs, while emerging online social platforms present technological barriers. Furthermore, life-cycle events such as bereavement and illness trigger social isolation (Chen&Peng, 2024), collectively exacerbating loneliness among the elderly.

Second, psychological care services are inadequate. The current elderly care system lacks specialized psychological support, leaving emotional issues largely addressed through non-professional counseling. Traditional "shame culture" stigmatizes seeking help, suppressing elderly individuals' willingness to access support and depriving them of belonging and respect. Market resources are overly concentrated in material domains, resulting in a persistent imbalance between supply and demand for mental health services (Gao&Jin, 2023).

Third, channels for social participation remain inadequate. Seniors lack institutionalized avenues for voicing opinions in grassroots governance (Long et al., 2024), marginalizing their rights advocacy. The rupture of social roles after retirement, diminished influence in family decision-making (Liu&Tan, 2016), and tokenistic volunteer activities all intensify seniors' sense of social disconnection, obstructing their needs for respect and self-actualization.

Finally, resources for senior education are limited. Current programs predominantly focus on recreational activities, lacking practical skills training. Simultaneously, uneven distribution of educational resources between urban and rural areas, compounded by the digital divide, severely restricts older adults' ability to realize their self-worth.

3. Analysis of Causes Behind the Imbalance in Elderly Care Demand and Supply

3.1 Causes on the Demand Side

The structural shift in elderly care demands is the primary factor causing this imbalance.

First, the elderly have limited capacity for self-care. Research indicates that self-care models face constraints due to health and

self-care abilities (Li, 2025). The digital divide further limits their ability to independently access resources, necessitating reliance on external support.

Second, attitudes toward eldercare are evolving. Influenced by factors like smaller family structures, the traditional reliance on children for support is declining, while expectations for socialized eldercare services are rising (He&Liu, 2020). This shift is driving demand for more diverse and higher-quality services.

Finally, elderly care demands have diversified and grown rapidly. The massive scale of the elderly population (Liu et al., 2024) has led to a surge in care needs. More importantly, these needs have shifted from single-dimensional subsistence security to multidimensional aspects encompassing survival, enjoyment, and development (Long et al., 2024). Existing single-dimensional policy provisions struggle to meet this structural transformation.

3.2 Supply-Side Factors

Supply-side lag and mismatch have exacerbated the imbalance between supply and demand.

First, the family's caregiving function has weakened. The trend toward smaller family units and population mobility has led to increased "empty-nest" and "single-person household" phenomena, severely diminishing the traditional family's informal support role (Huang&Chang, 2020). This has forced the transfer of caregiving responsibilities to society.

Second, the social elderly care system remains inadequate. Existing socialized elderly care services (Liu, 2019) suffer from structural deficiencies. Home-based, community, and institutional care services lack programs addressing higher-level needs such as psychological care and emotional support (Wang, 2015; Fu, 2020). Concurrently, the professionalization of the elderly care workforce is insufficient, hindering the delivery of high-quality services.

Finally, exploration of emerging care models lags behind. Innovative approaches like smart aging and integrated medical-care services remain in their exploratory phases. On one hand, related service offerings are immature with low coverage rates (Li&Dong, 2022). On the other hand, inadequate supporting policies and regulatory frameworks—such as the absence of medical insurance reimbursement mechanisms (Wang&Chen, 2023) and quality oversight

standards (Gao&Lu, 2025)—hinder the sustainable development of these new models.

4. Implementation Pathways for Metaverse-Empowered Elderly Care Models

The imbalance between supply and demand for elderly care services underscores the urgency of model optimization. As a medium enabling deep integration of virtual and physical realms (Wang&Chen, 2023) and immersive social experiences (Zhang et al., 2022), metaverse technology offers new pathways to address the higher-level care needs of the elderly.

4.1 Conceptual Framework for Metaverse-Empowered Elderly Care Models

The current imbalance between demand and supply in elderly care underscores the urgency of model optimization. As a medium for achieving deep integration between virtual and real worlds and immersive social experiences, the metaverse offers new pathways for optimizing care models. Integrating AR, VR, MR, and blockchain technologies (ZENG et al., 2022), the metaverse's high interactivity and immersive characteristics hold potential to compensate for deficiencies in elderly support networks, potentially fulfilling higher-level needs of the elderly.

In addressing physiological safety needs, metaverse technology can empower in two key ways. First, within medical rehabilitation, it enhances formal support from healthcare institutions. For seniors with mobility limitations who struggle to visit hospitals in person, the metaverse enables remote doctor-patient interactions using AR, VR, and digital twin technologies, overcoming geographical barriers. Simultaneously, constructing digital patient models assists healthcare providers in developing remote rehabilitation plans. For instance, international studies have applied VR games to balance rehabilitation training (LANGE et al., 2010) or employed wearable sensors like eWatch to monitor recovery metrics (COOPER et al., 2008). Domestically, smart elderly care cloud platforms utilize intelligent sensing devices for remote health monitoring (Zeng&Zeng Linghui, 2023). Second, in daily living assistance, the metaverse can compensate for reduced informal support. Addressing challenges like memory decline or care shortages among the elderly, digital avatars—a key component of the

metaverse (Su&Peng, 2023)—can enhance daily care quality through non-interactive reminders or interactive algorithmic companionship.

Regarding social belonging needs, the metaverse helps compensate for informal support gaps. As social circles shrink, older adults face heightened loneliness. Virtual social platforms built in the metaverse overcome temporal and spatial constraints, offering immersive interactions that prevent social network atrophy and enhance well-being. For instance, researchers have developed augmented virtual reality applications to create virtual living rooms for remote shared dining (KORSGAARD et al., 2019) or VR social apps for virtual travel and photo sharing (Dou&Li, 2023), effectively alleviating social isolation among the elderly.

Regarding respect and self-actualization needs, the metaverse can enhance both formal and informal support. Traditional senior university models struggle to meet diverse learning demands, whereas the metaverse's immersive and interactive nature delivers more accessible, vivid scenario-based learning experiences, driving upgrades in senior education. Furthermore, by establishing virtual volunteer platforms and interest communities, the metaverse can effectively boost seniors' social engagement, helping them realize self-worth through contributions.

4.2 Core Pathways for Constructing the "Metaverse" Elderly Care Model

This paper proposes an innovative framework for the "metaverse" elderly care model, aiming to establish a closed-loop system encompassing "needs capture – resource integration – service delivery – effectiveness feedback." This pathway seeks to overcome the spatial barriers of traditional elderly care services. By integrating physiological care, psychological support, and social participation into an organic whole through digital twin technology, it offers an actionable digital transformation solution for aging societies.

The closed-loop system begins with smart digital terminals capturing eldercare needs. Its underlying architecture relies on hardware adaptations for aging-friendly use, integrating AR, VR, and 5G technologies to develop low-power, high-sensitivity sensing devices—such as bone-conduction headphones and pressure-sensitive carpets—to build an unobtrusive data collection network that overcomes traditional touchscreen limitations (Yu, 2021). Simultaneously, multimodal interaction designs incorporating gestures and voice are introduced to bridge the usability gap and reduce frustration among elderly users. Within this framework, deploying edge computing nodes is crucial for data security. By processing sensitive information like biometric data locally on terminals, the risk of privacy leaks is significantly reduced.

Second, the metaverse platform integrates digital resources. The core of platform development lies in dismantling "data silos" between services like healthcare and social security. By establishing cross-platform data standard interfaces, it enables systematic reconstruction and flow of resources between virtual and physical worlds (Yu, 2021). The introduction of blockchain technology establishes a decentralized resource rights confirmation system, ensuring traceability of data contributions. Building upon this foundation, an open API ecosystem permits third-party developers to integrate into the service matrix, guaranteeing service diversity and preventing innovation stagnation.

Thirdly, diverse service providers must ensure effective supply. The decentralized nature of the metaverse necessitates building an open, collaborative supply system that emphasizes stakeholder participation (Yu&Geng, 2022). Governments, as regulators, must establish foundational infrastructure benchmarks—such as expanding 5G coverage and certifying virtual caregivers. Businesses should provide market-driven value-added services within regulatory frameworks. Crucially, social organizations must innovate their roles—for instance, leveraging volunteers to bridge generational gaps through digital mentoring via virtual avatars, thereby creating novel social support networks.

Finally, service effectiveness must be ensured through closed-loop feedback mechanisms. Continuous optimization of service effectiveness relies on a dynamic feedback system. On one hand, introducing affective computing modules quantifies the psychological state of the elderly through micro-expression and voice emotion analysis (Ge&Tian, 2023), enabling real-time service adjustments. On the other hand, establishing a tripartite rating system involving "users-family members-service

providers" and integrating it into a credit evaluation system creates a positive feedback loop of "service supply—quality assessment—credit incentives."

5. Risk Reflection and Optimization Pathways for the "Metaverse" Elderly Care Model

5.1 Risk Reflection on the "Metaverse" Elderly Care Model

Despite its immense potential, the metaverse-based elderly care model faces three categories of potential risks.

First, weak infrastructure and an access gap. The stable operation of the metaverse relies on the integration of technologies such as extended reality and digital twins (Fu, 2022) and hardware like VR headsets (Han et al., 2023), which necessitates robust infrastructure support. However, significant disparities in urban and rural infrastructure, coupled with high capital costs, hinder the deployment of metaverse elderly care services in underdeveloped regions. Simultaneously, these costs may cause qualified institutions to adopt a wait-and-see attitude, limiting overall accessibility.

Second, the blurred boundaries between virtual and real worlds may trigger digital addiction. The immersive experiences and blended virtual-reality interaction models created by the metaverse (Duan, 2025) may lead to excessive immersion among the elderly, blurring their ability to distinguish between virtual and real worlds. This overreliance on idealized virtual lifestyles could trigger digital addiction, increasing mental burdens for seniors (Ge&Tian, 2023) and inadvertently fostering new psychological risks.

Finally, inadequate top-level design and regulatory mechanisms are lacking. As a UGC platform, the metaverse digitizes users' bodies and facilitates their movement within the space (Zhang et al., 2022), posing severe challenges to data security and privacy protection and potentially enabling new forms of fraud. The current absence of regulatory frameworks and evaluation systems not only undermines the rights of the elderly but also hinders societal acceptance of this model, obstructing its sustainable development.

5.2 Optimization Pathways for the "Metaverse" Elderly Care Model

In response to the aforementioned risks, this paper proposes three optimization pathways.

First, enhance infrastructure development and promote access through pilot projects. On one hand, infrastructure should be upgraded in a timely manner to meet the technological demands of the metaverse. On the other hand, considering feasibility issues, pilot projects should be launched first in cities with superior infrastructure conditions. Adjustments and refinements should be made based on feedback from these pilots. Once the model matures, it can be scaled up while incorporating regional characteristics to improve technological accessibility.

Second, emphasize delineating virtual-reality boundaries to safeguard digital well-being among seniors. Clearly defining the distinction between virtual and real worlds is crucial for preventing digital addiction. This can be achieved through two approaches: First, integrating time management programs into smart devices that provide usage reminders to guide seniors toward balanced virtual and real-world social interactions, preventing excessive immersion. Second, establishing collaborative mechanisms between platforms, communities, and institutions to regularly share usage data. For seniors exceeding usage thresholds, community or institutional representatives can conduct home visits to assist in developing scientifically sound time management plans.

Finally, strengthen top-level institutional design and establish a robust regulatory framework. Regulatory assessments must proceed in tandem with technological implementation. Governments should spearhead the creation of regulatory bodies to formulate unified service standards and platform norms. Communities should form multi-stakeholder oversight groups including senior representatives to gather feedback and conduct safety education. Senior care facilities must establish internal review processes and data security officer systems. Through collaborative governance among governments, communities, and institutions, the rights and interests of seniors within the metaverse-based eldercare model can be comprehensively safeguarded.

6. Conclusion and Discussion

Against the backdrop of accelerating population aging, traditional eldercare models face severe

challenges in meeting seniors' higher-level needs. Drawing on Maslow's Hierarchy of Needs and social support theory, this paper reveals structural deficiencies in the transition from survival-oriented to developmental eldercare needs: while physiological and safety needs are largely secured, significant gaps exist in fulfilling higher-level demands for social belonging, respect, and self-actualization. This supply-demand disparity stems from combined factors on both sides.

Faced with this predicament, metaverse technology offers new possibilities for innovation in elderly care models. This paper proposes a framework for reshaping elderly care support networks through the metaverse, constructing a four-step core pathway: "needs capture – resource integration – service provision – effectiveness feedback." This pathway aims to collect needs via smart sensing devices, break down data silos using blockchain and APIs, and build a collaborative service network involving multiple stakeholders.

However, metaverse applications in elderly care still face numerous challenges, primarily including uneven infrastructure access, potential digital addiction stemming from blurred virtual-reality boundaries, and data security risks arising from regulatory gaps. To address these potential risks, this paper proposes three optimization strategies: enhancing technological accessibility through pilot programs, maintaining digital well-being via usage reminders and community interventions, and establishing a multi-layered regulatory framework led by government with multi-stakeholder participation.

While this study provides a theoretical framework and practical pathways, the long-term effectiveness of metaverse technology in elderly care remains to be validated through further empirical research, given its nascent stage of development. Future research should delve into variations in technology acceptance among the elderly and examine the profound impact of technological applications on the restructuring of social support networks. The exploration of metaverse-enabled elderly care is not merely about technological innovation but also involves social ethics and cultural adaptation issues. Throughout this process, it is essential to maintain a balance between humanistic care and technological rationality. By synergizing technology, institutions, and culture, we can build a new smart elderly care ecosystem that combines technological sophistication with human warmth.

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