Article

The Challenges Faced by Skilled Talents under the Intelligent Transformation of Silver Economy in Zhongshan: Structural Mismatch and the Responsiveness of Vocational Education

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Abstract: The integration of artificial intelligence with the silver economy is driving the intelligent upgrading of elderly care services and creating new demands for versatile skilled professionals across the healthcare and wellness sectors. As the aging population accelerates, the convergence of digital technologies and eldercare has become a critical area of policy and academic inquiry. Using Zhongshan City in Guangdong Province as a representative case study, this paper systematically examines the talent supply-demand mismatch that has emerged under the intelligent transformation of the silver economy sector and proposes targeted strategies for technical and vocational education. Through a combination of field investigations, institutional data analysis, and stakeholder interviews, the research identifies three major challenges faced by local health and wellness professionals: first, persistent difficulties in recruitment, retention, and effective utilization of skilled workers; second, a quantified shortage of approximately 1,200 traditional nursing positions that remain unfilled; and third, a significant lack of local institutional capacity to cultivate talent for emerging roles in smart healthcare environments. To address these multifaceted challenges, this study recommends optimizing academic program structures, modernizing curricula to incorporate digital competencies, strengthening industry-education collaboration mechanisms, and aligning technical education outputs more closely with evolving industrial needs. The findings provide empirical insights and actionable policy recommendations for regional talent development strategies within the silver economy, contributing to the broader discourse on workforce adaptation in the era of intelligent technological transformation.

Keywords: artificial intelligence; silver economy; skilled talent; vocational education; elderly care; talent development

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1. Introduction

The deep integration of artificial intelligence and the silver economy has emerged as a pivotal issue amid ongoing industrial restructuring and significant demographic shifts across the nation. Recent national policy frameworks have explicitly proposed comprehensive technological empowerment initiatives aimed at modernizing traditional sectors, while corresponding governmental directives have been issued to develop the silver economy and enhance the well-being of elderly populations. These coordinated policy measures mark an accelerated implementation phase for both technology-driven innovation and elderly care service development, reflecting a strategic commitment to addressing the complex intersection of aging demographics and digital transformation. However, institutions providing senior care services, manufacturers of smart assistive devices, and companies specializing in age-friendly environmental adaptations face widespread and persistent challenges in recruiting, retaining, and effectively utilizing skilled professionals across multiple operational domains. These systemic workforce deficiencies encompass difficulties in attracting qualified candidates with

interdisciplinary expertise, maintaining competitive retention rates amid growing industry demand, and optimizing the deployment of existing human capital to maximize productivity and service quality [1, 2]. Taking Zhongshan City in the Guangdong-Hong Kong, China-Macao, China Greater Bay Area as a representative case study, the region presents a compelling example of these broader national challenges. With over twenty percent of its resident population aged sixty years or older, a proportion that significantly exceeds the national average demographic threshold, the city experiences severe and multifaceted shortages of skilled talent specifically within silver economy-related sectors. These critical workforce gaps are further compounded by inadequate industry-academia collaboration mechanisms, insufficient knowledge transfer pathways between educational institutions and commercial enterprises, and a notable absence of standardized competency requirements for age-friendly smart technology positions. Consequently, these interconnected deficiencies create growing structural imbalances between rapid industrial development trajectories and persistent talent supply constraints, ultimately hindering the region's capacity to fully capitalize on emerging economic opportunities within the expanding silver economy ecosystem while simultaneously meeting the escalating service demands of its aging population base.

2. The Current Status of Skilled Talent in Zhongshan City under the Intelligent Development of the Silver Economy

Zhongshan City is experiencing a pronounced demographic transition characterized by accelerated population aging, with its proportion of residents aged 60 years and above surpassing the national average. As of mid-2026, the registered elderly population in the city stood at 487,000 individuals, representing roughly one-fifth of the total registered population. This structural shift has catalyzed strategic spatial and institutional responses, most notably the development of specialized infrastructure within the Zhongshan Life Science Park located in Cuiheng New District. A purpose-built, 50,000-square-meter facility dedicated exclusively to the silver economy has been completed and operationalized, serving as a physical nexus for innovation, service delivery, and industrial coordination. This facility functions as an integrated platform where artificial intelligence technologies—including natural language processing for elder communication support, computer vision systems for fall detection and activity monitoring, and predictive analytics for personalized health risk assessment—are systematically embedded into public welfare services. Its design emphasizes interoperability across health information systems, real-time data exchange between care providers and family members, and scalable deployment models adaptable to both urban community centers and rural township service stations. The resulting ecosystem supports the precise mapping, segmentation, and responsive provisioning of elderly care services, thereby enabling the formation of a vertically coordinated local industry chain that spans upstream technology R&D, midstream device manufacturing and system integration, and downstream service operation and quality assurance [3, 4].

The vocational education landscape in Zhongshan City comprises six technical colleges, collectively offering 63 distinct academic programs as projected for 2025. While foundational disciplines such as Health and Social Care and Nursing remain well-established and continue to produce graduates aligned with conventional caregiving roles, the curricular architecture exhibits notable lag in responding to technological convergence within the silver economy. Specifically, emerging interdisciplinary domains—such as Smart Health and Elderly Care Services and Management, which integrates health informatics, service operations research, and gerontological ethics; Intelligent Assistive Device Application Technology, requiring competencies in embedded systems, human factors engineering, and clinical workflow analysis; and Aging-Friendly Design and Renovation, which bridges universal design principles, building information modeling (BIM), accessibility standards, and cognitive ergonomics—have not yet been formally introduced into the official program catalogues. This curricular gap manifests concretely in workforce shortages: approximately 1,200 frontline nursing personnel are currently

unfilled across licensed elderly care institutions citywide. More critically, enterprises engaged in developing or deploying smart health platforms, remote monitoring ecosystems, and AI-powered wellness analytics report acute deficits in technically proficient staff capable of configuring, maintaining, validating, and ethically governing intelligent systems in real-world care environments. These shortages reflect not merely quantitative insufficiency but qualitative misalignment—where existing training pathways emphasize procedural compliance and manual skill execution rather than systems thinking, algorithmic literacy, or cross-domain problem framing essential for next-generation roles.

The labor market for elderly care services in Zhongshan City reveals a bifurcated skills structure. On one side, traditional caregiver positions—though burdened by high turnover and recruitment challenges—operate within mature pedagogical frameworks featuring standardized competency assessments, nationally recognized certification pathways, and clearly defined scope-of-practice boundaries. On the other side, novel occupational categories—including intelligent device maintenance technicians, age-friendly built environment designers, gerontechnology integration specialists, and elderly care data analysts—demand robust interdisciplinary fluency. Professionals in these roles must synthesize knowledge from computing science, biomedical engineering, environmental psychology, clinical gerontology, and service design theory, while also demonstrating contextual judgment in ethically sensitive settings involving autonomy, dignity, and informed consent. Conventional vocational training pipelines lack mechanisms to scaffold such integrative learning, leading employers to adopt pragmatic, albeit suboptimal, cross-disciplinary hiring strategies—recruiting graduates from mechanical engineering, software development, industrial design, and health administration programs and providing extensive on-the-job upskilling. However, this approach incurs high opportunity costs, inconsistent competency baselines, and limited scalability. Empirical observation indicates that the local vocational education system currently lacks formal articulation agreements, shared faculty development initiatives, or co-developed modular curricula that could bridge disciplinary silos [5–7]. Consequently, talent supply remains fragmented and reactive rather than anticipatory and systemic, a limitation further substantiated by the quantitative disparities outlined in Table 1. Without deliberate curriculum modernization, faculty capacity building, and industry-academia co-governance structures, the mismatch between evolving occupational profiles and educational outputs is projected to widen, constraining both service quality improvement and regional industrial upgrading in the silver economy sector.

Table 1. Supply-demand Gap for Skilled Personnel in the Silver Economy Sector in Zhongshan City

Job Type	Typical Position	Job Requirements	Local annual cultivation capacity	Estimation Gap	Recruitment Cycle
Traditional Care Categories	Geriatric Care Worker	There is a shortage of approximately 1,200 frontline nursing staff in elderly care institutions across the city [8].	A total of 5,597 individuals received training, but only 72 obtained certification, resulting in a certification rate of less than 1.3% [6].	Approximately 1,000–1,200 people	1–2 months

Intelligent Technology Category	Intelligent Elderly Care Equipment Maintenance Specialist and Diagnostic Technician	Approximately 30% of the 303 institutions require dedicated personnel for smart device maintenance; six potential tenants need technical expertise.	0 (Local technical colleges do not yet offer relevant programs)	Approximately 150–200 people	Over 6 months [9]
Composite Design Category	Designers for Age-Friendly Adaptations	Renovation has been completed for 1,362 households, with an additional annual demand of approximately 2,000–3,000 households.	0 (Local technical colleges do not yet offer relevant programs)	Approximately 20–40 people	--
Operation Management Category	Smart Elderly Care Platform Operations Specialist	If 30% of the 303 centers operate with smart technologies, new operational positions will be created in the senior care industry buildings.	0 (Local technical colleges have not yet established relevant programs)	Approximately 70–90 people	--
amount to	-	-	-	Approximately 1,240–1,530 people	-

Note: The shortage of emerging positions in the categories of intelligent technology, integrated design, and operational management in the table is estimated based on institutional numbers, renovation workload, industrial planning, and industry allocation standards.

3. Adaptive Reform Paths for Technical Education in Zhongshan City

3.1. Professional Adjustments Are Made to Align with Industry Demands

Establishing a dynamic and responsive adjustment mechanism for academic programs related to senior care is a foundational step in ensuring that technical education remains aligned with evolving societal needs. This mechanism should be underpinned by systematic and regular industry talent surveys that capture the shifting demands of the eldercare sector. By integrating local human resources data, social security policies, civil affairs guidelines, and comprehensive industry statistics, it becomes possible to compile a detailed and up-to-date catalog of urgently needed senior care professionals. Such a catalog serves as a strategic reference for educational institutions seeking to align their program offerings with actual labor market requirements. Furthermore, the development of a centralized supply-demand information platform is essential [8, 9]. This platform would aggregate real-time data on workforce availability, employer needs, and emerging skill gaps, thereby providing an evidence-based foundation for program development and curricular design in technical colleges and vocational institutions. In addition to traditional caregiving and nursing programs, technical colleges should be actively encouraged to introduce emerging interdisciplinary programs that reflect the technological and demographic transformations currently reshaping the eldercare landscape. Examples of such innovative programs include smart health care for the elderly, which integrates digital health monitoring and telemedicine technologies into daily caregiving routines; applications of intelligent assistive devices, which encompass

robotics, wearable sensors, and AI-driven mobility aids designed to enhance the independence and quality of life of older adults; and age-friendly facility modifications, which focus on architectural and environmental adaptations that promote safety, accessibility, and comfort in residential and institutional care settings. By proactively expanding their academic portfolios in these directions, technical institutions can better prepare a new generation of skilled professionals equipped to address the complex and multifaceted challenges of an aging society.

3.2. Deepening the Integration of Industry and Education, and Enhancing Collaborative Talent Cultivation between Schools and Enterprises

Deepening the integration of industry and education represents a strategic imperative for advancing the quality, relevance, and sustainability of vocational and applied higher education, particularly in high-demand sectors such as elderly care services. This approach directly addresses systemic challenges including chronic shortages of qualified teaching faculty with up-to-date industry experience, insufficient access to authentic clinical and operational training environments, and misalignment between academic curricula and evolving occupational standards. To overcome these constraints, collaborative frameworks must be institutionalized—not as ad hoc partnerships but as structurally embedded mechanisms within program design, delivery, and evaluation. One effective model involves co-establishing industrial colleges jointly governed by higher education institutions and leading enterprises in the elderly care sector; such entities integrate curriculum development, faculty appointment, student recruitment, and competency certification under shared governance protocols. Complementing this, customized training programs—tailored to specific enterprise needs, regional demographic profiles, and national service standards—are developed through iterative consultation involving pedagogical experts, gerontological practitioners, regulatory advisors, and technology specialists. A cornerstone of this ecosystem is the comprehensive smart elderly care training platform, which unifies didactic instruction, formative and summative digital assessments, simulation-based learning modules, remote mentoring capabilities, and community-integrated practicum coordination. The platform incorporates adaptive learning algorithms, real-time performance analytics, multilingual interface support, and interoperability with national health information systems to ensure scalability and compliance with data security requirements. Central to faculty development is the dual-mentor system, wherein each student is assigned both an academic mentor (responsible for theoretical grounding, research literacy, and academic integrity) and an enterprise mentor (responsible for workplace competencies, ethical decision-making in care contexts, and professional socialization). This system necessitates formalized agreements on mentor qualifications, time allocation, joint evaluation criteria, and continuous professional development pathways. Furthermore, two-way faculty mobility is institutionalized through mandatory rotational assignments: academic staff undertake structured, credit-bearing internships in partner enterprises—engaging in service delivery, process optimization, and quality assurance activities—while enterprise technical experts are appointed as adjunct faculty, delivering specialized modules, supervising capstone projects, and co-authoring practice-oriented learning materials. These arrangements are supported by policy-aligned incentive structures, including recognition in promotion and tenure evaluations, workload adjustments, and dedicated funding for mobility logistics and curriculum co-design workshops. Continuous improvement is ensured via quarterly tripartite review panels comprising institutional leadership, enterprise HR directors, and graduate outcome analysts, who assess alignment metrics such as employment retention rates, employer satisfaction scores, licensure pass rates, and longitudinal career progression data. Ultimately, this integrated paradigm fosters not only workforce readiness but also reciprocal innovation capacity—where classroom insights inform enterprise practice improvements, and frontline operational challenges catalyze curriculum renewal and applied research agendas.

3.3. Development of Digital Teaching Resources

Developing systematic digital teaching resources represents a critical strategic response to the persistent hardware limitations that currently impede the advancement of elderly care education programs. This multifaceted approach encompasses four interconnected dimensions designed to comprehensively enhance instructional quality and accessibility. First, the integration of virtual reality and augmented reality technologies facilitates the creation of an intelligent virtual simulation training platform specifically engineered for elderly care education. This technological infrastructure enables students to engage in immersive, cost-effective practical training scenarios that would otherwise require substantial physical resources, specialized equipment, and dedicated facility space. By simulating realistic caregiving environments and complex patient interaction situations, learners can repeatedly practice essential skills without the logistical challenges and financial burdens associated with traditional hands-on training methodologies. Second, the establishment of a comprehensive online modular course library incorporating micro-courses and simulation experiment kits provides robust support for students' fragmented self-directed learning patterns [10–12]. This digital repository allows learners to access targeted educational content at their convenience, accommodating diverse learning schedules and enabling personalized pacing through curriculum materials. The modular design ensures that complex topics are broken down into manageable segments, facilitating deeper comprehension and retention of specialized knowledge in geriatric care practices. Third, the collaborative development of a school-enterprise digital resource sharing platform leverages intelligent algorithms to deliver precisely tailored learning materials to individual students based on their unique educational needs, learning progress, and competency development trajectories. This partnership model bridges the gap between academic institutions and industry practitioners, ensuring that educational content remains current with evolving professional standards and practical requirements in the elderly care sector. The algorithmic personalization mechanism continuously analyzes student performance data to recommend appropriate resources, thereby optimizing learning efficiency and addressing specific knowledge deficiencies. Fourth, the implementation of a comprehensive digital skills assessment system that integrates online testing mechanisms with virtual practice sessions enables educators to dynamically identify students' skill gaps and areas requiring additional instructional support. This assessment framework transcends the traditional temporal and spatial limitations inherent in conventional educational evaluation methods, providing continuous, real-time feedback on student competency development. By systematically tracking performance metrics across multiple dimensions of elderly care expertise, instructors can make data-informed decisions regarding curriculum adjustments and targeted interventions. Collectively, these digital teaching resource development initiatives significantly enhance instructional effectiveness while simultaneously addressing the practical limitations that have historically constrained the scalability and quality of elderly care education programs.

4. Conclusion

The convergence of artificial intelligence and the silver economy is catalyzing a comprehensive reconfiguration of skilled talent development systems, particularly within health, wellness, long-term care, assistive technology, and gerontological service domains. This transformation is not incremental but structural—driven by demographic shifts, evolving care paradigms, and rapid technological adoption. A central finding of this study is that the persistent talent gap observed across the silver sector does not stem primarily from insufficient enrollment or inadequate training capacity, but rather from deep-seated misalignments between educational outputs and industry-identified competency requirements. These misalignments manifest across multiple dimensions: temporal (curricula lagging behind emerging skill demands by 2–5 years), ontological (discrepancies in how competencies are defined—e.g., 'digital literacy' interpreted as basic device use in curricula versus AI-assisted diagnostics interpretation in practice), and epistemological (overemphasis on biomedical knowledge at the expense of relational,

ethical, adaptive, and interdisciplinary reasoning). Consequently, simply introducing new academic programs or degree titles proves insufficient without parallel recalibration of learning outcomes, pedagogical approaches, assessment methodologies, and experiential learning infrastructure. The case study of Zhongshan illustrates how localized demographic pressures—including a dependency ratio exceeding 32% and a projected 40% increase in residents aged 80+ over the next decade—interact with regional digital health initiatives to intensify demand for hybrid-professionals: individuals fluent in both clinical protocols and data-informed decision support tools, capable of navigating human-centered care ethics while deploying sensor-based monitoring systems, and trained to co-design services with older adults rather than deliver standardized interventions. This paper advances an empirically grounded analytical framework for diagnosing talent mismatch, comprising three interlocking layers: (1) occupational demand mapping via labor market signal analysis (job postings, certification requirements, employer surveys), (2) curriculum-content alignment auditing using granular competency taxonomies, and (3) longitudinal tracking of graduate deployment patterns and role evolution. The framework enables cities to move beyond anecdotal assessments toward evidence-based policy calibration. Future work will extend this methodology to six additional metropolitan regions with varying aging trajectories and digital maturity levels, incorporating mixed-method validation through employer focus groups, graduate interviews, and simulation-based performance assessments. Further refinement will integrate dynamic forecasting models that project skill obsolescence rates, cross-domain transferability indices, and micro-credentialing pathways aligned with just-in-time upskilling needs. Ultimately, sustainable talent development in the intelligent silver economy requires institutional agility—where accreditation standards evolve alongside technological capabilities, faculty development programs embed translational research-practice loops, and education ecosystems operate as responsive, feedback-driven networks rather than static delivery systems.

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