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Sustainable Business Innovation: The Case of Smart Elderly Care Service in China

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Abstract

As demographic transition gives rise to ageing societies, technological advancements have sparked the business world to leverage the growing tide of consumer demand for elderly care services. This study looks at the emergent smart elderly care service model in the People's Republic of China to identify the priority strategies in decision making. A SWOT analysis is undertaken to bring out the strengths, weaknesses, opportunities and threats of the smart elderly care system in China through an extensive literature review. The impact and weight of these factors is calculated based on expert opinion. The scores are analyzed using the Analytic Hierarchy Process (AHP). Based on the SWOT-AHP method, ST (strength-threat) strategy group emerged as the highest priority group. The findings of the study suggest that the sustainability of smart senior care can be enhanced through incentivizing age-tech business enterprises, investing in technology-based research and designing an affordable and tech-enabled ecosystem for aging-in-place.

Keywords: *China, aging population, assistive technology, geriatric care, business innovation*

JEL Classification*: O31, 032, 035, O53, M13, L25, L26, L86*

1. Introduction

A silver tsunami is imminent in much of Asia and particularly in the People's Republic of China. In terms of the demographic predictions, the elderly population in China will grow at a faster pace than the total population. As per estimates, in 2015 the old age population (aged 65 years and above) stands at 140 million and this is predicted to reach a record of over 400 million in 2055-2060 (Zhou, 2019). It is becoming incredibly hard for the aged to rely on their members of the family for their healthcare and upkeep as a result of societal transformation and occupational movement (Singh, 2019). Additionally, China's medical and care staff is insufficient to meet the country's soaring requirements for aged care facilities. As a result, supporting the patient care and nursing needs of home-bound senior persons has become a critical concern for the growth of long - term care solutions in a rapidly ageing society (Zhang et.al, 2020).

The rise in elderly population is also going to interact with the rapid technological advancements. This interaction between the two inevitable phenomena will require that sustainable business models are developed to promote healthy aging, independent living and social inclusion of the elderly within smart environments (Singh, 2021). In other words, the gigantic demographic shift needs innovative approaches to create age-friendly policies and age-friendly community spaces where the geriatric population can flourish and lead a meaningful life. Smart elderly care has become indispensable in this pursuit. Sustained investments in smart technology and smart products and services for the elderly can greatly facilitate the creation of an integrated, community-based social and health-care system.

Recognizing the changing socio-demographic realities, the Chinese government has been actively pushing forward the development of the elderly care support system in China. A number of policy documents have been issued in recent years, progressively improving the social safety net for the older adults, comprehensively opening the growth of the elderly care service business, strenuously prospering the old user market, and openly

supporting specific new business ideas that would offer community-based residential at-home care as well as a combination of professional formal medical support and in-house elderly care. Thus, in the business landscape of China, a structural reform is taking place in the supply side to solve the imbalance in the industrial structure and the demographic reality (Yang et al., 2016). However, there is uncertainty about the future directions in business market. Smart products and services thrive on innovation and by definition innovation is something new and emerging. In-depth research on the uptake, expense, and effect is typically not accessible on these nascent goods and services in tech-enabled senior care. Therefore, in navigating through a dynamic business environment and utilizing new technology that can disrupt the traditional system, a robust forecasting and predictive analysis of competitiveness and market scenario can be the guiding light for business initiatives. While the analysis of age-tech business has been done from a variety of perspectives, the development strategies of the smart elderly care business in China have not been analyzed using the SWOT-AHP method to shape a sustainable long-term care model.

This paper is divided into five sections. In the second section, there is an extensive literature review pertaining to technology and elderly care; the growth of virtual care industry; and the application of SWOT-AHP method. The third section outlines the methodology adopted in the study to for the strategy formulation and prioritization of smart elderly care service in China. The fourth section reports the results of the study and discusses the findings of the study. The last section concludes the paper by summarizing the main findings and describing the research implications of the study.

2. Review of Literature

2.1 Technology and Elderly Care

The review of literature relating to technology and elderly care covers many dimensions. A host of studies have found a positive correlation between technology and elderly care especially in the arena of health informatics and ambulatory care. Reinhold et. al. (2020) studied the potential application of technology in home nursing for the disabled and the elderly people in Estonia and found that information technology aids in patient care quality improvement. Health management plans centered on primary care are more efficient and enduring if they are reinforced by systems intelligence, automated advancements, and policies that foster and strengthen network collaborations between the home, the workplace, and health care (Glasgow, 2019; Grady, 2014; Das, 2022). Logue (2002) looked into how technology can help self-medication amongst the elderly and suggests the help of assistive technology including beeping pill boxes and talking wearables to enhance medication adherence in elderly patients. In another study it was found that digital capabilities could improve the well-being of the elderly in terms of enjoyment, control, productivity, self-sufficiency, self-worth and personal growth based on their research study of residents in aged-care facilities using ICT for social purposes (Hasan & Linger, 2016). The Hague Centre for Strategic Studies (2013) called for a successful integration of technical aspects with social transformation to promise preventive, participatory, predictive and personalized care for the elderly. In a general sense, caregiving may be made simpler both physically and emotionally with the help of technology.

2.2 The growth of virtual care industry

There is also literature forecasting the growth of virtual care industry. According to the 2020 report of the Canadian Medical Association on virtual care (The Legislative Library of the Northwest Territories, 2020), the need for home- and facility-based ongoing virtual care is predicted to increase significantly. Latest studies conducted by Canada Health Infoway (CHI) indicate a glaring discrepancy between the automated approach that patients want and what doctors are already providing. The development of new elderly-focused solutions may be sustained in part thanks to the new digital technology and the new age-tech entrepreneurship. Peng and Yongmei (2016) opined that in China, owing to aging society, relevant service sectors, such as home-based care for the elderly, community support for the elderly, and institutions for long-term care, have encountered hitherto entirely unexpected development potential. However, according to the authors, the biggest

impediments to the growth of hospice care for the aged people in China include institutional ones, financial challenges, a shortage of people, and a low level of public acceptability. In order to provide a useful and practical framework for thinking about these technologies, Goldman (2016) defined four categories that correspond to the technology's primary use and location. This framework is based on a report on connected ageing that was published in 2014. Devices that help maintain and monitor an older person's functional status in their homes are categorised as follows: 1) Body, 2) Home environment, 3) Community, and 4) Caregiving.

Studies have also looked at the business innovation that addresses the technological needs of the elderly. Angeli and Jaiswal (2016) analyzed six health care managerial structures and found that co-creating patient needs, community involvement, ongoing customer involvement, cutting-edge healthcare technology, business alliances, economies of scale, and cross-subsidization are a few of the business model innovation strategies that facilitate comprehensive health care delivery. Andruszkiewicz and Fike (2015) have found that companies focusing on aging and caregiving proliferated as part of the Aging 2.0, a network for global innovation and startup acceleration. These age-tech entrepreneurs covered diverse products such as remote monitoring, reminders and adherence, transportation, housekeeping, grocery shopping and technology-enhanced people-driven caregiving platforms. In another study on the rural elderly, Lee (2019) found that as long as there was equal web access, artificial intelligence, the Internet of Things, and ride-sharing applications greatly help rural elderly age in place. In a similar vein, the quality and effectiveness of treatment provided by rural health practitioners are seen to be improved through technology-based delivery systems that personalize care and save costs evidence (Buckwalter et. al., 2002). Yet another set of literature highlighted the evidence that innovation in business exists not only in digital healthcare but also in social and emotional care. Ahlin (2009) found that different technologies enable various co-presences, and various families use various ICTs to provide care in various ways. The need for marketing strategies in the long-term care industry was identified by Cooper and Cronin (2000) as the most important competitive strategy, especially pertaining to internal marketing. Song (2020) looked at the government procurement in elderly care services and found that with asymmetric knowledge and divergent goals, government purchases of elderly care services provided by commercial, market-driven suppliers carry a higher risk of quality. Looking into the Internet of Things tech industry, Tun et. al (2020) found that the meaningful use of technology for elderly care can be enhanced with more efforts to increase the cost-effectiveness and usability of IoT technology.

2.3 *Studies utilizing SWOT-AHP method*

In order to determine the SWOT elements and analyse the application of the hybrid SWOT-AHP approach, a number of research papers have been reported in the literature. The goal of a SWOT analysis, according to Kangas et al. (2001), is to create and implement a strategy that produces a good match between internal and external components. SWOT categories and elements were employed by Kangas et al. (2001) to create the investment plan for Finnish forest industry in North America. Sharma (2005) utilized SWOT analysis to examine the medical education field in India. A decision model based on AHP is presented by Oddershede et al. (2007) to prioritise the activities that facilitate the development of rural areas in China. Jordan and Daim (2008) describe the construction of a hierarchical decision model based on AHP for determining the optimum variety of wheat to plant in order to maximise profit. Sambasivan and Fei (2008) used AHP to determine the relative importance and order of the crucial success elements for Malaysia's deployment of an ISO 14001-based environmental management system. According to the study's findings, management research, organisational transformation, technological features, external effects, and social impacts rank in order of significance as the most important crucial success components. AHP is used by Pticina and Yatskiv (2015) to

create the service quality index for the city's public transportation system. Yuan et al. (2012) identified sixteen SWOT elements for public housing through public-private partnership in China based on a thorough literature review. This was combined with AHP to enable the Chinese government decide on a public-private partnership development plan for public housing. Seker and Ozgurler (2012) used SWOT analysis for prioritizing the strategies for a Turkish consumer electronics business. Hybrid SWOT-AHP based technique was used to compare strategies for an East Asian container port, strategies for the agrifood supply chain, and strategies for an environmental assessment of an international distribution centre (Lee & Lin, 2008; Meena, Meena, Pratap, Patidar, & Daultani, 2019; Chang & Huang, 2006).

3. Methodology

The following are the study's main objectives:

1. To formulate the strengths, weaknesses, opportunities and threats of technology-enabled smart senior care in China
2. To devise the strategies for smart senior care businesses based on the strengths, weaknesses, opportunities and threats of the age-tech industry.
3. To find the optimum priority strategy for the sustainable development of smart senior care in China.

1. The SWOT-AHP Method

The paper uses a descriptive analysis method. The study embraces the qualitative assessment of smart elderly care service industry in China using the hybrid methodology of SWOT-AHP. The method is particularly useful in multi-criteria decision making and helps in identifying the optimum priority strategies for the development of senior care services in China. The path diagram in figure 1 is added to describe the methodological framework and direction of the study. The Strengths, Weaknesses, Opportunities, and Threats (SWOT) examination looks at a business's or industry's intrinsic strengths and weaknesses as well as extrinsic opportunities and threats from the competitive context. Through a TOWS matrix, effective fit strategies are generated and implemented based on internal and external aspects. Strength is used to maximise opportunities in a strength-opportunity (SO) strategy; weakness is minimised in a weakness-opportunity (WO) strategy by taking advantage of opportunities; threat is reduced in a strength

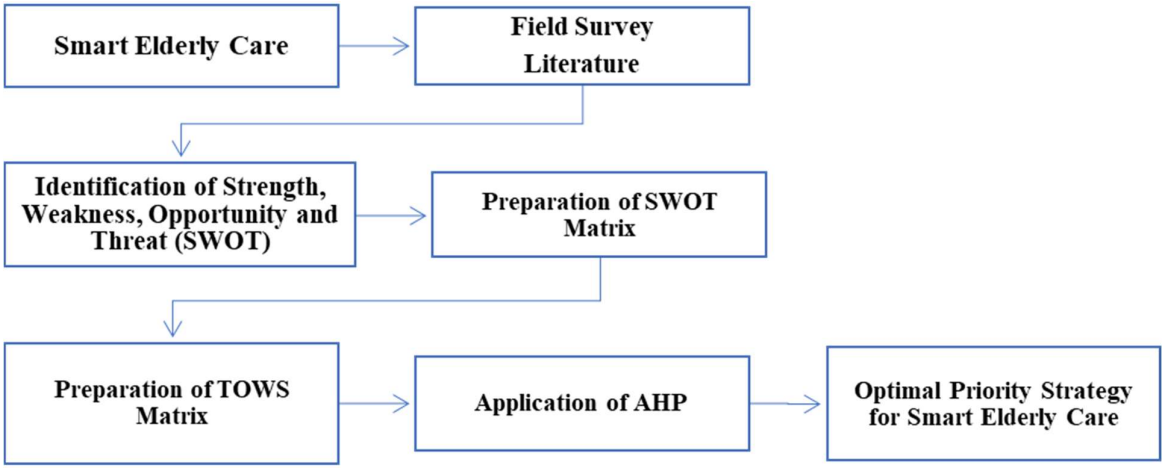

Figure1: Methodological framework of the study

threat (ST) strategy using strength; and both threats and weakness are avoided in a weakness-

threat (WT) strategy. In order to create strategies and create a TOWS matrix, the SWOT approach therefore employs methodical thought and factor diagnostics. To systematically classify SWOT components and compare their intensities, the Analytic Hierarchy Process (AHP) is used inside the SWOT framework. Using the eigenvalue calculation, the AHP technique enables pairwise comparisons between components or criteria in order to prioritize them. The combined technique is being used to enhance the quantitative component of strategic planning and arrive at the optimal strategies.

AHP is used for the prioritization of the strategy group as well as the sub-strategies in the TOWS matrix. In each level, the criteria are subjected to a pairwise comparison based on the relative influence and importance of the specified criteria in the superior level. The AHP model utilizes the nine point standardized comparison scale designed by Saaty. An (n x n) assessment matrix A is used to summarize the results of a pairwise assessment on n criteria. Here, each element of the matrix is a quotient of the weights of the criteria.

$$A = (a_{ij})_{nxn} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ a_{n1} & a_{n2} & . & a_{nn} \end{bmatrix}$$

Each matrix is normalized and the relative weights are determined in the next phase. The right eigenvector (w) corresponding to the largest eigenvalue (λ_{max}) provides the relative weights.

$A_w = \lambda_{max}. w$

The quality of the AHP comparison is determined by Consistency Ratio.The consistency ratios of the strategies are estimated using the AHP method and the overall priority. Consistency ratio is CI/RI, where CI is the consistency index and RI is the ratio index value. Consistency Index (CI) can be calculated, using the following formula:

$CI = (\lambda_{max} – n) / n-1$

RI value is based on Saaty's (1980) order n randomly generated reciprocal matrix (Table 2). The CR number has to be between 0.1 and 10%. Values beyond this threshold are inconsistent with AHP. If the outcome is inconclusive, the comparison should be repeated to clear up the ambiguity.

Table 1. Saaty's Scale for Pairwise Comparison

Importance	Explanation	Reciprocal Importance

1	Equal Importance	1/1 (1.000)
3	Slight Importance of one over another	1/3 (0.333)
5	Moderate Importance of one over another	1/5 (0.200)
7	Very Strong Importance	1/7 (0.143)
9	Extreme Importance of one over another	1/9 (0.111)
2, 4, 6, 8	Intermediate values between two adjacent values	1/2 (0.500),1/4 (0.250), 1/6 (0.167), 1/8 (0.125)

Table 2. Random Index Scale of Saaty

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The AHP survey questionnaire was created using the nine-point Saaty scale for the factors discovered through literature analysis and consultation with specialists. Random sample survey and personal interviews methodology was used to gather expert opinion. The experts belonged to a range of new tech industries working in providing digital health and other services to the elderly in China. The industries covered in the study range from telemedicine, artificial intelligence, and sensor manufacturing, mobile application software and network security. The respondents were chosen based on at least 5 years of experience in the field and a relatively high market share. Using their own choices, the respondents were asked to compare and contrast two criteria. The AHP scale was provided to the respondents to rate the components. For a sample of 20 respondents (field experts), the weighted average of the expert opinion's validation was calculated. The last step involved calculating the total priority scores for the sub-strategies by multiplying the strategy group weight with sub-strategy weights

4. Results and Discussion

The study undertook the analysis of the strategic factors that affect the smart senior care business in China by utilizing the SWOT-AHP hybrid model. The extensive field literature review and the assessment of field experts form the basis for arriving at the following SWOT factors.

4.1 SWOT Analysis of Smart Elderly Care in China

Strengths

Integrates physical care with emotional and psychological well-being

The elderly has a strong feeling of social integration and consciousness of a unique self that is embedded in a community with shared values. This subjective feeling or emotion can be preserved with the help of smart

elderly care (Zheng, 2018). The modernization of Chinese economy and society has also changed the aspirations and psycho-social needs of the elderly. These new senior subjectivities are both the product and source of newly imagined elder care spaces. Retirement universities and elder care estates offer opportunities to improve one's body and mind and develop one's own interests within a peer-based social atmosphere. This mirrors the trends observed among younger cohorts that show a rise in individualization and an increase in horizontal relationships (Yan, 2009).

Eliminates the uncertainty and insecurity in family-based care

The dependence on family members and the exigencies created by family members' work obligations are unable to ensure a steady care for the various needs of the elderly. Keimig (2021) suggested that 'contemporary *Chinese elders are a potential danger to themselves—but even worse, they are a potential danger to their children's livelihoods and lifestyles, as the energy required to care for them weakens one's ability to be oneself*'. This also leads to irritation on the part of the family members and a huge feeling of being a burden on the spouse, children or grandchildren. Both elders and adult children reported that generational gaps and lifestyle differences often made intergenerational living inconvenient, annoying, and stressful. Smart service model for the elderly caters to the day-to-day needs and requirements of the older people and provides a reliability and customer-satisfaction feedback mechanism which eliminates the uncertainty and insecurity inherent in family-based care.

Ideal Medical Care

The elderly care model that utilizes smart technologies has been able to provide ideal medical care to the geriatric population. The degeneration of physical body and reduced immunity as a result of aging as well as the loss of dexterity is not a visible and abrupt phenomenon. Traditional medical care is able to help only with the visible onset of the ailment or disease. However, smart elderly care with its constant health monitoring can provide timely and accurate care right from the gestation phase to the initial stages of clinical detection, therapy, and medical re-examination services. The medical costs and resources to treat acute and serious medical conditions can be reduced to a good extent by the smart medical care facilities most of which monitor the health of the elderly at their own homes and send messages and signals to their kith and kin residing elsewhere.

Weaknesses

Lack of a robust technological foundation

The policy impetus for the growth and expansion of the smart senior care businesses in China has not been an innate outcome of the progressive developments in technology and their social application. As such, the groundwork for such tech-driven business and commercial enterprises is not robust and sophisticated enough to stand steady sturdy in a rapidly changing technological space. There can be a provision for elderly care based on technology-enabled products, services and networks but these can only offer certain basic and modest care support ranging from online health check-ups, rescue operations, better communication and early diagnosis, and a sensor-driven monitoring. With regard to complex health conditions and a multi-dimensional care system for a holistic health management, wide-ranging assistance, and a well-connected home security and well-being framework, there is still a gap that needs to be filled (Xu, 2019).

Lack of standardization and benchmarking criteria

In China, there is no industry-wide technological touchstone for intelligent aged care. The diverse firms, companies and business establishments are vying for a share of the grey market without proper regulation. The streamlining of the products and services and compliance with industry regulations is yet to take shape. In a highly fragmented market, the tech-solutions provided by one enterprise concur and respond to only their own designed service console or operating system (Zhang et. al. 2020). As a consequence of this unique and particularized form of service platform, the intelligent gadgets and assistive amenities and facilities from different consoles do not match or are well-suited to work together. The lack of quality standards at national and regional level inhibits the proliferation of a growth-driven and viable smart elderly care market (Zhang and Li, 2018).

Lack of Coordination among Multiple Stakeholders

A number of departments and agencies in the government have a shared or joint responsibility for smart elderly care which adds to the convolution of responsibility, implementation and accountability for actions. Also, each department has its own sphere of influence and control as well as regulatory mechanism. For

example, the Ministry of Civil Affairs is in charge of overseeing the performance of the government's intelligent routine care and services; the Ministry of Industry and Information Technology (MIIT) is in charge of overseeing the function of the smart residential care console and the intelligent security apparatus; and the State Administration for Market Regulation is in charge of overseeing the effectiveness of smart residential care in the industry (Zhang et. al., 2020). This leads to concerns regarding proper coordination across departments and ministries to further the development of the senior care service model in China.

Opportunities

Anticipated Increase in demand for Smart elderly care services

The projected demographic trends coincide with the stage of development in China that is marked by changed family structure, atrophying of filial care, the immigration of young Chinese and the rise in chronic and non-communicable diseases. All these factors present a good opportunity for entrepreneurship to step in and fill the gaps. The model of elderly care in China has transitioned from a purely “family care” paradigm, to a new paradigm entailing “community care” and “institution care” (Zhu et al., 2014). Most elderly Chinese would want a home-based care under the supervision of both family and medical professionals and continuing their long-held social life in the same social environment. The young and working Chinese are willing and excited to use these services for their elderly parents, grand-parents or relatives.

Potential for public-private partnership in providing aging-in-place model of care

Aging-in-place is thought to be the preferable domestic alternative over the current scattered protracted treatment modalities (Marek et al. 2012; Popejoy et al. 2015). Age-friendly makeovers could be nurtured and enabled throughout a wide variety of dwellings, and viable techniques can facilitate a comfortable living experience for the elderly (Cohen and Passel 2016; (Bigonnesse and Chaudhury 2019). These involve systematic house evaluations, increasing people's awareness of the atmosphere's impact, and the establishment of programmes that provide inexpensive house retrofitting. To make aging-in-place schemes monetarily feasible, innovative financing arrangements are required. PPPs can help by letting market sector firms to team up with government entities. If private enterprise improves its awareness of changing market trends and propensities of the ageing generation, it may be in a good position to improve on current models. The rising diversity of medical, residential, and societal needs of older persons will impact future possibilities to age in place. (Hodgson, 2020).

Opening up of long-term elderly care insurance plans and pooled investment funds

As the demographic aging is going to escalate and will be affecting not only the current older population but also the middle-aged working population in the near future, it opens up opportunities for the insurance market. For the smart home-based elderly care management industry to thrive it would require to make the provisions, products and services affordable through various insurance schemes, insurance policy instruments and active income plans for the heterogeneous demands of the diverse elderly cohorts. For many peoplesuch schemes and plans can collectively address the issues of affordability and inequality in smart elderly care provision.

Threats

Insufficient demand caused by poor social perception

The digital revolution has not been socially inclusive. The perception of the elderly or the apprehensions towards technology has created an insufficient demand despite the huge policy support and excitement created around the benefits of smart care for the elderly. Many enterprises report very few takers for the smart home-based services offered by them which raise concerns for the market survivability of these firms and enterprises. The widespread apprehension relating to the low absorption and popularity of these smart services is discouraging the entrepreneurial spirit in smart aged care sector in China. A Qingdao research study revealed that a large number of providers of elderly care services, including Qingdao Huakai, Qingdao Lanchuang Technology, and Zhongkang Love Neighborhood are struggling to keep up their smart home care services due to a lack of enthusiasm. (Zhang et. al, 2018).

Incongruence between the demand for low-cost service and enterprise interest

Aging of the Chinese population is affecting the elderly belonging to all classes and income-groups. Since China is still a developing nation, there is a huge demand and expectation on the part of the lower middle class elderly population for free or low-cost services. Health insurance does not cover the cost of home-based or community-based elder care. Therefore, all fees must be paid out of pocket. This is a dilemma for the Chinese government as fiscal constraints limit the long-term welfare services that the state can deliver. Also, the various

enterprises venturing into elderly care services and products have an interest in making profits through paid services. Therefore, the micro level supply of smart aged care service suffers from the uncertainty of catering to the low-cost and affordable market demand.

Smart elderly care industry may not reach economies of scale

Health technology has made major advancements. Technology enhanced self-care devices for the elderly have also made foray into the consumer market. However, it is largely catering to the wealthy elderly class as they are costly and expensive. The emerging technology-enabled products and services have yet to achieve economies of scale in their production which is a looming threat with regard to the future sustainability of the smart senior care industry. Also, the labour costs in China have been rising. With the shrinking of working age population, labour shortfall can raise the cost of the production and large-scale manufacturing. Foreign investments in this sector seem uncertain too.

Table 3: The SWOT Matrix

Internal Factors	**Strengths (S)** **(S1)** Integrates physical care with emotional and psychological well-being **(S2)** Eliminates the uncertainty and insecurity in family-based care **(S3)** Ideal Medical Care	**Weaknesses (W)** **(W1)** Lack of a robust technological foundation **(W2)** Lack of standardization and benchmarking criteria **(W3)** Lack of Coordination among Multiple Stakeholders
External Factors	**Opportunities (O)** **(O1)** Anticipated Increase in demand for Smart elderly care services **(O2)** Potential for public-private partnership in providing aging-in-place model of care **(O3)** *Opening up of long-term elderly care insurance plans and pooled investment funds*	**Threats (T)** **(T1)** Insufficient demand caused by poor social perception **(T2)** Incongruence between the demand for low-cost service and enterprise interest **(T3)** *Smart elderly care industry may not reach economies of scale*

Table 4: Strategy Formulation using TOWS Matrix

	Strength	**Weakness**
Opportunity	**SO (Maxi-Maxi) Strategies:** *Strategies use strengths to maximize the opportunities* SO1- Designing tech-enabled integration of medical and socio-psychological well-being SO2- Developing Affordable Home-Based Elderly Care SO3- Providing pooled medical	**WO (Mini-Maxi) Strategies:** *Strategies minimize weaknesses to take the advantage of opportunities* WO1 – Public-private collaborative Management System for Smart Elderly Care WO2 – Improving Social Perception through public campaigns WO3- Setting up a quality-check mechanism for the inter-operability of

	insurance plans for long-term elderly care	the age-tech ecosystem.
Threat	**ST (Maxi-Mini) Strategies:** *Strategies use internal strengths to minimize the threats* ST1 – Promoting Cost-effective services in early diagnostic care ST2 – Incentivizing private enterprises to enter elderly care market ST3- Branding of Elderly Well-being with Chinese Characteristics	**WT (Mini-Mini) Strategies:** *Strategies reduce the internal weaknesses to avoid the external threats* WT1 – Forming a centralized task force for seamless delivery of age-tech services WT2 – Investing in R&D and Tech Transfers WT3- Promoting frugal innovations in technology-based elderly care

Table 5: Overall priority scores of SWOT Sub-Strategies

Strategy Group	Weight (AHP)	Sub-Strategies	Weight (AHP)	Overall Priority of Sub-strategy
		ST1	0.135	0.079
ST	0.582	ST2	0.784	0.456
		ST3	0.081	0.047
		WO1	0.717	0.171
WO	0.238	WO2	0.078	0.019
		WO3	0.205	0.049
		SO1	0.178	0.024
SO	0.135	SO2	0.751	0.101
		SO3	0.070	0.009

		WT1	0.072	0.003
WT	0.045	WT2	0.626	0.028
		WT3	0.301	0.014

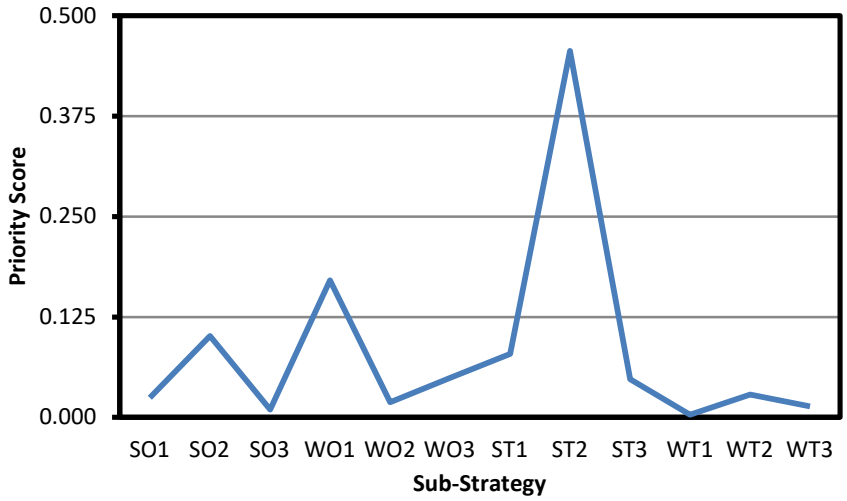

Figure 2: Optimum Priority Strategies for Smart Elderly Care in China

The findings of the hybrid SWOT-AHP method reveal hierarchically ordered priorities for the development of the age-tech service sector in China. Based on the AHP method, ST (strength-threat) strategy group emerged as the highest priority group with the AHP weight of 0.582. This is reflective of the overwhelming emphasis on utilizing the strengths to minimize the imminent or anticipated threats. The arena of smart care for the elderly in China is in a nascent stage of development. Thus, it is generating certain given as well as unforeseen threats with regard to the future of the business ventures and enterprises in both public and private sector. The second priority group is the WO (weakness-opportunities) strategy group with the AHP weight of 0.238. This mini-maxi strategy necessitates the curtailment of weaknesses inherent in the system to augment the power and capacity of the opportunities. This strategy has the benefit of overcoming the constraints and roadblocks that can derail the future potential of the smart geriatric care industry in China. The third priority strategy group is the SO (strength-opportunities) group having the AHP weight of 0.135. According to the results of the study, the strengths of the sector can be further enhanced and taken advantage of to capitalize on the opportunities for growth in the scope of senior care products and services. The study finds the WT (weakness-threat) group having the AHP weight of 0.045 as the least priority group. This mini-mini strategy calls for minimizing existing or apparent weaknesses in the system to deter the likely threats for the widespread use of smart senior care services along with the viability of the business enterprises. The points of weakness are closely related and at times also responsible for giving rise to the threats in the elderly care business development in China. Thus, this strategy can address the major concerns related to the upcoming age-tech industry. Overall, in the case of China, the demographic reality is highly conducive for the growth of smart care industry. Therefore, the strategy group that promotes and applies strengths and opportunities is favored more than the strategy group that concentrates on the handling of threats.

In terms of the sub-strategies, the study reveals primary and secondary strategies that can be pursued by both business and non-business stakeholders for a robust future growth in the services sector of the silver economy in China. Since the senior care products and services require advanced technology to enter the smart care

market, the cost factor reigns supreme in making and breaking sustainability of the innovative business ventures. Therefore, fostering cost-effective production is an optimum priority strategy to make the most of the demographic window of opportunity in elderly care. Using the new technological interface, advanced ideal medical facilities can be developed in early diagnosis and home-based care. The rural-urban socio-economic development disparity coupled with a differential purchasing power of different income-strata groups in China also calls for this strategy to be the main focus of elderly care businesses. The important policy thrust areas that emerge as primary sub-strategies in the study are investments in research, funding technology transfers, and providing financial incentives to private enterprises. The Chinese state has to develop and push for affordable home-based care through further policy support. The decentralized government structure can facilitate the multi-level policy implementation and ensure fruitful collaboration with the private providers. In the secondary strategies, the study finds social and brand-building as the main focus areas. As per the priority analysis using AHP, the smart elderly care industry needs to prioritize the integration of physical care with psychological and emotional care through technology. There is a need to align the development of elderly care industry with the interest and requirements of the silver demographic by way of designing and building up a unique brand image for elderly care services with Chinese characteristics. The groundwork strategy can be to shape the social discernment and support for smart elderly care via campaigns and marketing. The unique integration of medical and socio-psychological care for the elderly can be marketed for generating public support and acceptance of the new technologies.

The results of this study have socio-economic and policy implications in the medium to long term. Firstly, the private providers of smart elderly care need a better system of collaborating with the government in erecting a centralized cloud information management system that is robust and receptive to technological changes. Secondly, the stakeholder identification for smart senior care from business and non-business community including the geriatric people themselves can help in integration of resources and distribution of costs which can offset barriers to sustenance of new firms and other entrepreneurial ventures. Thirdly, the relevant data related to the market performance and evaluation needs to be gathered and inferred in an ongoing manner to feed into the research and development of the age-tech sector. Lastly, the complex and contradictory push and pull of technology in the Chinese socio-cultural setting needs to be studied in detail. This would necessitate a careful crafting of regulations and policies for the control and use of credible technological platforms for data exchange and decision-making, as well as for the sustainable financing of the competent businesses.

5. Conclusion

The future of the world lies in socially relevant use of technology. The present study looked at the use of newly emerging technology in enabling the support system for the elderly in China. New business ventures have proliferated in the burgeoning age-tech industry. Through an in-depth analysis of the strengths, weaknesses, opportunities and threats, the SWOT-AHP method has been instrumental in highlighting the major optimum strategies that can be pursued for the sustainable development of the smart senior care industry in China. The findings of the study suggest that the strengths of the sector provide enough leeway to minimize the imminent threats and take advantage of the existing opportunities. The economic cost and funding of the sector emerged as the most important defining factor for devising the effective strategies. The strategy that received highest priority score as per the study is centered on the creation of incentive structure for the firms and enterprises to enter the elderly care market. The most important incentive will be financial incentive that the government can fund for a limited period. Policies can be shaped in response to the specific demands of the tech-based businesses to transition towards age-tech products and services.

In the final analysis, the smart elderly care model in China is in its developing stage. It is a child of both demographic reality and technological sophistication. From a commercial standpoint, while China's newly developed senior care model appears promising in catering to the diverse needs and preferences of the elderly, it still has enormous room to improve. Coupled with a continued policy and resource-based support from the state and public sector at all levels of the government, the elderly care market can achieve its aim of providing long-term and individualized care for the older Chinese while engaging in productive and profitable enterprise. The innovative tech savvy elderly care service system and its thriving in the most populated nation can serve as a guide to other developing nations that are going to reach the aged society stage in the near future.

The study calls for further research to envisage the efforts and progress in smart elderly care from a multi-

stakeholder perspective. The future of smart elderly care lies in its adaptability and anticipatory approach in the business innovation framework. Therefore, state capacity in anticipatory governance within the context of tech-enabled elderly care remains a formidable challenge. The constraint faced by the smart elderly care ecosystem in its interoperability is another important dimension that can be studied through further research. The effect of technology and smart elderly care on the psycho-social well-being of the elderly also must be examined further. There is a need to undertake research on the intersectionality of elderly group's needs and the overlapping systems of disadvantage based on gender, region, class and medical status.

6. References:

1. Ahlin, T. (2019, June 10). *Digital Elder Care*. Anthropology News. https://www.anthropology-news.org/articles/digital-elder-care/
2. Angeli, F., & Jaiswal, A. K. (2016). Business Model Innovation for Inclusive Health Care Delivery at the Bottom of the Pyramid. *Organization & Environment*, *29*(4), 486–507. https://doi.org/10.1177/1086026616647174
3. Andruszkiewicz, G., & Fike, K. (2015). Emerging Technology Trends and Products: How Tech Innovations Are Easing the Burden of Family Caregiving. *Generations: Journal of the American Society on Aging*, *39*(4), 64–68. https://www.jstor.org/stable/26556164
4. Bigonnesse, C. & Chaudhury, H. (2019). The Landscape of Aging in Place in Gerontology Literature: Emergence, Theoretical Perspectives, and Influencing Factors. *Journal of Aging and Environment*, *34*(3), 233-251, DOI: 10.1080/02763893.2019.1638875
5. Bison, I., & Esping-Andersen, G. (2000). Unemployment, Welfare Regimes and Income Packaging. In D. Gallie, & S. Paugam (Eds.), *Welfare Regimes and the Experience of Unemployment in Europe* (pp. 69-86). Oxford University Press.
6. Coen Buckwalter, K., Lindsey Davis, L., Wakefield, B. J., Kienzle, M. G., & Ann Murray, M. (2002). Telehealth for elders and their caregivers in rural communities. *Family & community health*, *25*(3), 31–40. https://doi.org/10.1097/00003727-200210000-00007
7. Chang, H. H., & Huang, W. C. (2006). Application of a quantification SWOT analytical method. *Mathematical and Computer Modelling*, *43*(1–2), 158–169. https://doi.org/10.1016/j.mcm.2005.08.016
8. Chou, R.J. (2009). Willingness to live in eldercare institutions among older adults in urban and rural China: a nationwide study. *Ageing and Society*, *30*, 583-608. DOI: 10.1017/S0144686X09990596
9. Cohen, D. & Passel, J. (2018, April 5). *A Record 60.6 Million Americans Live in Multigenerational Households.* Pew Research Center. https://www.pewresearch.org/fact-tank/2018/04/05/a-record-64-million-americans-live-in-multigenerational-households/
10. Cooper, J. & Cronin, J. J. (2000). Internal Marketing: A Competitive Strategy for the Long-Term Care Industry. *Journal of Business Research*, *48*(3), 177-181. https://ideas.repec.org/a/eee/jbrese/v48y2000i3p177-181.html
11. Das, P. (2022). Dimensions of women empowerment: A structural equation modeling approach. *Journal of Statistics and Management Systems*, *25*(5), 1059-1072, DOI: 10.1080/09720510.2022.2040858
12. Goldman, L. & Wolf, R. (2016, June 8). *How Can States Support an Aging Population? Actions Policymakers Can Take*. Milibank Memorial Fund. https://www.milbank.org/publications/how-can-states-support-an-aging-population-actions-policymakers-can-take/
13. Glasgow, R. E., Huebschmann, A. G., Krist, A. H., & Degruy, F. V. (2019). An Adaptive, Contextual, Technology-Aided Support (ACTS) System for Chronic Illness Self-Management. *The Milbank quarterly*, *97*(3), 669–691. https://doi.org/10.1111/1468-0009.12412
14. Grady J. (2014). CE: Telehealth: a case study in disruptive innovation. *The American journal of nursing*, *114*(4), 38–47. https://doi.org/10.1097/01.NAJ.0000445682.52553.89
15. Hasan, H. & Linger, H. (2016). Enhancing the wellbeing of the elderly: Social use of digital technologies in aged care. *Educational Gerontology*, *42* (11), 749-757, DOI: 10.1080/03601277.2016.1205425
16. Hague Centre for Strategic Studies. (2013). *Innovating for Prevention and Health*. https://hcss.nl/report/innovating-for-prevention-and-health/
17. Heng, X. I., Ren, X., & Zhai, S. G. (2014). Smartpension: the elderly care service innovation with information technology. *Sci. Res. Aging,* 20, 12–20.

18. Hodgson, N. A. (2020). Aging in Place: The Role of Public-Private Partnerships. Wharton Pension Research Council Working Paper No. 2020-21. In Mitchell, O. (Ed.) *New Models for Managing Longevity Risk: Public-Private Partnerships*. Oxford University Press. http://dx.doi.org/10.2139/ssrn.3671571
19. Jordan, S. & Daim, T. (2008). Hierarchical modelling applied to agriculture: wheat planting
20. decisions in the Pacific Northwest. *International Journal of Society Systems Science*, *1*(2), 194–208. DOI:10.1504/IJSSS.2008.021919
21. Kangas, J., Pesonen, M., Kurttila, M. & Kajanus. M. (2001). *'A'WOT: integrating the AHP with SWOT analysis*. Proceedings-Sixth ISAHP, Switzerland. DOI:10.13033/isahp.y2001.012
22. Keimig, R. K. (2021). *Growing old in a new China: transitions in elder care*. Rutgers University Press.
23. Kurttila M., Pesonen, M., Kangas, J., & Kajanus, M. (2000). Utilizing the analytic hierarchy process in SWOT analysis - a hybrid method and its application to a forest-certification case. *Forest Policy and Economics, 1*(1), 41-52. https://doi.org/10.1016/S1389-9341(99)00004-0
24. Lee, N. T. (2019). Can Emerging Technologies Buffer the Cost of In-Home Care in Rural America? *Generations: Journal of the American Society on Aging*, *43*(2), 88-93, https://www.jstor.org/stable/10.2307/26760121
25. Lee, K. L., & Lin, S. C. (2008). A fuzzy quantified SWOT procedure for environmental evaluation of an international distribution center. *Information Sciences*, *178*(2), 531–549. https://doi.org/10.1016/j.ins.2007.09.002
26. Logue, R. M. (2002). Self-Medication and the Elderly: How Technology Can Help. *The American Journal of Nursing*, 102(7), 51–55. https://doi.org/10.1097/00000446-200207000-00037
27. Marek, D. M., Stetzer, F. Adams, S.J. Popejoy, L.L. & Rantz, M. (2012). Aging in Place versus Nursing Home Care. *Research in Gerontological Nursing*, *5*(2), 123–129. DOI: 10.3928/19404921-20110802-01
28. Meena, S. R., Meena, S. D., Pratap, S., Patidar, R., & Daultani, Y. (2019). Strategic analysis of the Indian Agri-food supply chain. *OPSEARCH*, 56, 965–982. https://doi.org/10.1007/s12597-019-00380-5 Oddershede, A., Arias, A. & Cancino, H. (2007). Rural development decision support using the analytic hierarchy process. *Mathematical and Computer Modelling*, *46*(7/8), 1107–1114. https://doi.org/10.1016/j.mcm.2007.03.006
29. Peng, D. & Yongmei, W. (2016). Development of Hospice Care Service for the Elderly in China. *Development and Society*, *45*(2), 275-295. DOI:10.21588/dns/2016.45.2.005
30. Popejoy, L.L., Galambos, C., Stetzer, F., Popescu, M., Hicks, L.L., Khalilia, M., Rantz, M.J., & Marek, K. (2015). Comparing Aging in Place to Home Health Care: Impact of Nurse Care Coordination On Utilization and Costs. *Nursing economics, 33*(6), 306-13.
31. Pticina, I. & Yatskiv, I. (2015). Weighting the urban public transport system quality index (UPTQI) using the analytical hierarchy process. *International Journal of Society Systems Science*, *7*(2), 107-126. https://doi.org/10.1504/IJSSS.2015.069739
32. Reinhold, K., Tint, P., Traumann, A., Tamme, P., Tuulik, V., & Voolma, S.R. (2020). Digital Support in Logistics of Home-Care Nurses for Disabled and Elderly People. In: Ahram, T., Taiar, R., Colson, S., & Choplin, A. (Eds.), *Human Interaction and Emerging Technologies* (pp. 563-568). Springer Nature Switzerland. https://doi.org/10.1007/978-3-030-25629-6_87
33. Saaty T. L. (1980). *The Analytic Hierarchy Process*. McGraw-Hill.
34. Sambasivan, M. & Fei, N.F. (2008). Evaluation of critical success factors of implementation of ISO 14001 using analytic hierarchy process (AHP): a case study from Malaysia. *Journal of Cleaner Production*, *16*(13), 1424–1433. https://doi.org/10.1016/j.jclepro.2007.08.003
35. Seker, S. & Ozgurler, M. (2012). Analysis of the Turkish consumer electronics firm using SWOT-AHP method. *Procedia – Social and Behavioral Sciences*, *58*(1), 1544–1554. DOI: 10.1016/j.sbspro.2012.09.1141
36. Sharma, M. (2005). Health education in India: a strengths, weaknesses, opportunities, and threats (SWOT) analysis. *The International Electronic Journal of Health Education*, *8*(1), 80–85. https://eric.ed.gov/?id=EJ794068
37. Singh, V. (2021). Technology, Future of Work and Ageing Workforce Readiness. *International Journal of Systematic Innovation*, *6* (4), 55-63. DOI : 10.6977/IJoSI.202106_6(4).0005
38. Singh, V. (2019). Ageing Society and China's Welfare Regime: Examining the Sub-National Variations in Pension Provision (2005-2015), *International Journal of China Studies*, *10*(2), 245-271.

39. Song, H., Yu, S., & Sun, T. (2020). Reducing the quality risk of elderly care services in government procurement from market-oriented private providers through ex ante policy design: lessons from the principal-agent theory analysis. *BMC health services research*, *20*(1), 1-11. https://doi.org/10.1186/s12913-020-05994-w
40. The Legislative Library of the Northwest Territories. (2020). *Virtual care: recommendations for scaling up virtual medical services.* Report by Virtual Care Task Force; Canadian Medical Association; College of Family Physicians of Canada; Royal College of Physicians and Surgeons of Canada; Rich, Pat; Cleveland, Caitlin.
41. Tun, S., Madanian, S., & Mirza, F. (2021). Internet of things (IoT) applications for elderly care: a reflective review. *Aging clinical and experimental research*, *33* (4), 855-867. DOI: 10.1007/s40520-020-01545-9
42. Xu X. (2019). Resource shortage or resource dependence: resource dilemma of elderly care service in smart community. *Lanzhou Academic J. 39*(5), 196–208.
43. Yan. Y. (2009). *The individualization of Chinese society*. Routledge.
44. Yan, Y. (2011). The changing moral landscape. In A. Kleinman, Y. Yan, J. Jing, S. Lee, E. Zhang, T. Pan, et al. (Eds.), *Deep China: The moral life of the person: What anthropology and psychiatry tell us about China today* (pp.36-77). University of California Press.
45. Yang, M., He, H., Yuan, H., & Sun, Q. (2016). Interaction design of products for the elderly in smart home under the mode of medical care and pension. In In: Zhou, J., & Salvendy, G. (Eds.), *Human Aspects of IT for the Aged Population. Healthy and Active Aging* (pp. 145–156). Springer Nature.
46. Yuan, J., Guang, M., Wang, X., Li, Q., Skibniewski, M.J. & Asce, M. (2012). Quantitative SWOT analysis of public housing delivery by public – private partnerships in China based on the perspective of the public sector. *Journal of Management in Engineering*, *28*(4), 407–420. DOI:10.1061/%28ASCE%29ME.1943-5479.0000100
47. Zhang, Q., Li, M. & Wu, Y. (2020). Smart home for elderly care: development and challenges in China. *BMC Geriatrics*. *20*(318), 1-8. https://doi.org/10.1186/s12877-020-01737-y
48. Zhang, Q., Li L., & Ji G. (2018). *Challenges and solutions to the coordinated development of smart home for elderly care in Qingdao.* Outstanding research compilation of human resources and social security department of Shandong province, China. https://caod.oriprobe.com/journals/caod_767/Shandong_Human_Resources_and_Social_Security.htm
49. Zhang C., & Li, J. (2018). Research on the current development and standardization of smart homecare home and abroad. *China Standardization*, *24*(20), 201–203.
50. Zheng, Q. (2018). *Study on countermeasures of spiritual consolation for the elderly*. Shenyang Normal University Press.
51. Zhou, G. (2019). The Smart Elderly Care Service in China in the Age of Big Data. *Journal of Physics Conf. Series, 1302*(4), 1-6. DOI:10.1088/1742-6596/1302/4/042008
52. Zhu, H., Rohm, C.E., Zhu, J., & Lin, F. (2014). Information Technologies and Elderly Care in China: A New Paradigm. *Communications of the IIMA*, *14*(3), 27-36. https://scholarworks.lib.csusb.edu/ciima/vol14/iss3/3