Research on the Causes of Gray Divide Generated in Smart Elderly Care in Liangshan Prefecture: Based on AHP-FCE Operational Model

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Abstract: This research takes Liangshan Prefecture as an example, the purpose is to explore the causes of the gray divide generated in the smart elderly care service in Liangshan Prefecture. To accomplish this, this study combines the depth-interview and grounded theory as research method in order to collect data, then put them to the AHP-FCE operational model, run the model getting the main causes jointly lead to the generation of gray divide are as follows: (1) limitation of conventional thought; (2) digital infrastructure is incomplete; (3) lack of digital capability improvement system; (4) the using effect is unsatisfactory. Based on these, the paper puts forward some specific suggestions to construct the governance framework of multiple cooperation in order to narrow the gray divide as well as promote the construction of Chinese smart elderly care research a new height.

1 INTRODUCTION

Increasing the quantity and quality of the supply of elderly care services for the quality improvement of life of the aging population takes on a critical significance to improving people's lives and works in the ethnic areas in western China after poverty alleviation. Moreover, it is critical to consolidating the achievements of poverty alleviation and effectively connecting the rural revitalization strategy. On the one hand, digital information technology has essentially changed people's living habits and conceptions of thinking in a wide variety of fields while reshaping the local government's public service supply system.

In the context of building digital China, the Chinese government at all levels is actively exploring the novel supply pattern combining information technology and elderly services. As a result, smart old-age service has been boosted with the proper time and conditions, which shows an irresistible development situation. On the other hand, the population aging in Chinese western ethnic minority areas, such as Liangshan Prefecture tends to increase and deepen, and other reality factors (e.g., the gradual weakening of the function of the conventional elderly services mode) are becoming progressively prominent (Li and Zhang, 2021). Accordingly, an effective mode is in urgent needed to improve the supply quality of elderly services. In brief, smart elderly care tends to be a fundamental solution to solve the problems of lagging supply and low quality of elderly care services in Liangshan Prefecture. However, the adaptive construction level of the smart elderly care in there should be further improved under numerous factors. Compared the aged population in other areas, there is a significant gap in the acceptance willingness and awareness of this novelty pension model, such that this group cannot equally benefit from the development of Chinese smart pension services. The gray divide in it is generate and tends to expand.

2 LITERATURE REVIEW

The external policy environment has been continually optimized, and the smart elderly care services industry has been developing worldwide. Under the above context, relevant research results on this issue has progressively enriched. Furthermore, the diversity of research topics is a major step forward,

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with a major focus on the acceptance willingness and the relevant factors. The novelty supply mode of smart elderly care, the dilemma, and risk in its development process are explored.

The acceptability and willingness of the aging population, the main body of the smart elderly care service, will significantly affect the development of the smart elderly care service. The low acceptability and willingness of the users is also one of the leading causes of the generation of gray divide. Existing research in this field also reveals a distinct ideology of contingency, thus indicating that various elderly people have different factors for their demand for smart elderly care services and their willingness to use these services (Zhang, Li and Wu, 2020). To be specific, age, places to live, ability to accept novel things, average ratio of monthly income to expenditure and the support from families, as well as NGOs (Zhuo et al., 2020), subjective norms, perceived usefulness, and perceived ease of use (Yang at al., 2020) will affect the aging population's willingness to use smart elderly care services from the perspective of users' subjective and objective conditions. Moreover, the research results about the factors for the willingness though the model construction have been relatively rich. To be specific, the quality of material and interaction environment, elderly care information, platform system and service, as well as the service satisfaction will significantly affect users' willingness to adopt smart elderly care services (Zhu et al., 2021).

Along with the supply system of Chinese smart elderly service has been gradually formed and improved, the new supply modes of smart elderly care service is being explored both in daily practice and in theory research, mainly includes the intelligent community caring services, intelligent home-based caring and virtual pension service.

First, compared with three conventional supply modes of elderly care services, namely "government-led public model", "market-led private model" and "socially-led mutual assistance model", intelligent community caring services have the different characteristics of components, merit and demerit, and adaptive dimensions (Liu et al., 2022), which has significant superiority of reducing pension burdens of social and family and lifting the efficiency of the pension industry chain.

Second, intelligent home-based elderly caring is a novel model to effectively solve the problem of Chinese elderly care built with the core idea of "openness, equality, innovation and free" (Xu et al., 2021). Compared with the conventional home-based elderly care mode, it shows significant advantages in such fields as exchange of elderly care information, expansion of elder care projects, and optimization of elderly care supply. However, in the process of development, this mode will be significantly limited by the fragmented development of nursing, caring, and medical treatment (Sui et al., 2016). Thus, the future development trend of this new elderly care mode should enhance the integrity of all components in it and build the supply platform and model that stress the characteristics of being integrated and refined.

Lastly, virtual pension service relies on the information platform to integrate pension resources and realize the integration of modern technology and conventional pension model, which is not only a new model to break through the conventional dilemma of Chinese elderly care services (Du and Sun, 2020), it also represents the future development direction of China’s smart elderly care services (Zhu, 2021).

The smart elderly care, newly produced by the combination of the conventional pension modes and the background of the information age, has a bright prospect, whereas twists and turns remain in its development path. Besides, a variety of difficulties and risks exposed during its development arouse wide public and academic attention.

First, from the institutional perspective, the lagging-behind of the supply-based guidance, the deep integration of resources, the reform of institution offering services for the elderly will significantly limit its development (Du and Zang, 2020). In addition, problems such as the immature business model, mismatch between supply and demand (Uddin, Khaksar and Torresen, 2018), difficulties in information sharing, incomplete construction of norms and standardization system (Ghamesi, Rezaee and Rahmani, 2019), and lack of professional talents are all exposed in the development process of smart elderly care worldwide (Wu, 2021).

Second, from the perspective of supply and demand side, cognitive bias, market, industrial order and access dilemma (Chen, 2021) are all the the fetches that need to be broken in the development process of smart elderly care services.

Lastly, digital technology is a two-edged sword and it also had the spillover effect, in the development process of smart elderly care worldwide, it may also causes such ethical risks as safety uncontrollable during the human-computer interacting, ambiguity of responsibility under subject recognition dilemma and moral abnormality due to the change of family relationship (Wang, 2021). At the same time, some social, market and technical risks will be induced by

some causative factors such as the incompatibility between the conventional legal system and the new pension service model as well as the imperfect regulatory system. (Zhu, 2020).

3 RESEARCH DESIGN

In this study, 20 communities or towns in 5 counties of Liangshan Prefecture is taken as a research case. The data are obtained using the research method combining questionnaire survey and in-depth interview. Subsequently, the obtained data are analyzed in accordance with grounded theory in order to obtain the indicators as well as construct the indicator system of AHP-FCE model, after assessing it, this research found the main causes of the generation of gray divide in smart elderly services in Liangshan Prefecture. And some policy suggestions are proposed to further narrow it (Fig. 1).

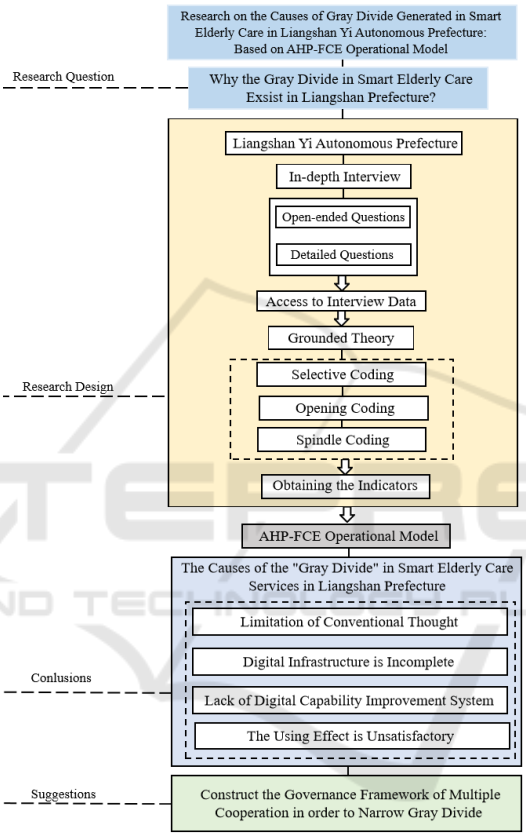

Figure 1: Research Framework

3.1 Data Selection

In this study, questionnaire survey, in-depth interview, and grounded theory are adopted to investigate 20 communities or towns in 5 counties of Liangshan Prefecture (Table 1). First, a semi-structured in-depth interview has been conducted with 61 aging population over 60 years old following the theme of "The views of smart elderly care services". Table 2 lists the basic information of the interviewees. In this study, the interview content is converted into text and numbered. Subsequently, the grounded theory is applied to code the text data word by word. Next, 250 questionnaires have been distributed in the research areas, and 206 valid questionnaires have been collected to theoretically support the follow-up research of this study. The reliability and validity of samples are tested using SPSS 26.0, and the Cronbachs α coefficient value reaches 0.72, thus indicating that the reliability of the questionnaire is acceptable, and the KMO value of the model index reaches 0.791, greater than 0.7. On that basis, the above result confirms that the validity conforms to the requirements.

Table 1: Selection of Investigation Areas.

Cities (Countries)	Communities (Villages, Towns)	The Copies of Valid Questionnaires Collection	Number of Interviewees
Xichang City	Zhangmuqing Village, Minsheng Village, Xianghe Community,Jianxin Community, Yingbin Community	61	17
Xide Country	Heboluo Village, Mianshan Town, Shangyejie Community	24	13
Puge Country	Bazhe Town, Huashan Community, Chengnan Community	33	14
Yanyuan Country	Luguhu Town, Tengqiao Town, Jinhe Town, Weicheng Community, Yanrui Community	40	7
Butuo Country	Baoguping Town, Telimu Town. Dongcheng Community, Yisa Community	48	5

3.2 Research Model Selection

AHP-FCE Fuzzy Analytic Hierarchy Process is a combination of fuzzy comprehensive evaluation method FCE and AHP. AHP (Analytic Hierarchy Process) was first proposed by American operations research scientist T.L. Saaty in 1975 (Hamido, 2012). Fuzzy Comprehensive Evaluation (FCE) is a kind of comprehensive evaluation method based on mathematical model. It uses fuzzy mathematics to deal with the indicators which are affected by qualitative factors. Ahp-FCE Fuzzy Analytic Hierarchy Process (AHP) is the integration of advantages and complementary disadvantages of the two. The questionnaire was designed based on Likert scale, and the evaluation set V={V1, V2, V3, V4, V5} was set, where V1: very low (satisfactory/Accord with); V2: relatively low (satisfactory/Accord with); V3: general (satisfactory/Accord with); V4: Relatively high (satisfactory/Accord with); V5: Very high (satisfactory/Accord with) (He, 2020). The principle of weighted average is adopted to treat each rank as a relative position and make it continuous. In order to display the evaluation results more intuitively, the percentage system was used to obtain the membership function image by referring to relevant literature, as shown in Figure 2.

Figure 2: The Corresponding Estimation Scale of Quantitative Data.

fi was set as the number of people evaluated by the questionnaire for each index, Wi was the index weight, gij was the matrix data corresponding to the index evaluation, Vt was the corresponding score of each level, T was the total score of the actual evaluation, t was the theoretical score, and Tt was the scoring rate. Then:

$$f_{i_1} + f_{i_2} + f_{i_3} + f_{i_4} + f_{i_5} = \text{Total questionnaire} \tag{1}$$

$$g_{i_{1\sim5}j} = f_{i_{1\sim5}} / (f_{i_1} + f_{i_2} + f_{i_3} + f_{i_4} + f_{i_5}) \tag{2}$$

$$v_{t_1} = 55 * g_{i_1 j_1} + 65 * g_{i_2 j_1} + 75 * g_{i_3 j_1} + 85 * g_{i_4 j_1} + 95 * g_{i_5 j_1}$$
$$\vdots$$
$$v_{t_n} = 55 * g_{i_1 j_n} + 65 * g_{i_2 j_n} + 75 * g_{i_3 j_n} + 85 * g_{i_4 j_n} + 95 * g_{i_5 j_n} \tag{3}$$

$$T = v_{t_1} + v_{t_2} + v_{t_3} + v_{t_4} + v_{t_5} \ldots + v_{t_{14}} \tag{4}$$

$$t = w_{i_1} * 100 + w_{i_2} * 100 + \ldots + w_{i_{14}} * 100 \tag{5}$$

$$T_{t_{n(n=1\sim14)}} = V_{t_{n(n=1\sim14)}} / T \tag{6}$$

The construction of pair comparison matrix is the mathematical basis of fuzzy Analytic Hierarchy Process (AHP-FCE). Aiming at specific problems, professionals who have the right to speak in a specific field will give the index comparison results as the basis of index weighting. The research sets i and j as the comparison factors respectively, then aij represents the comparison results of item i and item j, and the evaluation factors are shown in Table 1.

Table 2: The Matrix of Pairwise Comparison by Experts.

Scoring	Connotation (Two factors in comparison)
1	Equally important
3	The former is slightly more important than the latter
5	The former is more important than the latter
7	The former is much more important than the latter
9	The former is absolutely important than the latter
2/4/6/8	The median value of the adjacent comparison judgment above
Diagonal description	$a_{ji}{*}a_{ij}=1$
Pairwise comparison the characteristics of matrix	$a_{ij}>0$, $a_{ji}>0$, $a_{ij}=\frac{1}{a_{ji}}$

Set Wi as the final weight corresponding to the i-th index (i=1-14), Xi (i=1-14) as the average result of expert comparison and proof by line, and Yij (i=1-15, j=1-15) as the standardized result by column, then:

$$y_{ij_{(1\sim n)}}=a_{ij_{n(n=1\sim n)}}/\left(a_{ij_1}+a_{ij_2}+a_{ij_3}+a_{ij_{\ldots}}+a_{ij_n}\right) \quad (7)$$

$$x_{i_{(1\sim n)}}=1/\left(y_{i_1 j}+y_{i_2 j}+y_{i_3 j}+y_{i_{\ldots} j}+y_{i_n j}\right) \quad (8)$$

$$w_i=1*x_{\text{First Grade Index}}{*}x_{\text{Second Grade Index}} \quad (9)$$

$$w_{i_1}+w_{i_2}+\ldots+w_{i_{14}}=1 \quad (10)$$

3.3 Construction of Index System

Based on the grounded theory analysis of the interviewees' interview data, this paper finally condensed 17 indicators leading to the generation of gray divide in the smart elderly care service in Liangshan Prefecture, and further summarized them into the access divide, power divide, psychology divide and effect divide. The above indicators are form an evaluation model index system for the causes of the generation of gray divide in smart elderly care services in Liangshan Prefecture, as shown in Table 3.

Table 3: The Evaluation Model Index System of the Generation of Gray Divide in Smart Elderly Care Services in Liangshan Prefecture.

Target Hierarchy	Inherent Hierarchy	Performances Hierarchy
The Evaluation Model of the Gray Divide Generated in Smart Elderly Care Services in LiangShan Prefecture A	Access The Intelligent Devices of Smart Elderly Care (Access Divide) B1	The device operation C1
		The network stabilization C2
		The convenience degree of operate the devices C3
		Income level C4
	Basic Digital Ability and Literacy (Power Divide) B2	Personal cognitive and physical function C5
		The willingness of participate in digital ability training C6
		The self-efficacy of improving digital capacity C7
		The condition of digital ability training in family C8
		Education Level C9
	The Psychology of Obtaining the Smart Elderly Care Services (Psychology Divide) B3	The willingness to accept smart elderly care services C10
		The demand for children to care them on-hand C11
		The Recognition condition of smart pension mode C12
		The concerns about network security problems C13
	The Effects of Using Smart Elderly Care Services (Effect Divide) B4	The fit-aging level of smart elderly care services C14
		The price of accessing smart elderly care services C15
		The construction level of industry regulatory mechanisms C16
		The construction level of quality assessment mechanism C17

4 MODEL EVALUATION

According to the standards of the same level and the same type, the index system was divided into four comparison intervals: [B1, B2, B3, B4], [C1, C2, C3, C4], [C5, C6, C7, C8, C9], [C10, C11, C12, C13] and [C14, C15, C16, C17]. Then, through the questionnaire design, the importance of the relevant evaluation indicators were analyzed by experts, and 5 interval index systems were constructed by combining the expert opinions and the final scoring results to provide evidence for comparison and judgment, and then the consistency test was carried out. The following is an example of the index interval [C5, C6, C7, C8, C9] for calculation. First, construct [C5, C6, C7, C8, C9] expert pairs comparison matrix and assign weight:

[C5, C6, C7, C8, C9] Contrast Proof by Experts=

$$\begin{bmatrix} 1 & 1/3 & 1/7 & 1/8 & 1/9 \\ 3 & 1 & 1/4 & 1/5 & 1/6 \\ 7 & 4 & 1 & 1/2 & 1/5 \\ 8 & 5 & 2 & 1 & 1/3 \\ 9 & 6 & 5 & 3 & 1 \end{bmatrix}$$

Then, consistency in the matrix, calculates the maximum characteristic radix λ is 5.285, the eigenvector corresponding to is (0.160, 0.332, 0.828, 1.221, 2.458). C_I is set as a consistency index, and we can get $C_I=(\lambda -n)/(n-1)=0.071$. R_I was set as a random consistency index, $C_R=C_I/R_I=0.071/1.120$. In the matrix test, the smaller the C_R value, the better the consistency of the judgment matrix. When C_R value is less than 0.1, the consistency test of the judgment matrix passes. If the value of C_R is greater than 0.1, it indicates that there is no consistency. Based on the fifth-order judgment matrix, the value of C_I is 0.071, as shown in Table 4, and the value of R_I is 1.120, as shown in Table 5. Therefore, the value of C_R is 0.064<0.1, indicating that the judgment matrix meets the consistency test standard and the weight obtained is consistent.

Table 4: The AHP Analysis Result of [C5, C6, C7, C8, C9].

Item	Eigenvector	Weighted Value	Eigenvalue of Maximum	The Value of CI
C5	0.160	3.208%		
C6	0.332	6.633%		
C7	0.828	16.562%	5.285	0.071
C8	1.221	24.429%		
C9	2.458	49.169%		

Table 5: The Comparison Table of Random Consistency Index of RI.

Nth-order	4	5	6	7	8	9	10	11	12	13	14
RI	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58
Nth-order	18	19	20	21	22	23	24	25	26	27	28
RI	1.6133	1.6207	1.6292	1.6358	1.6403	1.6462	1.6497	1.6556	1.6587	1.6631	1.6670

According to the above process, the remaining [B1, B2, B3, B4], [C1, C2, C3, C4], [C10, C11, C12, C13] and [C14, C15, C16, C17] were checked and the CR values were 0.070, 0.061, 0.063 and 0.069, which were all less than 0.1. Therefore, the indexes of the quasi - test layer and the scheme layer meet the consistency test standard. Then, the above formulas (7), (8) and (9) are used to calculate the weight of indicators, and the theoretical scores are calculated according to the formula (5), and the analogy results are shown in Table 6. Verify the formula (10), Wi1+Wi2+Wi3+... + Wi17 = 0.0075 + 0.0033 + 0.0163 + 0.038 +... +0.1217+0.1796+0.3615=1, the test passed.

Table 6: The Index Weight and Theoretical Score of the Model.

Target Hierarchy	Inherent Hierarchy	Weights	Performances Hierarchy	Weights	Combination Weight Wi	Theoretical Score
A	B1	0.0654	C1	0.1154	0.0075	0.75
			C2	0.0502	0.0032	0.33
			C3	0.2488	0.0163	1.63
			C4	0.5856	0.0383	3.83
	B2	0.1994	C5	0.2300	0.0321	4.59
			C6	0.0408	0.0081	0.81
			C7	0.0735	0.0147	1.47
			C8	0.5379	0.1073	10.73
			C9	0.1178	0.0235	2.35
	B3	0.7352	C10	0.0321	0.0236	2.36
			C11	0.0663	0.0213	4.87
			C12	0.1656	0.1217	12.17
			C13	0.2443	0.1796	17.96
	B4	0.5623	C14	0.4917	0.3615	36.15
			C15	0.2321	0.0121	7.32
			C16	0.1782	0.0021	3.98
			C17	0.3212	0.0271	9.03

After analogy, the score value and scoring rate in the evaluation model of the gray gap generated in the process of obtaining smart elderly care services in Liangshan Prefecture are as shown in Table 7:

Table 7: The Assessment Result of Evaluation Model of the Gray Divide Generated in Smart Elderly Care Services in Liangshan Prefecture.

Target Hierarchy	Performances Hierarchy	Combination Weight Wi	Theoretical Score t	Practical Score T	Scoring Average of Performances Hierarchy	Scoring Average of Inherent Hierarchy	Scoring Average of Target Hierarchy
A	C1	0.0075	0.75	0.64	85.33%	B1=79.66%	82.24%
	C2	0.0032	0.33	0.24	72.73%		
	C3	0.0163	1.63	1.28	78.53%		
	C4	0.0383	3.83	3.05	79.63%		
	C5	0.0459	4.59	3.84	83.66%	B2=75.99%	
	C6	0.0081	0.81	0.56	69.14%		
	C7	0.0147	1.47	1.02	69.39%		
	C8	0.1073	10.73	8.06	75.12%		
	C9	0.0235	2.35	1.68	71.49%		
	C10	0.0236	2.36	1.71	72.46%	B3=84.17%	
	C11	0.0487	4.87	3.65	74.95%		
	C12	0.1217	12.17	9.39	77.16%		
	C13	0.1796	17.96	14.55	81.01%		
	C14	0.3615	36.15	32.57	90.10%	B4=85.79%	
	C15	0.0121	7.32	6.01	82.10%		
	C16	0.0021	3.98	3.53	88.69%		
	C17	0.0271	9.03	7.86	87.04%		

5 CONCLUSIONS

5.1 Limitation of Conventional Thought: Difficult to Cross Psychology Divide

The psychological divide of gray divide in smart elderly care services refers to the gap in demand, willingness and attitude of different aging groups when facing the emerging technologies, modes and products regarding smart pension services. There are two main reasons why the aging population in the Liangshan Prefecture is difficult to close the psychological divide.

First, the conventional concept and cognitive bias of elderly care limit their acceptance of the smart elderly care service mode. Taking Liangshan Prefecture as an example, out of the special emotion for parents and ancestors, the Yi community in Liangshan Prefecture has formed a unique idea and consumption concept of elderly care, and the concept of "great burial and poor care" is deeply rooted in their mind. On that basis, a grand funeral after parents died is the critical form of filial piety, whereas the daily elderly care improving the quality of life of an aging population has been neglected. As indicated by the results of the questionnaire and interview, 85.3% of the respondents said, "they are willing to spend a high amount of money for their parents' funerals, whereas they are not willing to spend more money on daily elderly care services". The above result reveals that the conservative pension and consumption concept in LiangShan.

Prefecture will not only form the unhealthy practice of extravagance and waste, but also reduce the quality of life in the elderly.

At the same time, the cognitive bias of the aging population and their children against the smart pension service is also widespread. As mentioned above, the pension model in the above areas is relatively simple, conventional home-based pension model accounts for a large proportion, and the proportion of some emerging modes (e.g., community pension and institutional pension) approaches zero. In Liangshan Prefecture, for example, 99.31% of the aging population said "they would not accept the institutional pension" and 99.72% of respondents said "it is unfilial to send parents to a nursing home or other institution". As indicated by the above results, the cognitive bias against emerging pension modes (e.g., institutional pension and community pension) will further hinder their psychological acceptance of smart elderly care services.

Second, the pessimistic fear of technology will further drop the willingness of the elderly people to accept smart elderly care service. With the rapid advance of information technology in China, the ethical and legal risks (e.g., network fraud and personal information leakage) have emerged in endlessly. The probability of aging population in there become "victims" of network risks increases remarkably due to the generally poorly educated and very limited digital literacy and ability of them. According to The Survey Report on Internet Access and Risks of the Chinese Elderly released in 2018. Over half of Chinese elderly Internet users have been exposed to online pyramid schemes, financial fraud, and online shopping fraud. The aging population is difficult to distinguish and process the exponential growth of network information due to their low education level, limited digital literacy and related abilities, which significantly reduces their trust of Internet and information technology, resulting in the emergence of "technophobia", it makes them extremely resistant to the intelligent pension mode built based on Internet and information device. In the survey, 30.4% of respondents said, "the reason they are reluctant to access the smart pension mode is that they are afraid of suffering Internet fraud."

In brief, the conventional conception of elderly care and consumption in Liangshan Prefecture, the cognitive bias against the emerging smart elderly care and the pessimistic fear of technology together lead to the difficulty of the aging population to cross the psychological divide.

5.2 Digital Infrastructure Is Incomplete: Difficult to Cross Access Divide

The access divide of silver divide in smart elderly care services refers to the gap generated in the process of enjoying the development achievement of smart elderly care services between those who have access to Internet as well as intelligent devices and those who do not, which is the material basis of the gray divide. The reasons why it is difficult for the aging population to bridge the access divide are mainly as follows.

First, after poverty alleviation, although the construction of digital infrastructure in Liangshan Prefecture has made remarkable progress, it is still in a relatively weak position compared with other areas in China. Taking Liangshan Prefecture as an example, it is clearly pointed out in the 14th Five-Year Plan of Digital Economy Development issued by the Economic and Information Bureau of Liangshan Yi

Autonomous Prefecture that "the informatization level of the prefecture is at a relatively low level in the province, the supporting capacity of communication network infrastructure is insufficient, and the intensive construction of information infrastructure need to be further improved".

Second, as the main body of the production and supply of smart elderly care services, the development quality and level of related industries are of great importance for the integral development of smart elderly care service. In general, the development foundation of the intelligent elderly care industry in China's western ethnic areas is relatively weak, still exists some practical problems, such as lack of driving force for industrial agglomerative development and leading enterprises, the weak support ability of technological innovation for industrial development.

Third, the landform and topography of ethnic areas in western China are mainly mountainous. The above natural conditions also determine that the construction cost of digital infrastructure in there is relatively high. The special topography and poor transportation conditions together result in bad access conditions of smart elderly care services in China's western ethnic areas such as Liangshan Prefecture. In the process of the survey, 36.41% of respondents said that "the instability of the network and mobile phone signal is one of the reasons why they are not willing to access in smart elderly care."

Lastly, on the one hand, the above enterprises retain their nature of profit-seeking. In the pricing of related products and services of smart elderly care, they will pursue the greatest interests as the fundamental goal. On the other hand, as a part of public services, the publicness of elderly care services should also be paid attention to. In the games between the above two natures, the former tends to seize the advantage. Thus, the high pricing of the smart elderly care services and products will hinder the aging population in ethnic areas in western China from crossing the access divide significantly, and it is a common phenomenon of hard to bear the cost of digital devices (e.g., smart phones and network telecommunications) in China's western ethnic areas. Taking Liangshan Prefecture as an example, the results of the questionnaire showed that 30.1% and 29.3% of respondents said they "do not have smart phones" and have "no Internet connection at home", respectively.

In brief, factors (e.g., the incomplete digital infrastructure and the weak development foundation of smart elderly care industries) have led to the realistic dilemma that the aging population in ethnic areas in western China is difficult to bridge the access divide.

5.3 Lack of Digital Capability Improvement System: Difficult to Cross Power Divide

The power divide of gray divide in the smart elderly care service refers to the gap in the ability and accomplishment of the aging population when accessing the smart pension service. For the aging population in China's western ethnic areas, even if they have successfully crossed the psychological and access divide, they remain in a relatively weak position in terms of their ability to use the services due to the lack of the cultivation and improvement system of the digital capability of smart elderly care services.

On the one hand, there are still some defects in the top-level design of the digital ability cultivation and promotion system in ethnic areas in western China, which mainly reflected in the lack of clear policy support at the national level, and the low importance attached to its role and position in the process of ensuring the aging population in China's western ethnic areas are able to enjoy the equality of the development achievement of the smart pension service. Moreover, the premise of establishing a perfect system to cultivate and enhance the digital ability of smart pension is to promote the aging group to form the right comprehension of it. However, the relevant propagandization activities have been significantly hindered in ethnic areas in western China, especially in the grass roots. In addition, the propaganda strength of smart elderly care is insufficient, and the forms of propaganda are relatively simple. With Liangshan Prefecture as an example, the survey found that 79.23% of the respondents said "they know nothing about the smart elderly care services".

On the other hand, the vacancy of the grass-root governance subjects (e.g., communities and villages) in digital ability promotion activities in China's western ethnic areas will also lead to the further expansion of the power divide. With Liangshan Prefecture as an example, 79.23% of respondents said that "villages or communities have never held any training activities related to digital ability".

In brief, factors (e.g., defective top-level design, insufficient publicity, and the absence of governance subjects) have caused the inability of the aging population in ethnic areas in western China to bridge the power divide.

5.4 The Using Effect Is Unsatisfactory: Difficult to Cross Effect Divide

The effect divide of gray divide in smart elderly care services represents the gap in the effect, experience feeling and benefit of the aging population applying the smart pension services. As the aging society in China has been deepening, their needs and preferences of the smart pension tend to be diversified. Although a wide variety of communities, institutions and other subjects of the smart pension have taken corresponding measures to satisfy the diversified needs of the elderly care, the precision design of the aged and minority groups of the smart pension service in China's western ethnic areas still have considerable improvement rooms.

On the one hand, smart elderly care devices designed for the aging population are subject to numerous problems. Several problems remain (e.g., the service is difficulty to satisfy the diversified needs of the aging population, the high price, and their design defects for applying to the aging population) since the contradiction between the nature of profit-seeking and publicity of smart pension enterprises has not been eliminated.

Moreover, the precise design of service and product fitting the minority groups has a large room for improvement for the aging population in ethnic areas. An interviewee from Xichang city said, "my Chinese proficiency is not very good, whereas there is no way to choose my own national language in the smart device of elder care, which has significantly hindered my progress (2021-7-13-XCS-MSX-03)". As revealed by the above finding, for the users of smart elderly care services in ethnic areas in western China, products and related services with the low level of being suitable for aging and nationality will directly lead to the effect divide.

On the other hand, the lack of uniform standards of regulatory and supervision in the smart elderly care service industry leads to the quality of smart elderly care services supply. An interviewee from Xide County indicated that "Pop-up ads have occurred several times in the software of smart elderly care services, while some functions also require the extra payment. (2021-7-18-XDX-SYJSQ-01)". As revealed by the above finding, the differences in the quality of its products and services are increasingly prominent since the smart elderly care service has become increasingly common in Chinese grassroots and ethnic areas. Moreover, the supervision system of industry and product quality supervision remains not perfect. As a result, compared with other developed and urban areas, the aging population in China's western ethnic areas has a significant gap in use effect of smart pension services. As a result, the generation of effect divide and the equality of enjoying the development achievement of Chinese smart pension services will be damaged.

In brief, factors (e.g., the design defect of service and product which fitting the minority and aging groups, lack of uniform standards of regulatory and supervision of smart elderly care services and related products) will hinder the aging population in ethnic areas in western China from bridging the effect divide.

6 SUGGESTIONS

According to the above research results, the gray divide generated in ethnic areas in Liangshan Prefecture arises from the failure factors of the aging population to cross the psychological, access, power and effect divide. They are intertwined and complicated, thus leading to the fact that the single governing subject may can not achieve the governance goal of bridging the gray divide of smart elderly care services in there independently. Accordingly, constructing and improving the governance system framework of multiple cooperation in that place is the critical path to bridge the gray divide in smart elderly care services.

As depicted in Fig. 3, this framework contains two basic elements: the first is the multiple subjects participate in the construction of the smart elderly care in Liangshan Prefecture, such as the governments, communities and social organizations, enterprises, and families. The second part is the combination of the external development environment and foster conceptual change of the aging population, and implement the above two elements into key strategic arrangements (e.g., the top-level system design, crossing the psychological divide, access divide, power divide and effect divide) to achieve the goal of bridge and eliminate the gray divide of smart elderly care service in Liangshan Prefecture and further safeguard their equally rights of enjoying the development achievement of China's smart elderly care services.

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