Analysis of "Internet + Embedded" Community Aging Based on AHP-Fuzzy Comprehensive Evaluation Method

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Abstract. With the increasing aging of China's population, there is an urgent need to establish a new type of social pension service system, which is led by the government and based on effective resources. This paper adopts a fuzzy comprehensive assessment model to construct a community aged care evaluation index system and identify the main factors affecting the quality of "Internet + embedded" community aged care services based on the assessment results. The findings are: Embedded community elderly care should focus on improving the cultural activities and adaptive services provided to the elderly, ensuring the living and health status of the elderly, and implementing the protection of the legitimate rights and interests of the elderly.

Keywords: "Internet + embedded" community care · Hierarchical analysis · Fuzzy comprehensive evaluation

1 Introduction

According to the statistics of the National Census Bureau, the population aged 60 or 60 and 60 or 60 or higher is 18.7%, or 264.01 million [1]. As China's population continues to age and serious social problems become increasingly prominent, China has also put forward the new community elderly care model of "Internet + embedding", the meaning of which is based on the "Internet+", combining intelligent terminals with community care to achieve a precise match between supply and demand. This is a precise match between supply and demand, with a view to improving productivity while saving production costs and better meeting the individual needs of the elderly.

Blandford A (1989) pointed out that "community-based" is the inevitable trend for the future development of China [2], and Mitter (2004) argued that the community-embedded care model can promote a good balance between individuals and groups in daily life [3]. Schnell M W (2010) based on the concept of "smart nursing home" in Tokyo, Japan, proposed to integrate the idea of "Internet+" into community-based health care [4]. Ballesteros (2011) argues that the state should provide some support for community-based elderly care services and develop diversified services [5]. Ma Kai and Liu Fengzhi (2012) proposed that community-based home care is a comprehensive

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network support system for the elderly [6]. Susan Baxter (2018) believes that integrated healthcare can reduce costs and improve service quality [7]. Zhou Yue et al. (2019) proposed that elderly people's ageing behaviour shows an inter-embedding of economic and social types [8].

Generally speaking, at present, the academic cognition of embedded aging is still in the initial state, and a unified and authoritative cognition has not been formed in the related theories. The current state of research is no longer able to meet the country's growing living needs and there is an urgent need for in-depth theoretical research on it.

2 Construction of the Pension Evaluation Index System

2.1 Evaluation Model

This paper follows the principles of objectivity, science, consistency, practicality and guidance [9]. The construction of a system of indicators for the evaluation of old age is carried out from 3 aspects:

(1) Availability of sites and hardware facilities.
(2) The level of services provided by the institution.
(3) Institutional attractiveness and fees: The embedded care home model, with the home as the core, the community as the foundation and the institution as the support, is different from the previous mode of operation of most care homes, and the issue of attractiveness and affordability for the elderly and their relatives is a concern [10].

The evaluation index system in this paper consists of 3 levels, with a total of 24 sub-indicators, and the AHP hierarchical analysis method is applied to calculate the weights, resulting in the factor set matrix W.

2.2 Determination of Indicator Weights Based on Hierarchical Analysis

This article uses the AHP to calculate the weights of indicators. Firstly, establish a corresponding hierarchical structure. The target layer represents the evaluation index system; The decision-making level represents the various structural variables that affect the evaluation of community elderly care; The scheme layer represents the observed variables corresponding to each structural variable. In combination with this article, the "Internet plus Embedded" community aging evaluation index system has been constructed. See Table 1 for details.

It can be seen that for B1, B2, B3, B4, B5, B6, B7 a total of 7 items to construct the 7th order judgment matrix for AHP hierarchy method research, according to the eigenvector calculation formula $\lambda_{\max} = \frac{\sum (aW)_i}{nW_i}$ (in the formula, a W indicates the matrix a and W multiplied, n is the number of order).

The eigenvectors are (0.349, 0.647, 0.991, 0.341, 2.021, 0.843, 1.807) and the total 7 items corresponding to the weight values are: 4.990%, 9.241%, 14.164%, 4.873%, 28.872%, 12.049%, 25.811%. In addition to this, the maximum eigenroot (7.195) can be calculated by combining the eigenvectors. The CI value (0.033) is then calculated using the maximum eigenroot value as follows: $\mathrm{CI} = \frac{\lambda_{\max} - n}{n-1}$(where n denotes the order of the matrix) and the CI value is used for the following consistency test.

Table 1. "Internet + Embedded" Community Aging Evaluation Index System

Target level (Tier 1 indicators)	Guideline level (secondary indicator)	Guideline level Weighting	Programme level (Level 3 indicators)	Programme level Indicator weights
"Internet + Embedded" Community Aging Evaluation Index System A	Functional facilities (*B1*)	0.0499	Degree of equipment intelligence (*B11*)	0.1226
			Safety in elderly facilities (*B12*)	0.3202
			Security of fire and other safety facilities (*B13*)	0.5571
	Suitability services (*B2*)	0.0924	Rehabilitation Nursing (*B21*)	0.3333
			Quality of care centre services (*B22*)	0.6667
	Emotional support (*B3*)	0.1416	Spiritual Solace (*B31*)	0.7143
			Regular visits by relatives (*B32*)	0.2857
	Space (*B4*)	0.0487	Bed Setting and Bedroom Space Planning (*B41*)	0.2500
			Planning of facilities and equipment for the elderly (*B42*)	0.7500
	Health Management (*B5*)	0.2887	Physical health monitoring (*B51*)	0.4237
			Meal Taste and Nutritional Mix (*B52*)	0.1828
			Mental Health Concerns (*B53*)	0.3934

(*continued*)

In this study, a 7th order judgment matrix was constructed, and a random consistency RI value (See Table 2 for details) of 1.360 could be obtained by querying the RI value chart, which was used for the following consistency test calculation. When using the AHP hierarchical analysis method for weight calculation, through the comparison of each weight, the consistency of each weight is compared, and the consistency is analyzed. The compatibility index of CR was calculated $CR = \frac{CI}{RI}$.

Table 1. (*continued*)

Target level (Tier 1 indicators)	Guideline level (secondary indicator)	Guideline level Weighting	Programme level (Level 3 indicators)	Programme level Indicator weights
	Cultural activities (*B6*)	0.1205	Recreational activity development (*B61*)	0.1667
			Cultural Literacy Learning (*B62*)	0.8333
	Price (*B7*)	0.2581	Collection of fees by elderly care institutions (*B71*)	0.2014
			Attractiveness of community embedded homes for elderly residents (*B72*)	0.1180
			Relatives' ability to pay for elderly care services (*B73*)	0.6806

Table 2. RI value corresponding query table

n order	3	4	5	6	7	8	9	10
RI price	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

Table 3. Summary of consistency inspection results

Maximum characteristic root	CI value	RI value	CR value	Consistency test results
7.195	0.033	1.360	0.024	By

The CI value calculated for the 7th order judgment matrix is 0.033, and the table check for the RI value is 1.360, so the calculated CR value is 0.024 < 0.1, It shows that the evaluation matrix proposed in this paper meets the consistency requirements, and the evaluation indicators have a good consistency. Summarize the consistency check results, as shown in Table 3. On this basis, the evaluation indicators of different levels are quantified, and the evaluation results are summarized, as shown in Table 1.The weights are denoted by W as the weight vector of the influence of the indicators on the target level indicators. The factor set matrix is obtained.

$$W = (W_{B1}, W_{B2}, W_{B3}, W_{B4}, W_{B5}, W_{B6}, W_{B7})$$
$$= (0.0499, 0.09241, 0.14164, 0.04873, 0.28872, 0.12049, 0.25811)$$

3 Comprehensive Evaluation of "Internet + Embedded" Community Nursing Homes

The evaluation of the indicators of "Internet + embedded" community elderly care cannot be accurately characterized by quantitative data and has great fuzziness. This paper carries out scientific evaluation based on by using the subordinate principle of fuzzy mathematics and the principle of fuzzy comprehensive evaluation, the transformation from qualitative to quantitative analysis is realized, and the conclusion of quantitative analysis is used to test the correctness of quantitative analysis.

3.1 Determining the Set of Factors to Be Evaluated

It is possible to set P evaluation indicators, $U = \{\mathrm{u}_1, u_2, \ldots, u_i\}$; from the secondary indicators of the "Internet + embedded" community elderly evaluation index system and its tertiary indicators of each factor may constitute.

3.2 Determining the Evaluation Set

In this paper, five evaluation levels are determined, namely very unsatisfactory, unsatisfactory, generally satisfactory, relatively satisfactory and very satisfactory.

Let $V = \{v_1, v_2, \ldots, v_p\}$, each rank can correspond to a fuzzy subset, i.e. the set of ranks.

To quantify the qualitative results of the above evaluation set, the evaluation set U is assigned a quantitative rating of 100, 80, 60, 40 and 20 on a percentage scale to form a quantitative evaluation set: $U = \{20, 40, 60, 80, 100\}$.

3.3 Constructing a Fuzzy Relationship Matrix

After constructing the hierarchical fuzzy subset, according to each factor u_i, p), that is, the membership degree of the object to be evaluated, quantify the object to be evaluated one by one evaluated to the rank fuzzy subset from a single factor $(R|u_i)$ is determined, which in turn yields the fuzzy relationship matrix, as follows:

$$R = \begin{bmatrix} R|u1 \\ R|u2 \\ \ldots \\ R|u_p \end{bmatrix} = \begin{bmatrix} r11 \; r12 \ldots r1m \\ r21 \; r22 \ldots r2m \\ \ldots \; \ldots \; \ldots \; \ldots \\ rp1 \; rp2 \ldots rpm \end{bmatrix}$$

where the element r_{ij} in row i and column j, represents the affiliation of a rated thing u_i to a fuzzy subset of V_j levels in terms of factors.

3.4 Determining the Weight Vectors of Evaluation Factors

In the fuzzy comprehensive evaluation, the weight vectors of the evaluation factors were determined: $W = \{a_1, a_2, \ldots, a_p\}$. In the pre-text section, the relative order of importance among the evaluation indicators was determined using hierarchical analysis, and the weight coefficients were determined and normalised by SPSS 26.00.

3.5 Analysis of the Fuzzy Integrated Evaluation Result Vector

In the comprehensive evaluation of this article, 30 experienced personnel rated the indicators based on the five evaluation levels set. The proportion of the 30 evaluation levels that agreed with the indicators was taken as the membership degree, and an evaluation matrix was constructed, as shown in Table 4.

Table 4. Index fuzzy membership evaluation table

Level 1 Indicator Affiliation	Serial number	Secondary indicators	Very good	Better	General	Poor	Very poor
R_{B1}	1	*B11*	0.2333	0.3	0.2333	0.1333	0.1
	2	*B12*	0.3333	0.2667	0.3333	0.0667	0
	3	*B13*	0.2	0.5333	0.1667	0.0667	0.0333
R_{B2}	4	*B21*	0.1333	0.2	0.4333	0.1667	0.1667
	5	*B22*	0.0667	0.2333	0.3667	0.1667	0.0333
R_{B3}	6	*B31*	0.2667	0.2333	0.4	0.0333	0.0667
	7	*B32*	0.4667	0.2667	0.2667	0	0
R_{B4}	8	*B41*	0.0333	0.1333	0.4667	0.2333	0.1333
	9	*B42*	0.1667	0.3333	0.4667	0.0333	0
R_{B5}	10	*B51*	0.2333	0.7	0.0333	0.0333	0
	11	*B52*	0.3333	0.4667	0.2	0	0
	12	*B53*	0.1333	0.1667	0.3	0.2667	0.1333
R_{B6}	13	*B61*	0.1	0.1	0.5333	0.2333	0.0333
	14	*B62*	0.0667	0.1	0.3667	0.3	0.1667
R_{B7}	15	*B71*	0.1	0.2333	0.4333	0.1667	0.0667
	16	*B72*	0.3333	0.4667	0.2	0	0
	17	*B73*	0.3	0.3333	0.2667	0.1	0

Combining the W and R of each evaluated object, the Fuzzy comprehensive evaluation vector B of each evaluated object is obtained from the Fuzzy operator *:

$$B = W * R = \left(a_1, a_2, \ldots, a_p\right)\begin{bmatrix} r11\ r12 \ldots r1m \\ r21\ r22 \ldots r2m \\ \ldots\ \ldots \ldots \ldots \\ rp1\ rp2 \ldots rpm \end{bmatrix} = (b_1, b_2, \ldots, b_m)$$

Here, B_i represents the correlation between an object being evaluated at the V_j level and a fuzzy subset.

The calculation process is as follows:

B1 evaluation vector:

$$B_1 = (0.1226, 0.3202, 0.5571)\begin{bmatrix} 0.2333 & 0.3 & 0.2333 & 0.1333 & 0.1 \\ 0.3333 & 0.2667 & 0.3333 & 0.0667 & 0 \\ 0.2 & 0.5333 & 0.1667 & 0.0667 & 0.0333 \end{bmatrix}$$

$$= (0.2467, 0.4193, 0.2282, 0.0748, 0.0308)$$

Similarly, it can be concluded that:

$$B_2 = (0.0889, 0.2222, 0.3889, 0.1667, 0.1334)$$

$$B_3 = (0.3238, 0.2429, 0.3619, 0.0238, 0.0476)$$

$$B_4 = (0.1333, 0.2833, 0.4667, 0.0833, 0.0333)$$

$$B_5 = (0.2123, 0.448, 0.1687, 0.1190, 0.0524)$$

$$B_6 = (0.0722, 0.1, 0.3945, 0.2889, 0.1444)$$

$$B_7 = (0.26365, 0.328919, 0.292372, 0.101632, 0.013427)$$

After calculation, a fuzzy membership degree table for the first level indicators was established, and an overall fuzzy comprehensive evaluation model was constructed. Please refer to Table 5 for details.

After constructing the overall model, the fuzzy integrated evaluation vector of each evaluated thing is continued to be obtained by the fuzzy operator* ie:

$$C = W \times R = (W_1, W_2, W_3, W_4, W_5, W_6, W_7)[C_{B1}, C_{B2}, C_{B3}, C_{B4}, C_{B5}, C_{B6}, C_{B7}]$$

The normalized eigenvector is

$$C = (0.210931, 0.315816, 0.29303, 0.121979, 0.058244)$$

Quantitative analysis of comprehensive evaluation results: From the final evaluation results of the above analysis, the fuzzy evaluation set and the comprehensive evaluation

Table 5. Fuzzy comprehensive evaluation model

Affiliation	Indicators	Very good	Better	General	Poor	Very poor
C_{B1}	*B1*	0.2468	0.4193	0.2282	0.7484	0.0308
C_{B2}	*B2*	0.0889	0.0222	0.3889	0.1667	0.1334
C_{B3}	*B3*	0.3238	0.2429	0.3619	0.0238	0.0476
C_{B4}	*B4*	0.1333	0.2833	0.4667	0.0833	0.0333
C_{B5}	*B5*	0.2123	0.4475	0.1687	0.1191	0.0524
C_{B6}	*B6*	0.0722	0.1	0.3945	0.2889	0.1444
C_{B7}	*B7*	0.2637	0.3289	0.2924	0.1016	0.0134

results of the first-level evaluation results can be calculated. The evaluation system is transformed from a qualitative analysis to a quantitative analysis and the overall rating value of user satisfaction and the rating value of the first level indicators are calculated based on the set of comments. $V = \begin{bmatrix} 100\ 80\ 60\ 40\ 20 \end{bmatrix}$.

The combined assessment value model for each level of indicator is

$$D_i = C_i \times V^{\tau}$$

Calculate the final score of the “Internet + Embedded” community care evaluation based on the above model

$$F = VC^T = \begin{bmatrix} 100\ 80\ 60\ 40\ 20 \end{bmatrix} \begin{bmatrix} 0.21093 \\ 0.31582 \\ 0.29303 \\ 0.12198 \\ 0.05824 \end{bmatrix} = 69.9842$$

Table 6. Comprehensive evaluation value and first level indicator evaluation value

Tier 1 indicator items	Overall score
B1	75.5278
B2	59.3333
B3	75.4285
B4	68.0000
B5	72.9621
B6	53.3334
B7	74.5546
Overall	69.9842

The overall rating is 69.9842, which is between average and good. From Table 6, we can see that "cultural activities", "adaptable services" and "space" are the keys to improving the development of "Internet + embedded" elderly services. The two indicators of functional services and emotional services both score below 80 points, and the overall rating is low, so there is still a need to optimize the community-based elderly care services as a whole.

4 Conclusion

This paper conducts research on users' needs, establishes an evaluation index system for user satisfaction, uses the fuzzy comprehensive evaluation method to make a comprehensive assessment and find out the crucial factors affecting the embedded community elderly services, hoping to add to the research system of embedded elderly services.

This paper puts forward two problems worthy of further discussion. On the one hand, there are few existing evaluation criteria, and it is necessary to add some evaluation criteria that can reflect the characteristics of the times, such as adding some new evaluation criteria to the old-age service; In addition, because there are great differences in pension policy, aging degree and population composition in different regions, we can further refine the objectives of the survey and carry out more surveys for specific regions in the future, and compare the comparison between regions; Through the analysis of the universality and particularity of the model, summed up its optimal solution, so as to promote the further development of the model.

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