

Exploring Weight Coefficient of Intelligent Home Care Service Quality Evaluation Index Based on G1 and Entropy Methods

Bo Yang Jianzhong Chou
Faculty of Business, City University of Macau, Avenida Padre Tomás Pereira Taipa, Macau 999078, China
E-mail: hao.hany@163.com

The research is financed by the China MOE Project of Humanities and Social Sciences (14YJC790020)

Abstract
As aging people is growing quickly in many countries, the fall problem is formed a curial public health and clinical problem among elderly persons. As an important pension model, the wisdom of the elderly at home in solving the pension problem has played a huge role. How to reasonably determine the weight of the evaluation indicators of the quality of home care services is a difficult problem in practice. Based on the SERVQUAL model, this paper develops five dimensions of reliability, ease of use, tangibility, responsiveness and empathy. First, the subjective weight of evaluation index is determined by G1 method. Secondly, the entropy weight method is used to determine the objective weight of the evaluation index. Finally, the subjective weight and the objective weight are reasonably integrated based on the ideal scheme method. This paper will help the follow-up research on the evaluation of the service quality of the intelligent home-aged care, with strong practical significance and theoretical value.
Keywords: Weight Coefficient; Evaluation Index; Intelligent Home Care; Care Service

1. Introduction

Many countries will be confronted with an overwhelming demand for elderly care, due to the steadily aging population(Costa et al,2012). The United States Census Bureau released the "aging world: 2015 report" that the global population continues to soar, and there will have 1.6 billion elderly people in the world by 2050 and more than 21% of the aging in 94 countries(Wan et al,2015). A potential solution to this difficulty is to encourage old people to use health care service that are integrated into their own homes through an intelligent high-tech. The wisdom of the old-age home is a more popular pension model; the elderly in their own homes can get high-quality old-age service. In the process of the promotion of intelligent home care, people pay more attention to the evaluation of service quality. However, there is not a scientific and reasonable method to evaluate the service quality of the intelligent home care service at current stage. A more critical question is that we can not be scientific and reasonable to determine the weight of each indicator. Based on it, this paper first develops the scale of intelligent home care service quality, using the G1 method and the entropy weight method to determine the subjective weight and objective weight of the evaluation index respectively, and adopt the ideal scheme method to fuse the subjective weight and the objective weight.Finally, the weight of the evaluation index is calculated.

2. The Evaluation Index of Intelligent Home Care Service Quality

In 1991 the United States released the MDS (Minimum Data Set) quality evaluation tools. Hirdes et al (1998) explored the use of MDS quality indicators in evaluating the quality of institutional care [1]. Zimmerman (2003) found that the quality of MDS was good, but the actual operation was difficult [2]. After years of practice, the United States has put forward the MDS2.0 on this basis, retaining only 24 representative evaluation indicators on 12 aspects of the quality of old-age service. Wu et al. (2009) found that the quality evaluation system of MDS was affected by the subjective factors of the respondents, and which will lead to unstable evaluation results [3]. In 2009, the United States put forward MDS3.0 version. On the basis of MDS2.0 it adding the elderly emotional, mental state and pain and other aspects of the content and paying attention to the elderly perception of service evaluation. Saliba et al. (2012a) pointed out that MDS2.0 does not pay attention to the elderly's own feelings about the service, which leads to the evaluation of service quality is not accurate [4]. Saliba et al. (2012b) also pointed out that the improvement of MDS3.0 is beneficial to the application of service quality evaluation system in reality [5]

The United Kingdom has always paid great attention to the evaluation of the quality of old-age services, the British Care Quality Committee (CQC)have twice inspections a year for the quality of care services, including advance notice of inspection and surprise checks. British Care Quality Committee will reveal the final test results to the public to help them keep abreast of the quality of old-age service, which to some extent, promoting the overall quality of care services in the UK. The evaluation of the quality of the old - age service Quality in the United Kingdom based on privacy, respect for dignity, independence, the right to choose, the right and satisfaction, and used of existing quality assessment tools to evaluating the service provider's staff conditions, service processes, quality of life of the elderly, and the views of older persons and other aspects of evaluation.

Japan takes the mechanism of self-evaluation, evaluation of elderly and third-party evaluation model to evaluating the quality of old-age service. Ikegami and Campbell (1995) pointed out that the quality of service in Japan is in the forefront of the world [6].

SERVQUAL model was proposed by Parasuraman, Valarie,and Zeitham--three marketers in the United States, which is the most widely used research methods in large number of service quality evaluation methods. When evaluating the enterprise's service quality by using SERVQUAL model, we can not only find out the gap in different enterprises according to the customer's evaluation of the overall service quality, but also find the reasons of the gap through perceived service and expected service of each different dimension. SERVQUAL model evaluates the service quality with five dimensions, which are reliability, tangibility, responsiveness, Ease of use and empathy. SERVQUAL model favored by many scholars(Shama et al,2016; Halvorsrud et al,2016; Hall et al,2015; Jaakkola et al,2015) , but some scholars questioned the model. Carman (1990) found that SERVQUAL model stability is well, but the SERVQUAL model should be different between different industries. Asubonteng, McCleary and Swan (1996) pointed out that the research on service quality should combine the qualitative and quantitative, while studying the quality of service structure should also explore the corresponding measurement methods and research to adjust SERVQUAL model in different industries.

By referring to the second chapter of the SERVQUAL scale, combined with the depth of consumer interviews, this study concluded that the wisdom of the 5 evaluation dimensions of home care service quality, a total of 24 items, as shown in table 1.After determining the initial item, we need to make a progress assessment on the surface validity and content validity of these items, and give the corresponding revision. The design of the questionnaire we used the Likert 5 scale. A total of 723 questionnaires were distributed in China, and 609 valid questionnaires were retrieved after screening. The effective recovery rate was 84.2%.This paper adopts and exploratory factor analysis of the scale of the reliability and validity of internal consistency reliability analysis, test results show that the dimensions of the wisdom of home-based care services quality is reasonable, all items through the validity test.

Table 1. Initial survey item

Dimension	code	Measurement item	Source
Tangibility （T）	T1	offers good food and beverage flavor	SERVQUAL scale Qualitative interview
	T2	Service personnel clothes clean and tidy	
	T3	Rescue workers advanced equipment	
	T4	Monitoring and monitoring equipment, advanced technology	
	T5	A complete leisure and entertainment facilities	
Reliability （RL）	RL1	Food and beverage nutrition with reasonable	SERVQUAL scale Qualitative interview
	RL2	Rehabilitation service personnel proficient in rehabilitation nursing skills	
	RL3	Service personnel have professional psychological counseling skills	
	RL4	Be able to monitor your health indicators, effective early warning health risks	
	RL5	One key to help improve the efficiency of the rescue, the rescue success rate	
	RL6	Children can get your personal data at any time, so that both sides feel at ease	
Responsiveness （RP）	RP1	for the appointment time services (for example, to provide clean room)	SERVQUAL scale Qualitative interview
	RP2	Service personnel can be the first time to respond to your request	
	RP3	For problems that can not be dealt with immediately, the service personnel can give the exact service time	
	RP4	When the service process errors, the service personnel can promptly remedy	
	RP5	To provide you with all weather service	
Empathy （E）	E1	will be in accordance with your physical condition and travel requirements customized travel plans	SERVQUAL scale Qualitative interview
	E2	In accordance with the pricing of taste, physical condition, economic situation with you	
	E3	According to your health status and needs, to develop rehabilitation programs to provide nursing services	
	E4	Will be in accordance with the characteristics of your personal needs to provide a specific service program	
Ease of use （EU）	EU1	intelligent pension system and the use of equipment and easy to learn	Qualitative interview
	EU2	The use of the service platform is easy to master	
	EU3	Operation of these devices will not make people feel a waste of time	
	EU4	Family members are able to skillfully use the intelligent pension system and equipment	

3. The weight calculation by using G1 method

3.1 The weight of the calculation criterion layer for the overall goal

The first step, the experts determined the order relation of the criterion layer according to the G1 method, sorting

the tangible (T), reliability (RL), timeliness (RP), empathy (E) and ease of use of the intelligent home care service (EU). The importance of these five dimensions is as follows:

Reliability (RL)> Timeliness (RP)> Empathy (E)> Usability (EU)> Tangible (T)

In order to facilitate the subsequent derivation, we assume that reliability (RL) is X1, timeliness (RP) is X2, empathy (E) is X3, ease of use (EU) is X4, tangibility (T) is X5, the importance dimension becomes:

$$X_1 > X_2 > X_3 > X_4 > X_5 \quad (1)$$

The second step, the expert gives the rational assignment of the ratio rk about the two adjacent dimensions between Xk-1 and Xk. Among them, the ratio of reliability X1 to timeliness X2 is r2, the ratio of timeliness X2 to empathy X3 is r3, the ratio of empathy X3 to ease of use X4 is r4, The ratio of the ease of use X4 to the tangible X5 importance is r5. The specific figure given by the expert is:

$$\begin{aligned} r_2 &= X_1/X_2 = 1.6 \\ r_3 &= X_2/X_3 = 1.2 \\ r_4 &= X_3/X_4 = 1.2 \\ r_5 &= X_4/X_5 = 1.4 \end{aligned} \quad (2)$$

The third step, after obtaining the rational assignment of experts' ratio of importance degree rk, the G1 weight ω_5 of the fifth criterion layer "tangibility (T)" to the total target layer is:

$$\begin{aligned} \omega_5 &= \left(1+\sum_{k=2}^{5}\prod_{i=k}^{5} r_i\right)^{-1} \\ &= \left(1+r_2\times r_3\times r_4\times r_5 + r_3\times r_4\times r_5 + r_4\times r_5 + r_5\right)^{-1} \\ &= \left(1+1.6\times 1.2\times 1.2\times 1.4 + 1.2\times 1.2\times 1.4 + 1.2\times 1.4 + 1.4\right)^{-1} \\ &= 0.107278 \end{aligned} \quad (3)$$

The fourth step, we have known ω_5 and we can derive the weight of the other four criteria layers, such as ease of use (EU), empathy (E), timeliness (RP) reliability (RL), ω_4, ω_3, ω_2, ω_1, and the formula is as follows:

$$\omega_{n-1} = r_n \times \omega_n,\ n = 5,4,3,2,1 \quad (4)$$

Specific calculation shows that:

$$\omega_4 = r_5 \times \omega_5 = 1.4\times 0.107278 = 0.150189 \quad (5)$$

$$\omega_3 = r_4 \times \omega_4 = 1.2\times 0.150189 = 0.180227 \quad (6)$$

$$\omega_2 = r_3 \times \omega_3 = 1.2\times 0.180227 = 0.216272 \quad (7)$$

$$\omega_1 = r_2 \times \omega_2 = 1.6\times 0.216272 = 0.346035 \quad (8)$$

In summary, the weight of tangibility (T) is 0.107278, the weight of reliability (RL) is 0.346035, the weight of timeliness (RP) is 0.216272, the weight of empathy (E) is 0.180227, EU) weight of 0.150189, as shown in Table 2:

Table 2. The weights of the criterion layer for the overall goal by the G1 method

Importance Ranking	Criterion Layer (dimension)	The importance ration	Weights ω
1	Reliability	—	0.107278
2	Responsiveness	1.6	0.346035
3	Empathy	1.2	0.216272
4	Ease of use	1.2	0.180227
5	Tangibility	1.4	0.150189

3.2 Calculate the weight of the indicator layer for the criterion layer

This paper also needs to calculate the weight of different items in the same dimension. Following the previous calculation, experts on the same dimension of the items are sorted, sorted after the adjacent two items given the importance of the ratio, and then calculate the specific weight of the item v.

According to the G1 method, the experts determined the order of importance among the five items under the tangible dimension, specifically:

$$T1 > T3 > T4 > T5 > T2 \quad (9)$$

Then, the experts give the importance of the adjacent two items between the ratio of r_k, specifically:

$$\begin{aligned} r_2 &= T1/T3 = 1.2 \\ r_3 &= T3/T4 = 1.2 \\ r_4 &= T4/T5 = 1.4 \\ r_5 &= T5/T2 = 1.4 \end{aligned} \quad (10)$$

Then, we can calculate the weight of the five items (index layer) for the dimension (criterion layer), we can calculate the weight of item T2, specifically:

$$\begin{aligned} \upsilon_5 &= \left(1+\sum_{k=2}^{5}\prod_{i=k}^{5} r_i\right)^{-1} \\ &= \left(1+r_2\times r_3\times r_4\times r_5 + r_3\times r_4\times r_5 + r_4\times r_5 + r_5\right)^{-1} \\ &= \left(1+1.2\times 1.2\times 1.4\times 1.4 + 1.2\times 1.4\times 1.4 + 1.4\times 1.4 + 1.4\right)^{-1} \\ &= 0.104883 \end{aligned} \quad (11)$$

Therefore, the weight of the item T5 is:

$$\upsilon_4 = r_5\times\upsilon_5 = 1.4\times 0.104883 = 0.146837 \quad (12)$$

The weight of item T4 is:

$$\upsilon_3 = r_4\times\upsilon_4 = 1.4\times 0.146837 = 0.205571 \quad (13)$$

The weight of item T3 is:

$$\upsilon_2 = r_3\times\upsilon_3 = 1.2\times 0.205571 = 0.246686 \quad (14)$$

The weight of item T1 is:

$$\upsilon_1 = r_2\times\upsilon_2 = 1.2\times 0.246686 = 0.296023 \quad (15)$$

To sum up, the weight of T1 is 0.296023, the weight of T2 is 0.104883, the weight of T3 is 0.246686, the weight of T4 is 0.205571, and the weight of T5 is 0.146837.

In the same way, we can get the weighted result of the index layer on the criterion layer, as shown in Table 3:

Table 3. The weight of the indicator layer under the G1 method

Criteria Layer (dimension)	Importance Ranking	Indicator Layer (Item)	The importance ratio r	Weight υ
Tangibility （T）	1	T1	—	0.296023
	2	T3	1.2	0.246686
	3	T4	1.2	0.205571
	4	T5	1.4	0.146837
	5	T2	1.4	0.104883
Reliability （RL）	1	RL4	—	0.284676
	2	RL5	1.2	0.237231
	3	RL6	1.6	0.148269
	4	RL2	1.0	0.148269
	5	RL1	1.4	0.105907
	6	RL3	1.4	0.075648
Responsiveness （RP）	1	RP2	—	0.357067
	2	RP1	1.2	0.297556
	3	RP4	1.4	0.212540
	4	RP3	1.6	0.132837
Empathy （E）	1	E3	—	0.432990
	2	E4	1.4	0.309278
	3	E2	1.2	0.257732
Ease of use （EU）	1	EU1	—	0.377407
	2	EU4	1.4	0.269576
	3	EU2	1.4	0.192555
	4	EU3	1.2	0.160462

3.3 Calculate the weight of the target layer to the total target layer

In order to facilitate the subsequent calculation, this article directly calculate the target layer on the target layer weight, the formula is as follows:

$$\rho_{ki} = \sum_{k=1}^{5}\sum_{i}^{6} \omega_k \times \upsilon_{ki} \qquad (16)$$

Where ω_k is the weight coefficient of the kth rule layer with respect to the total target, υ_{ki} is the weight coefficient of the i th index layer with respect to the criterion layer under the kth criterion layer, ρ_{ki} is the ith index of the kth criterion layer The weighting factor of the layer relative to the total target.

After calculation, we can calculate the target layer of the overall target weight coefficient, as shown in Table 4:

Table 4. The weighting results based on the G1 method

Serial number	Criterion layer weight		Indicator layer weight		The final weight ρ
	Criteria Layer(dimension)	Weight ω	Indicator Layer (Item)	Weight υ	
1	Tangibility （T）	0.107278	T1	0.296023	0.031757
2			T2	0.246686	0.026464
3			T3	0.205571	0.022053
4			T4	0.146837	0.015752
5			T5	0.104883	0.011252
6	Reliability （RL）	0.346035	RL1	0.284676	0.098508
7			RL2	0.237231	0.082090
8			RL3	0.148269	0.051306
9			RL4	0.148269	0.051306
10			RL5	0.105907	0.036648
11			RL6	0.075648	0.026177
12	Responsiveness （RP）	0.216272	RP1	0.357067	0.077224
13			RP2	0.297556	0.064353
14			RP3	0.212540	0.045966
15			RP4	0.132837	0.028729
16	Empathy （E）	0.180227	E2	0.432990	0.078036
17			E3	0.309278	0.055740
18			E4	0.257732	0.046450
19	Ease of use （EU）	0.150189	EU1	0.377407	0.056682
20			EU2	0.269576	0.040487
21			EU3	0.192555	0.028920
22			EU4	0.160462	0.024100

4. Entropy Method of the weight calculation

4.1 Calculate the weight of the criteria layer for the overall goal

According to the idea of weighting by entropy weight method, the concrete steps of weight calculation in this paper are as follows:

The first step is to calculate the membership ratio of the jth criterion layer of the i-th surveyee. The specific formula is as follows:

$$f_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}} \qquad (17)$$

Where xij is the score of the i-th surveyor's importance to the jth rule layer; $i = 1, 2, ..., m$； $j = 1, 2, ..., n$

In the second step, entropy criterion to define the j-th value layer EW_{ij}:

$$EW_j = -k\left[\sum_{j=1}^{n} f_{ij} \ln\left(f_{ij}\right)\right] \qquad (18)$$

Where EWij is the entropy of the jth rule layer; $k = 1/\ln m$； $i = 1, 2, ..., m$； $j = 1, 2, ..., n$

In the third step, we define the entropy weight of the jth rule layer γ_j. The concrete formula is as follows:

$$\gamma_j = \frac{1 - EW_j}{n - \sum_{j=1}^{n} EW_j} \quad (19)$$

At the same time must be met. $\sum_{j=1}^{n} EW_j = 1$ (20)

In the fourth step, based on the entropy method, the entropy weight of the five dimensions is calculated by using the first-hand data obtained by the research. It is found that the weights of tangibility (T) are 0.091740, the weight of reliability (RL) is 0.452246, the weight of timeliness (RP) is 0.191026, the weight of empathy (E) is 0.147510, the ease of use) Is 0.117479. Specifically, as shown in Table 5:

Table 5. The weights of the criterion layer for the total objective under the entropy weight method

Criteria Layer (dimension)	Weight γ	Importance Ranking
Tangibility（T）	0.091740	5
Reliability（RL）	0.452246	1
Responsiveness（RP）	0.147510	3
Empathy（E）	0.191026	2
Ease of use（EU）	0.117479	4

4.2 Calculate the weights of the target layer for the target layer

In the same way, according to the entropy weight method, this paper calculates the weights of the items in five dimensions in a single dimension. As the calculation process is more complex, limited space, the text does not list the calculation process, the specific calculation results in Table 6.

Table 6. Weight of the indicator layer under the entropy weight method

Serial number	Criteria layer	Indicator level	Weight γ
1	Tangibility（T）	T1	0.192763
2		T2	0.165818
3		T3	0.249672
4		T4	0.229305
5		T5	0.172442
6	Reliability（RL）	RL1	0.163816
7		RL2	0.140337
8		RL3	0.136884
9		RL4	0.141227
10		RL5	0.179898
11		RL6	0.237838
12	Responsiveness（RP）	RP1	0.301445
13		RP2	0.271750
14		RP3	0.222402
15		RP4	0.204403
16	Empathy（E）	E2	0.295384
17		E3	0.345735
18		E4	0.358881
19	Ease of use（EU）	EU1	0.278427
20		EU2	0.227889
21		EU3	0.199407
22		EU4	0.294277

4.3 Calculate the weight of the target layer for the overall target layer

In the same way, we calculate the weight of the target layer to the target layer, the formula is as follows:

$$\delta_{ki} = \sum_{k=1}^{5} \sum_{i}^{6} \gamma_k \times \xi_{ki} \quad (21)$$

Where δ_{ki} is the weight coefficient of the ith item in the kth criterion layer for the total target, γ_k is the weight coefficient of the kth rule layer relative to the total target, and ξ_{ki} is the i-th index layer in the kth criterion layer Compared with the weight coefficient of the criterion layer, we can calculate the final weight coefficient of the target layer based on the entropy weight method, as shown in Table 7:

Table 7. Weighted results based on entropy weight method

Serial number	Criteria layer	Weight γ	Indicator level	Weight ξ	Final weightδ
1	Tangibility （T）	0.091740	T1	0.192763	0.017684
2			T2	0.165818	0.015212
3			T3	0.249672	0.022905
4			T4	0.229305	0.021036
5			T5	0.172442	0.01582
6	Reliability （RL）	0.452246	RL1	0.163816	0.074085
7			RL2	0.140337	0.063467
8			RL3	0.136884	0.061905
9			RL4	0.141227	0.063869
10			RL5	0.179898	0.081358
11			RL6	0.237838	0.107561
12	Responsiveness （RP）	0.147510	RP1	0.301445	0.044466
13			RP2	0.271750	0.040086
14			RP3	0.222402	0.032806
15			RP4	0.204403	0.030151
16	Empathy （E）	0.191026	E2	0.295384	0.056426
17			E3	0.345735	0.066044
18			E4	0.358881	0.068556
19	Ease of use （EU）	0.117479	EU1	0.278427	0.032709
20			EU2	0.227889	0.026772
21			EU3	0.199407	0.023426
22			EU4	0.294277	0.034571

5. Combinatorial Weight Calculation Based on Ideal

In this paper, we use the G1 method and the entropy weight method to compute the subjective weight and the objective weight respectively. This section mainly calculates the proportion of subjective and objective weights.

$$\mu_j = \alpha \times \rho_j + \beta \times \delta_j \quad (22)$$

Where μ_j is the combined weight of the jth index, ρ_j is the subjective weight, δ_j is the objective weight, α and β is the subjective weight coefficient and the objective weight coefficient, respectively.

In the case of a similar problem in this paper, the traditional study of the two methods to give a 0.5: 0.5. This method does not take into account the actual differences between the data, a simple determination of subjective and objective weight is equal to empowerment. Changes in objective data will result in changes in weight, only a comprehensive consideration of the status of objective data method is more reasonable. Based on this, this paper intends to use the ideal method to calculate the main and objective weight. The basic steps are as follows:

The first step is to build the ideal solution.

$$P^* = \left\{ \max x_{ij} \middle| i = 1, 2, ..., m \right\} = \left\{ x_1^*, x_1^*, ..., x_n^* \right\} \quad (23)$$

Among them, P^* the ideal scheme matrix; x_j^* ideal data for the program

In the second step, we calculate the weighted distance between the realistic scheme and the ideal scheme.

$$d_i = \sum_{j=1}^{n} \left| x_{ij} - x_j^* \right| \mu_j \quad (24)$$

Where, d_i is the distance between the realistic scheme and the ideal scheme. When $d_i = 0$, the realistic scheme is regarded as the ideal scheme.

The third step is to build a linear programming model.

$$\begin{cases} \min\ d=\sum_{i=1}^{m} d_i=\sum_{i=1}^{m}\sum_{j=1}^{m}\left|x_{ij}-x_j^*\right|\mu_j=\sum_{i=1}^{m}\sum_{j=1}^{m}\left|x_{ij}-x_j^*\right|\left(\alpha\times\rho_j+\beta\times\delta_j\right) \\ s.t.\ \ \frac{1}{\alpha}+\frac{1}{\beta}=1 \qquad\qquad \alpha,\beta>1 \end{cases} \tag{25}$$

In the fourth step, the optimal solution of the Lagrange function is used to obtain the unique solution of the sum of α and β .

$$L=\sum_{i=1}^{m}\sum_{j=1}^{m}\left|x_{ij}-x_j^*\right|\left(\alpha\times\rho_j+\beta\times\delta_j\right)+\lambda\left(\frac{1}{\alpha}+\frac{1}{\beta}-1\right) \tag{26}$$

Order, $\frac{\partial L}{\partial\alpha}=0$, $\frac{\partial L}{\partial\beta}=0$, obtain α and β :

$$\alpha=\left(\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}+\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}\right)\Bigg/\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j} \tag{27}$$

$$\beta=\left(\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}+\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}\right)\Bigg/\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j} \tag{28}$$

The fifth step, normalized processing. Because of $\sum_{j=1}^{n}\mu_j=1$, it is necessary to normalize the sum of α and β .

$$\alpha^*=\frac{\alpha}{\alpha+\beta} \tag{29}$$

$$\beta^*=\frac{\beta}{\alpha+\beta} \tag{30}$$

And can be derived α^* and β^* , the specific formula is as follows:

$$\alpha^*=\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}\Bigg/\left(\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}+\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}\right) \tag{31}$$

$$\beta^*=\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}\Bigg/\left(\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}+\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}\right) \tag{32}$$

Since the indexes in this paper all lie between [1, 5], the ideal scheme in this paper has a maximum of 5.

$$\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\delta_j}=\sqrt{\left|x_{1,1}-5\right|\times0.031757+\left|x_{1,2}-5\right|\times0.026464+\ldots+\left|x_{609,22}-5\right|\times0.024100} \tag{33}$$

$$\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|x_{ij}-x_j^*\right|\rho_j}=\sqrt{\left|x_{1,1}-5\right|\times0.017684+\left|x_{1,2}-5\right|\times0.015212+\ldots+\left|x_{609,22}-5\right|\times0.034571} \tag{34}$$

Furthermore, the optimal subjective weight coefficient α^* and the optimal objective weight coefficient β^* are calculated:

$$\alpha^*=0.510917 \tag{35}$$

$$\beta^*=0.489083 \tag{36}$$

It can be seen that the formula for calculating the combined weight is:

$$\mu_j = 0.510917 \times \rho_j + 0.489083 \times \delta_j \quad (37)$$

After finishing, we will be based on the ideal combination of weights calculated, and are listed in Table 8.

Table 8. The results based on the weight of the ideal combination

Serial number	Criteria layer	Indicator level	G1 method Subjective Weight ρ	Entropy weight method Objective weightδ	Combined weight μ
1	Tangibility （T）	T1	0.031757	0.017684	0.024874
2		T2	0.026464	0.015212	0.020961
3		T3	0.022053	0.022905	0.022470
4		T4	0.015752	0.021036	0.018336
5		T5	0.011252	0.01582	0.013486
6	Reliability （RL）	RL1	0.098508	0.074085	0.086563
7		RL2	0.082090	0.063467	0.072982
8		RL3	0.051306	0.061905	0.056490
9		RL4	0.051306	0.063869	0.057450
10		RL5	0.036648	0.081358	0.058515
11		RL6	0.026177	0.107561	0.065981
12	Responsiveness （RP）	RP1	0.077224	0.044466	0.061203
13		RP2	0.064353	0.040086	0.052484
14		RP3	0.045966	0.032806	0.039530
15		RP4	0.028729	0.030151	0.029424
16	Empathy （E）	E2	0.078036	0.056426	0.067467
17		E3	0.055740	0.066044	0.060780
18		E4	0.046450	0.068556	0.057262
19	Ease of use （EU）	EU1	0.056682	0.032709	0.044957
20		EU2	0.040487	0.026772	0.033779
21		EU3	0.028920	0.023426	0.026233
22		EU4	0.024100	0.034571	0.029221

6. Conclusion

Reasonable calculation of index weight is an important prerequisite for evaluating service quality. This paper based on the five dimensions of reliability, ease of use, tangibility, responsiveness and empathy, and developed the scale of intelligent home care service quality. The data on the importance of evaluation indicators were collected from 609 Chinese aged people who had been tested with the intelligent home care service. The subjective weight of evaluation index was determined by G1 method. The objective weight of the evaluation index is determined by the entropy weight method. Finally, the weight of the index is calculated based on the comprehensive weighting of subjective weight and objective weight. And the specific weight of the index is calculated. The contribution of this paper lies in the comprehensive use of subjective empowerment and objective empowerment; it calculated the weight of the evaluation index of intellectual home care service quality reasonably, which has important theoretical value and practical significance for the follow-up study. This paper has important implications for future research. The future research can continue to focus on the evaluation of the quality of service at home, analyze the difference of service quality among different countries, point out the importance of hi-tech in home care service, and try to find out the future direction of home care.

References

Asubonteng P, Mccleary K J, Swan J E. (1996). SERVQUAL Revisited:A Critical Review of Service Quality. *Journal of Services Marketing*, 10(6):62-81.

Carman J M. (1990).Consumer Perceptions of Service Quality: An Assessment of the SERVQUAL Dimensions. *Journal of Retailing*, 66(1):33-55.

Costa Â, Castillo J C, Novais P.(2012).Sensor-driven Agenda for Intelligent Home Care of the Elderly. *Expert Systems with Applications*, 39(15): 12192-12204.

Hall Z R, Ahearne M, Sujan H. (2015). The Importance of Starting Right: The Influence of Accurate Intuition on Performance in Salesperson-Customer Interactions. *Journal of Marketing*, 79(3): 91-109.

Halvorsrud R, Kvale K, Følstad A. (2016). Improving Service Quality Through Customer Journey Analysis. *Journal of Service Theory and Practice*, 26(6):1-36.

Hirdes JP, Zimmerman D, Hallman KG.(1998).Saucier PS: Use of MDS Quality Indicators to Assess Quality of Care in Institutional Settings. *Canadian Journal of Quality in Health Care*, 14 (2): 5-11

Ikegami N, Campbell J C.(1995).Medical care in Japan. *New England Journal of Medicine*, 333(19): 1295-1299.

Jaakkola E, Helkkula A, Aarikka-Stenroos L. (2015). Service Experience Co-creation: Conceptualization, Implications, and Future Research Directions. *Journal of Service Management*, 26(2): 182-205.

Saliba D, Buchanan J. (2012).Making the investment count: Revision of the Minimum Data Set for Nursing Homes MDS 3.0. *Journal of the American Medical Directors Association*, 13(7): 602-610.

Saliba D, Jones M, Streim J, et al.(2012). Overview of Significant Changes in the Minimum Data Set for Nursing Homes Version 3.0. *Journal of the American Medical Directors Association*, 13(7): 595-601.

Sharma P, Kong T T C, Kingshott R P J. (2016). Internal Service Quality as a Driver of Employee Satisfaction, Commitment and Performance–exploring the Focal Role of Employee Well-being. *Journal of Service Management*, 27(5):773-797.

Wan H, Daniel G, Kowal P.(2016) An Aging World:2015.www.census.gov.

Wu N, Mor V, Roy J.(2009). Resident, Nursing Home, and State Factors Affecting the Reliability of the Minimum Data Set Quality Measures. *American Journal of Medical Quality*, 24: 229-240.

Zimmerman D R.(2003). Improving Nursing Home Quality of Care through Outcomes Data: The MDS Quality Indicators. *International Journal of Geriatric Psychiatry*, 18 (3): 250-257.