Identification and Evaluation of Factors Influencing the Quality of Elderly Services Supply Chain Based on DEMATEL-ISM-TOPSIS Method

Jingshi He, Dongguan Polytechnic, China*

ABSTRACT

With the intensification of aging, the importance of the elderly care service supply chain is gradually being recognized by people. A systematic analysis of the quality of elderly care services from the perspective of the supply chain will help provide decision-making reference for improving the quality of elderly care services. The evaluation index system of elderly care services’ quality is constructed from the perspective of the integrated SCOR model. The integrated DEMATEL-ISM-TOPSIS method is proposed for evaluation and analysis. The research pointed out the surface and deep influencing factors as well as the weight of each evaluation factor of the elderly care services’ quality. The interpretative structure model was constructed to point out the hierarchical relationship and the principal-subordinate logical relationship of each evaluation factor. The weight of the quality factors of elderly care services was obtained, and the applicability of the model and method was verified by an evaluation case of elderly service institutions.

KEYWORDS

DEMATEL, Factors of Elderly Care Services, Integrated SCOR Model, ISM, Quality of Elderly Care Services, Supply Chain of Elderly Care Services, TOPSIS

1. INTRODUCTION

With the continuous increase of the global elderly population, elderly care services have increasingly become the focus of social attention, and this trend will be more obvious in the next few decades. The aging of China’s population is accelerating. At the end of 2020, the number of people over 60 in China was 264.02 million, accounting for about 18.7% of the total population, which is about 10.14 million more than that at the end of 2019. In 2020, The number of people over 60 in China was 168 million, accounting for 23.24% of the world. The housekeeping services for the elderly, the medical rehabilitation for the elderly, the machinery supplies for the elderly, the daily necessities for the elderly, the cultural and spiritual comfort for the elderly, the finance and real estate for the elderly and other related industry systems, are becoming more and more perfect to meet the living and consumption needs of the huge group of elderly people, which has become a new growth point of China’s regional economy (An et al., 2019). The elderly care service industry includes various institutions, such as elderly care institutions, suppliers of upstream and downstream, and elderly care service providers. The elderly care service industry has formed a service chain with a clear structure
and an explicit subject (Zhao, 2021; Gao & Zhou, 2020). The current development of enterprises is inseparable from the competition and cooperation of upstream and downstream enterprises. The production and operation, service implementation, procurement and after-sales of any elderly care service organization are all in the ecological chain and supply chain network structure of elderly care services. The supply chain that integrates elderly care service resources can effectively achieve resource complementarity, efficiently improve service satisfaction, and greatly weaken the bullwhip effect in the elderly care service supply chain (Gao & Zhou, 2020). Community-based elderly care services, institutional elderly care services, and home-based elderly care services are the three most important elderly care service models in China. However, no matter which elderly care service model it is, it is inseparable from the cooperation between upstream and downstream enterprises in the supply chain. The service quality of elderly care service providers and upstream and downstream enterprises will affect the service experience and satisfaction of customers. Supply chain innovation has become all the more important in today’s competitive world (Mandal, 2016), and from the perspective of supply chain, the elderly care service industry should pay attention to the construction of upstream and downstream partner network. Understanding and researching the elderly care industry based on the SCOR model of the supply chain is the inevitable development trend of competition and cooperation in the ecological chain and industry chain of elderly care services under the current complex ecosystem. In terms of the quality of elderly care services, not only should the basic service quality of elderly care service providers be paid attention to, but also the service quality needs to be examined from the perspective of the supply chain system, and the factors affecting service quality need to be analyzed and studied, so as to provide reference for improving the overall efficiency and service satisfaction of the supply chain.

The quality of elderly care services has gradually attracted the attention of scholars. The existing literature has carried out research on the quality of elderly care services from many aspects, including focusing on the quality of nursing homes from the perspectives of medical quality (Chang, 2006; Fahey et al., 2003; Heras et al., 2008; Lee et al., 2018; Naylor et al., 2016), public service (Leung & Qi, 2019; Supromin & Choonhakhlai, 2017; Yu et al., 2017; Zhang et al., 2019), the satisfaction with the service quality of nursing homes (Chao et al., 2016; Kazemi & Kajonius, 2020; Stolt et al., 2010; Zhang et al., 2016), as well as the auxiliary equipment and solutions for elderly care services (Reijula et al., 2010; Siegel et al., 2014; Xu & Zhang, 2021). However, there is a lack of analysis from the perspective of supply chain systems, and no attention is paid to the impact of the upstream and downstream of the elderly care service chain on the quality of elderly care services. Regarding the quality of elderly care services, research and practice need to be carried out from an innovative perspective. Therefore, this study intends to construct an evaluation index for the quality of elderly care services from the perspective of the supply chain, which is conducive to the systematic analysis of the influencing factors of service quality, so as to provide guidance for industrial and corporate decision-making. In terms of research methods, this research proposes a new method, integrated DEMATEL-ISM-TOPSIS method, which combines the main advantages of the three methods, namely, DEMATEL (Decision Making Trial and Evaluation Laboratory), ISM (Interpretative Structural Modeling), and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), simplifies the calculation process. The integrated DEMATEL-ISM-TOPSIS method proposed in this research is a hybrid and diversified decision-making evaluation method, and is an innovative research methodology.

To sum up, the basic framework of this paper is as follows: Firstly, the influencing factors and evaluation indicators of the quality of elderly care services will be put forward based on the supply chain model. Secondly, the attributes of the influencing factors of the quality of elderly care services will be analyzed through the DEMATEL-ISM-TOPSIS model, and a multi-level interpretive structure model will be constructed. Finally, the paper evaluates the supply chain service quality of elderly care service institutions, and puts forward targeted measures to provide decision-making basis for the upstream and downstream enterprises of elderly care services to improve service quality.
2. LITERATURE REVIEW

2.1 Literature Review of Elderly Care Services Based on the Supply Chain

With the increase of the elderly population and the expansion of the elderly care industry, the quality of elderly care services has gradually attracted scholars’ attention. Service quality refers to meeting the needs and expectations of service target customers, and quality is suitability for the purpose (Ajmal, et al., 2016). The complexity of the services provided by nursing homes and the difficulty in defining practical standards have brought special problems to the quality management system and processes, which involve the supervision of departments of nursing homes. There is no authoritative standard for how to evaluate the quality of elderly care services. The quality management system and model must be linked to the institutions that provide home care services, and linked to the quality of medical services provided to residents, and the life quality of all related personnel (Heras et al., 2008). Regarding the quality of elderly care services, research and practice need to be carried out from an innovative perspective. Innovativeness, service quality, and information quality affect patients’ satisfaction with nursing services (Al-Hasson & Abu-Shanab, 2021). Djellal and Gallouj (2006) proposed to provide innovative services for the elderly, such as deployed (tangible and intangible) technological innovation, institutional environment innovation. Choy et al. (2018) developed a intelligent knowledge management system to identify service standards, so to improve the service quality and performance of nursing homes. Kazemi & Kajonius (2020) proposed a new perspective of social resource theory to understand the quality of elderly care.

The supply chain theory was first applied in the industrial field. Later, scholars put forward the service supply chain theory, such as the logistics service supply chain (Liu et al., 2018), the medical service supply chain (Hares et al., 2021), and the tourism service supply chain (Huang, 2018). Using the supply chain theory to analyze the elderly care service industry is an emerging research field, and the research on this aspect is very scattered and scarce. For example, the SCOR model was introduced to evaluate the reverse logistics of household goods (Putthinoi et al., 2015), and the channel coordination problem of the two-level elderly care service supply chain composed of an elderly service integrator and a service provider (Zhao, 2021). There are also researches on the resource coordination mechanism of the cluster community elderly care service system (Gao & Zhou, 2020), and the performance indicators of the sustainability of the retirement service supply chain (Mezouar & Afia, 2018). Kazemi and Elfstrand Corlin (2021) proposed a service profit chain to analyze nursing services.

Some literature focuses on the service quality of elderly care service institutions or nursing homes from the perspective of medical quality. Some scholars pointed out that the first two aspects of the service quality of nursing homes that need to be improved are the speed of dealing with emergencies and the recruitment of professional medical personnel (Chang, 2006). The elderly living in nursing homes get worse quality due to inadequate monitoring of chronic diseases (Fahey et al., 2003). The quality of nursing homes for the elderly are affected by internal rules and regulations, residents’ complaint procedures, forms for suggestions and complaints (Heras et al., 2008), and affected by depression symptoms, physical function, emotional well-being and so on (Naylor et al., 2016). The evaluation criteria of medical quality for the elderly care service institutions include communication and service, care process, space planning, and traffic flow design (Lee et al., 2018).

Some studies have also analyzed the impact of quality factors of elderly care services on the life quality of the elderly from the perspective of public services, such as the hygiene and distance of the public area (Leung & Qi, 2019), and the room distance, the space of nursing homes, the barrier-free design, the indoor environment, daily nursing services, cleaning services, and medical care services (Yu et al., 2017). The health of the elderly is also susceptible to various factors affecting the quality of life, such as neighborhood housing, entertainment density, park quality, and public open space (Zhang et al., 2019), and affected by the municipal government’s decision-makers, national policies, partnership and network of stakeholders, etc (Supromin & Choonhakhhlai, 2017).
Regarding the service quality satisfaction of elderly care service institutions or nursing homes, some scholars pointed out that nursing staff with higher job satisfaction in nursing homes in a high-ethical atmosphere can provide better services (Chao et al., 2016). The service quality of elderly care is usually described in terms of human-centered care, and the autonomy of the elderly must be brought into play to improve the satisfaction of service quality (Kazemi & Kajonius, 2015). There are physical differences, economic differences and regional differences in the service content, service scope and service quality of community elderly services (Zhang et al., 2016). Researcher pointed out that private care providers in elderly care pay more attention to services and do better than the public care (Stolt et al., 2010). In addition, some scholars believe that assistive devices and solutions for elderly care services will have a positive impact on the quality of elderly care services (Reijula et al., 2010; Siegel et al., 2014), and more elderly people can enjoy high-quality and comprehensive services (Xu & Zhang, 2021).

The literature summary found that the elderly care service has been paid more and more attention. However, there are few researches on the application of the service supply chain theory to analyze the elderly care service, and there is no relevant literature on the analysis of the quality factors of elderly care services from the perspective of the supply chain. Therefore, analyzing the quality factors of the elderly care services from the perspective of the supply chain is a new perspective and innovation.

2.2 Literature of Integrated DEMATEL-ISM-TOPSIS

With regard to the model and method, this paper intends to construct the evaluation index of the quality factors of the elderly care services from the perspective of the supply chain, and proposes an integrated DEMATEL-ISM-TOPSIS method to analyze and evaluate the attributes of the factors of the emergency capability of the elderly care service supply chain.

The DEMATEL method uses graph theory and matrix relationships to analyze the causality relationship between various factors of the decision matrix. This method is used to screen the main elements of complex problems and simplify the process of system structure analysis. DEMATEL can be used to calculate the influence degree and the degree of being influenced among the factors of the decision-making evaluation matrix (Yazdi et al., 2020; Kilic & Yalcin, 2020), so as to obtain the relationship degree between various indicators of the decision-making evaluation matrix by calculating the centrality degree and the causality degree. By sorting the centrality factors and causality factors of the emergency capability of elderly care service supply chain, the importance of each factor of the quality of elderly care services can be obtained. The ISM method can decompose the complex and disordered relationship among these factors in the decision matrix system into a clear multi-level hierarchical structure. However, DEMATEL and ISM also have shortcomings that cannot be ignored. The DEMATEL method can’t reveal the inner logical structure within each factor. The relationship between the factors of decision matrix stratified by the ISM method in the same level has no primary or secondary relationship. Researchers use the integrated DEMATEL-ISM for analysis factor evaluation, which can avoid the shortcomings of the two methods. The integrated DEMATEL-ISM method is used to analyze the factors of decision-making unit in multiple fields, such as using the DEMATEL-ISM method to analyze the obstacles to the sustainable transportation in Indian inland waterways (Trivedi et al., 2021), the research on the factors affecting the safety of coal mine production (Wang et al., 2018), the obstacles to the implementation of e-waste management practices (Kumar & Dixit, 2018) and the causes of accidents in the gas pipeline network (Li et al., 2019).

In the existing literature, the integrated DEMATEL-ISM method is adopted to carry out decision analysis, but this method is often applied to factor analysis and the evaluation of various factors of decision-making units, and can’t evaluate and rank multiple decision-making units. TOPSIS is a method of ranking according to the proximity between the evaluation objects and the idealized objectives, evaluating the relative advantages and disadvantages among the existing objects. Based on the DEMATEL-ISM method, the TOPSIS method is used to obtain the approximate ideal solution
of each evaluation factor, so as to calculate the weight of each evaluation factor and the total score of decision-making unit (DMU), which simplifies the calculation process.

Based on the DEMATEL-ISM method in the previous study, an integrated DEMATEL-ISM-TOPSIS method was proposed. The integrated DEMATEL-ISM-TOPSIS is a hybrid and diversified decision-making evaluation method which integrates the advantages of DEMATEL, ISM and TOPSIS and simplifies the calculation process. The DEMATEL-ISM-TOPSIS method is used to get the score of the causality degree and the centrality degree of each indicator, so as to sort them. Moreover, the hierarchical structural relationship of each indicator can be obtained, and finally the total score of the evaluation decision-making unit can be acquired. This research intends to analyze and rank the quality factors of elderly care services. By the integrated DEMATEL-ISM-TOPSIS method, not only can the index ranking of the service quality factors be obtained, but also the structural hierarchical relationship and the master-slave logical relationship of each elderly care service quality factor can be clarified, and the total score of the evaluation unit of the elderly care service organization can be finally obtained. The integrated DEMATEL-ISM-TOPSIS method proposed in this research is a hybrid and diversified decision-making evaluation method, which is conducive to the element analysis and decision-making evaluation of complex decision-making evaluation systems. It is an innovative research methodology.

3. THE QUALITY FACTORS OF ELDERLY CARE SERVICES FROM THE PERSPECTIVE OF INTEGRATED SUPPLY CHAIN

The Supply Chain Operations Reference (SCOR) model is a concept of managing the advanced business operation technology brought up by the Supply Chain Council (SCC) to improve the competitiveness and cooperation between upstream and downstream trading partners. The SCOR covers activities from demand confirmation to product delivery, such as plan, purchase, production, delivery, and sales return (Stewart, 1997), and it is further subdivided into process categories, elements, tasks and activities (Ntabe et al., 2015; Cao et al., 2018). As the traditional SCOR does not include sales, design, product development, etc., it can't fully describe the business framework components, so the SCC later proposed the Design Chain Operation Reference (DCOR) model and the Customer Chain Operation Reference (CCOR) model. DCOR spans activities between customer demand and product design or specifications to meet customer demand, and CCOR covers activities related to establishing and maintaining customer relationships, identifying customer needs, and product support. The integrated business framework model composed by DCOR, CCOR and SCOR extends the connotation of the traditional SCOR model. It can be more widely used in various service industries rather than being limited to traditional industrial fields. Thus, it can be called the integrated SCOR model.

In the elderly care services supply chain, the elderly are the end-consumers. Community-based elderly care service institutions and third-party elderly care organizations are the SIs of the supply chain. They are the core of the supply chain and are responsible for the integration and matching of demand to resources. The upstream of the elderly care services supply chain includes housekeeping, life care, spiritual comfort, medical care, and cultural and entertainment SPs. In the process of elderly supply chain operation, there are a series of activities, such as service planning, demand tracking, service feedback, information flow, logistics, and capital flow, all of which are set to achieve the goal of caring for the elderly. At present, there is no authoritative definition on the operation model of the service supply chain. This research summarizes the characteristics of the elderly care services. The operation model of the elderly care service supply chain is integrated into planning, design, supply, implementation, customer service and the support system.

Design: The design in the supply chain of elderly care services aims to meet the needs of customers, putting forward ideas and service plans so as to improve the service experience. The
integrated SCOR design includes functions such as “design”, “R&D” and “integration”. The design quality of elderly care services should focus on new services, new models, and workflow design.

Planning: The planning in the elderly care service supply chain analyzes the internal and external resources and service capabilities of the elderly care service company, and predicts, arranges and dispatches the service to meet the service demand. The quality of the elderly care service planning should focus on the completion rate of the plan, the accuracy of the plan, and the degree of informatization of the plan, etc.

Supply: The supply activities in the elderly care service supply chain are the organizational activities for establishing and maintaining purchasing relationships with the upstream companies of elderly care services so as to meet service needs. These upstream companies may include service integrators, and providers of medical services, psychological counseling, facilities and equipment, etc. The quality of elderly care service supply should focus on factors such as the outsourcing satisfaction rate, integrator capabilities and evaluation, resource utilization and evaluation.

Implementation: The implementation in the elderly care service supply chain includes the “production”, “delivery” and “contract” referred to in the traditional supply chain. The delivery of industrial products is realized through distribution and logistics, and the delivery in the elderly care service supply chain is the process of implementing services to the service objects. The implementation of elderly care services includes basic functional services such as medical services, psychological counseling, and daily living care services.

Customer-Service: Elderly care service is an intangible product characterized by service being produced and consumed simultaneously, so the service can not be returned in the service process. The facilities and equipment in the elderly care service process involve returns and repairs. Therefore, the “return” and “assistance” functions in the traditional supply chain model of customer service in the elderly care service supply chain model should pay attention to service feedback and tracking, service exception and complaint handling, supervision and evaluation, etc.

Support system: In order to support the five processes of elderly care services, namely, planning, design, supply, implementation, and customer service, the elderly care service supply chain should also include a supply chain support system. The support system should focus on the performance management implementation and evaluation, facilities and equipment management, knowledge and information management, etc.

Based on the SCOR’s configuration model of the elder care service supply chain, this research intends to establish an elderly care service quality evaluation index system from design, planning, supply, implementation, customer service and the support system. After the initial questionnaire design was completed, the research team surveyed a total of 78 respondents from 11 elderly care service organizations located in Guangzhou, Shenzhen and Dongguan. Among the respondents, there are managers and staff from elderly care institutions, equipment suppliers of elderly care institutions, service providers of elderly care institutions, senior government management departments, scholars and family members of the elderly in the elderly care institutions. After discussion, the survey team deleted some indicators that the interviewees did not understand clearly and those that were difficult for them to score, and finally retained 20 evaluation indicators as shown in Table 1.

4. METHODS

In the existing literature, the integrated DEMATEL-ISM method is adopted for decision analysis, but this method is often applied to factor analysis and the evaluation of various factors of decision-making units, and can’t evaluate and rank multiple decision-making units. Based on the DEMATEL-ISM method in the previous research, an integrated DEMATEL-ISM-TOPSIS method was proposed. The process diagram of the methodology is given as Figure 1.
### Table 1. Elderly care service quality evaluation indicators from the perspective of integrated supply chain

| Classification (First-Grade Indicator) | Quality Factors (Second-Grade Indicator) |
|----------------------------------------|------------------------------------------|
| Design quality factors of the elderly care services | $S_i$: New service development  
$S_i$: Design of new management and business model  
$S_i$: Design of information system and workflow |
| Planning quality factors of the elderly care services | $S_i$: Informatization degree of elderly care services  
$S_i$: Accuracy rate of service plan completion  
$S_i$: Accuracy rate of service information transmission |
| Supply quality factors of the elderly care services | $S_i$: Satisfaction rate of service outsourcing  
$S_i$: Capabilities of service integrator  
$S_i$: Ability of service resource utilization |
| Implementation quality factors of elderly care services | $S_{i\text{int}}$: Daily living care services for the elderly  
$S_{i\text{int}}$: Medical care services for the elderly  
$S_{i\text{int}}$: Elderly rehabilitation services  
$S_{i\text{int}}$: Mental comfort services for the elderly  
$S_{i\text{int}}$: Social development services for the elderly |
| Quality factors of customer service in elderly care services | $S_{i\text{ex}}$: Service feedback and tracking  
$S_{i\text{ex}}$: Handling of service exceptions and complaints  
$S_{i\text{ex}}$: Evaluation and supervision of services |
| Quality factors of the elderly care service support system | $S_{i\text{pm}}$: Implementation and evaluation of performance management  
$S_{i\text{pm}}$: Maintenance management of facilities and equipment  
$S_{i\text{pm}}$: Management of knowledge and information |

**Step 1: Establish initial direct influence matrix**

Assuming that the scales 0, 1, 2, 3, 4 and 5 represent the range from “no influence” to “very high influence”, experts are asked to propose the influences among these factors based on pairwise factor comparisons in terms of the influence degree and directions. Matrix $W$ represents the interaction between the quality factors of elderly care services in the supply chain, and $w_{ij}$ represents the influence degree to which the factor $S_i$ affects the factor $S_j$.

**Step 2: Get the comprehensive influence matrix**
By normalizing the initial direct influence matrix, the normalized direct influence matrix $W_1$ is obtained by Eq. (1), and the comprehensive influence matrix $T$ is obtained through the calculation of matrix $W_1$ by Eq. (2).

$$W_i = \frac{W}{\max_{i \leq n} \left( \sum_{j=1}^{n} w_{ij} \right)}$$

$$T = W_i (1 - W_i)^{-1} = (t_{ij})_{non}$$

Step 3: Calculate the influence degree, the degree of being influenced, the centrality degree and the causality degree of decision-making evaluation factors
The factors of the matrix $t_{ij}$ are added by rows and columns to get the influence degree $F_i$ and the degree of being influenced $E_i$ using Eq. (3)-(4). The influence degree $F_i$ represents the comprehensive influence of the factor $s_i$ on other factors. The degree of being influenced $E_i$ represents the comprehensive influence of other factors on factor $S_i$.

$$F_i = \sum_{j=1}^{n} t_{ij}, (i = 1, 2, 3, \ldots, n) \quad (3)$$

$$E_i = \sum_{j=1}^{n} t_{ji}, (i = 1, 2, 3, \ldots, n) \quad (4)$$

The centrality degree $M_i$ and causality degree $N_i$ of decision-making evaluation factors are obtained by the addition and subtraction of the influence degree and the degree of being influenced of each factor respectively using Eq. (5)-(6).

$$M_i = F_i + E_i \quad (5)$$

$$N_i = F_i - E_i \quad (6)$$

The centrality degree $M_i$ reflects the importance of factor $S_i$ in the risk system, where factors with higher centrality degree are more important. The causality degree $N_i$ reflects the pure influences of factor $S_i$ on other factors. The causality degree $N_i > 0$ indicates that the factor has a great influence on other factors, then this factor is called the causal factor; the causality degree $N_i < 0$ indicates that other factors have a great influence on this factor, then this factor is called the resultant factor.

Step 4: Draw factor matrix distribution map

Taking the causality degree $N_i$ and the centrality degree $M_i$ of each factor as the X and Y axis to get the coordinate graph, the factor matrix distribution map is obtained by marking out the coordinate position of each factor.

Step 5: Construct the reachability matrix

The overall influence matrix $H$ is gotten by adding the matrix $T$ and the unit matrix $I$ using Eq. (7).

$$H = I + T = (h_{ij})_{n \times n} \quad (7)$$

Given a threshold $\lambda$, the reachability matrix $K$ can be derived using Eq. (8).
\[ K = (k_{ij})_{n \times n}, k_{ij} = \begin{cases} 1, & h_{ij} \geq \lambda \\ 0, & h_{ij} < \lambda \end{cases} \] (8)

\( k_{ij} \) of the reachability matrix represents the relationship between node \( i \) and node \( j \), where \( k_{ij} = 1 \) means there is a connection between node \( i \) and node \( j \), and \( k_{ij} = 0 \) means there is no connection. Through setting a threshold value \( \lambda \), minor factors in the influence matrix can be filtered out, and the value of \( \lambda \) is assigned \([0, 1]\). The larger the value of \( \lambda \) is, the more influencing factors will be removed, and the clearer the ISM structure model will be. Therefore, the value of \( \lambda \) should be moderate, and the final \( \lambda \) can be obtained after several tests and modifications.

Step 6: Construct the hierarchical network model of ISM

The reachability matrix \( k_{ij} \) can be decomposed to reachable set \( R(k_{ij}) = \{ S_j \in n | k_{ij} = 1 \} \) and antecedent set \( Q(k_{ij}) = \{ S_j \in n | k_{ij} = 1 \} \), and the common factor can be extracted from these sets according to Eq. (9)

\[ A = \{ S_j \in n | R(k_{ij}) \cap Q(k_{ij}) = R(k_{ij}), i = 0, 1, ... n \} \] (9)

What are extracted in the first level are the top-level factors as Eq. (9), and a new reachable matrix \( k^1 \) is obtained through deleting the corresponding rows and columns of factors extracted from the first level of the original reachability matrix. The above operations are repeated to get factors of the second level, and the like, until all factors are extracted to determine the factor of the lowest level, and then the ISM structure model can be drawn according to these extracted factors.

Step 7: Evaluate factors by TOPSIS

Taking the value of \( M_i \) and \( N_i \) as the element of the evaluation matrix \( U \):

\[ U = \begin{bmatrix} M_1 & N_1 \\ M_2 & N_2 \\ \vdots & \vdots \\ M_n & N_n \end{bmatrix} \]

As the dimensions of the values of \( M_i \) and \( N_i \) are not uniform, the data is standardized to obtain a standardized matrix \( Z \), where \( z_{ij} \) is the element in the matrix. The distance between each evaluation object and the best ideal solution, and the distance between each evaluation object and the worst ideal solution are calculated to obtain the \( L_i^+ \) and \( L_i^- \). The calculation formulas are as follows:

\[ L_i^+ = \sqrt{\sum_{j=1}^{m} (\max z_{ij} - z_{ij})^2} \] (10)
\[ L_i = \sqrt{\sum_{j=1}^{m} (\min z_{ij} - z_{ij})^2} \]  

(11)

By calculating the closeness of ideal solution \( L_i^* = \frac{L_i}{L_i + L_i^L} \), it’s obvious to obtain \( 0 \leq L_i^* \leq 1 \), and the larger the \( L_i^* \), the higher the weight of the indicator. Score the performance of each evaluation unit, and get the score of each indicator as \( q_i \), the total score is calculated of the evaluation unit as follows:

\[ Q = q_i L_i^* \]  

(12)

5. MODEL EVALUATION AND ANALYSIS

5.1 Evaluation of the Attributes of Each Factor

\( w_{ij} \) represents the direct impact of factor \( S_i \) on factor \( S_j \) in the quality of elderly care services, and 0 to 5 are used to represent different degrees of impact relationship grade indicators. “0” means that factor \( S_i \) has no influence on \( S_j \), and the degree of influence from low to high is 1, 2, 3, 4, and 5. The interviewees were invited to score the evaluation indicators, and the evaluation matrix \( W \) was obtained by averaging the scoring results of respondents. A total of 11 elderly care service institutions were investigated and 78 evaluations were collected. Among the 11 institutions surveyed, 5 are from Guangzhou, 3 from Dongguan and 3 from Shenzhen, in the 1~5 star evaluation of elderly care service institutions launched by the Guangdong Provincial Department of Civil Affairs. These elderly care institutions are all authorized by three-star qualification. Among the respondents, 35 were managers and staff from elderly care institutions; 10 were equipment suppliers of elderly care institutions; 6 were other service providers of elderly care institutions; 8 were from senior government management departments; 6 were scholars, and 11 were family members of the elderly in the elderly care institutions.

The evaluation matrix \( W \) was obtained by averaging the scoring results of respondents as follows:

According to the Eq. (1) - (6), the influence degree \( F_i \), the degree of being influenced \( E_i \), the centrality degree \( M_i \) and the causality degree \( N_i \) of various factors of the elderly care services’ quality are obtained as shown in Table 2. The centrality degree of the factor reflects the importance of each evaluation factor of the emergency capability. The causality degree indicates the influence relationship between the factors of emergency capability and other evaluation factors. When the causality degree value of the factor is greater than 0, it can be called the causal factor, and it shows that this factor has a great influence on other factors. When the causality degree value of the factor is less than 0, it can be called the resultant factor, which indicates that the factor is greatly influenced by other factors.

5.2 Evaluation of Factor Quadrant Distribution

Taking the causality degree and centrality degree of each factor in the decision-making evaluation matrix as the X-Y axis of coordinates, the quadrant distribution diagram of the quality factors of the elderly care services is as shown in Figure 2.
Table 2. Influence degree, degree of being influenced, centrality degree and causality degree

| Index | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | $S_9$ | $S_{10}$ |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| $F_i$ | 0.336 | 0.258 | 0.388 | 0.320 | 0.288 | 0.498 | 0.369 | 0.451 | 0.272 | 0.413   |
| $E_i$ | 0.382 | 0.350 | 0.332 | 0.371 | 0.485 | 0.494 | 0.539 | 0.603 | 0.404 | 0.347   |
| $M_i$ | 0.718 | 0.608 | 0.721 | 0.690 | 0.773 | 0.992 | 0.908 | 1.054 | 0.675 | 0.760   |
| $N_i$ | -0.050 | -0.102 | 0.057 | -0.053 | -0.215 | 0.006 | -0.171 | -0.157 | -0.141 | 0.063   |

| Index | $S_{11}$ | $S_{12}$ | $S_{13}$ | $S_{14}$ | $S_{15}$ | $S_{16}$ | $S_{17}$ | $S_{18}$ | $S_{19}$ | $S_{20}$ |
|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| $F_i$ | 0.379 | 0.372 | 0.391 | 0.378 | 0.464 | 0.441 | 0.522 | 0.613 | 0.399 | 0.414   |
| $E_i$ | 0.384 | 0.383 | 0.354 | 0.328 | 0.458 | 0.398 | 0.419 | 0.418 | 0.164 | 0.298   |
| $M_i$ | 0.763 | 0.755 | 0.745 | 0.706 | 0.922 | 0.840 | 0.941 | 1.030 | 0.564 | 0.712   |
| $N_i$ | -0.009 | -0.017 | 0.035 | 0.049 | 0.007 | 0.043 | 0.104 | 0.198 | 0.235 | 0.117   |

Figure 2. Quadrant distribution diagram of the quality of elderly care services
Table 3. The first-level reachability set, antecedent set and intersections

| Index code | Reachability set | Antecedent set | Intersection set | Level |
|------------|------------------|----------------|------------------|-------|
| S_1        | 1,3              | 1,4            | 1                |       |
| S_2        | 2,3              | 2,4            | 2                |       |
| S_3        | 3,4,5            | 1,2,3,4        | 3,4              |       |
| S_4        | 1,2,3,4          | 3,4            | 3,4              |       |
| S_5        | 5,7,8            | 3,5,17         | 5                |       |
| S_6        | 6                | 6,9            | 6                | 1     |
| S_7        | 7,8,16           | 5,7,11         | 7                |       |
| S_8        | 8                | 5,7,8,15       | 8                | 1     |
| S_9        | 6,9              | 9              | 9                |       |
| S_{10}     | 10               | 10             | 10               | 1     |
| S_{11}     | 7,11             | 11             | 11               |       |
| S_{12}     | 12               | 12             | 12               | 1     |
| S_{13}     | 13               | 13             | 13               | 1     |
| S_{14}     | 14               | 14             | 14               | 1     |
| S_{15}     | 8,15             | 15             | 15               |       |
| S_{16}     | 16               | 7,16           | 16               | 1     |
| S_{17}     | 5,17             | 17             | 17               |       |
| S_{18}     | 18               | 18             | 18               | 1     |
| S_{19}     | 19               | 19             | 19               | 1     |
| S_{20}     | 20               | 20             | 20               | 1     |

Figure 3. ISM model of factors affecting the quality of elderly care services
5.3 Evaluation by ISM Model

Given that $\lambda = 0.05$, the reachability matrix $K = (k_{ij})_{20 \times 20}$ was obtained. According to the calculation steps of the ISM model, the first-level reachability set, antecedent set and intersections obtained by completing the first-level iteration are shown in Table 3. Similarly, iterations are continued for determining the intersection of each level, so as to get the ISM model of the quality factors of elderly care services as shown in Figure 3.

5.4 Evaluation on Service Quality of Elderly Care Institutions

The factors of the decision evaluation matrix are compared in pairs to obtain indicators such as the centrality degree and the causality degree by using the DEMATEL method. Finally, the approximate ideal solution $L_i^*$ of each evaluation factor is obtained, which is used as the weight of each evaluation factor after normalization, as shown in Table 4.

Table 4. Values of indicator weights

| Indicator | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | $S_9$ | $S_{10}$ |
|-----------|------|------|------|------|------|------|------|------|------|-------|
| $L_i^+$   | 0.386| 0.490| 0.321| 0.403| 0.481| 0.215| 0.390| 0.359| 0.473| 0.292  |
| $L_i^-$   | 0.197| 0.108| 0.283| 0.182| 0.161| 0.416| 0.293| 0.413| 0.109| 0.303  |
| $L_i^*$   | 0.338| 0.180| 0.469| 0.311| 0.251| 0.659| 0.429| 0.535| 0.188| 0.509  |
| Weight    | 0.036| 0.019| 0.049| 0.033| 0.026| 0.069| 0.045| 0.056| 0.020| 0.054  |

| Indicator | $S_{11}$ | $S_{12}$ | $S_{13}$ | $S_{14}$ | $S_{15}$ | $S_{16}$ | $S_{17}$ | $S_{18}$ | $S_{19}$ | $S_{20}$ |
|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| $L_i^+$   | 0.332    | 0.343    | 0.317    | 0.338    | 0.234    | 0.249    | 0.150    | 0.037    | 0.410    | 0.304    |
| $L_i^-$   | 0.250    | 0.239    | 0.274    | 0.269    | 0.366    | 0.332    | 0.433    | 0.548    | 0.412    | 0.329    |
| $L_i^*$   | 0.430    | 0.411    | 0.464    | 0.444    | 0.610    | 0.571    | 0.742    | 0.937    | 0.501    | 0.520    |
| Weight    | 0.045    | 0.043    | 0.049    | 0.047    | 0.064    | 0.060    | 0.078    | 0.099    | 0.053    | 0.055    |

Table 5. Initial scores of service quality of the three elderly care institutions

| Institution | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | $S_9$ | $S_{10}$ |
|-------------|------|------|------|------|------|------|------|------|------|-------|
| Institution A | 2.3  | 3.4  | 3.2  | 4.2  | 3.9  | 4.2  | 4.6  | 4.8  | 4.3  | 4.7    |
| Institution B | 2.4  | 3.5  | 3.2  | 4.2  | 3.6  | 3.9  | 4.3  | 4.9  | 4.3  | 4.7    |
| Institution C | 2.5  | 3.8  | 3.5  | 4.3  | 4.0  | 4.5  | 4.8  | 4.9  | 4.3  | 4.4    |

| Institution | $S_{11}$ | $S_{12}$ | $S_{13}$ | $S_{14}$ | $S_{15}$ | $S_{16}$ | $S_{17}$ | $S_{18}$ | $S_{19}$ | $S_{20}$ |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Institution A | 4.3  | 4.3  | 4.6  | 4.3  | 4.5  | 4.7  | 4.4  | 3.8  | 3.8  | 3.6    |
| Institution B | 4.3  | 3.9  | 4.3  | 4.1  | 4.6  | 4.2  | 4.1  | 3.7  | 3.6  | 3.4    |
| Institution C | 4.3  | 4.2  | 4.7  | 4.3  | 4.5  | 4.8  | 4.4  | 4.4  | 3.8  | 3.7    |
Through the survey and evaluation data of 11 elderly care institutions in the Pearl River Delta region as mentioned above, the attribute evaluation and weight score of each indicator were obtained. The performance of each indicator of the three elderly care institutions was scored, and 38 evaluation scores were collected. After taking the average value, the initial scores of the service quality of the three elderly care institutions are shown in Table 5.

Table 6. Evaluation score of elderly care service quality

|                     | Institution A | Institution B | Institution C |
|---------------------|---------------|---------------|---------------|
| Quality of design   | 0.3           | 0.31          | 0.33          |
| Quality of Planning | 0.53          | 0.5           | 0.56          |
| Quality of Supply   | 0.56          | 0.56          | 0.58          |
| Quality of Implementation | 1.06     | 1.02          | 1.04          |
| Quality of customer service | 0.92 | 0.87          | 0.92          |
| Quality of support system | 0.77     | 0.74          | 0.8           |
| Total score         | 4.15          | 3.99          | 4.23          |

According to the calculation results, the evaluation score of institution C is the highest, and the total evaluation score is 4.23, followed by institution A and institution B. The results show that the implementation quality evaluation of the three elderly care service institutions is the highest among the six first-level indicators, which are 1.06, 1.02 and 1.04 respectively. The evaluation of the implementation quality of elderly care services includes daily living care services, medical services, rehabilitation services, mental comfort services, social development services and other basic functional services. It can be seen that the basic functional service is the most concerned and does the best, followed by the quality of customer service and the support system. The scores for the quality of design and the quality of planning are relatively low, indicating that the importance of these two services has not been recognized from the perspective of the supply chain.

6. RESULTS AND DISCUSSION

6.1 Analysis and Discussion of Factor Attributes

The causality degree indicates the influence relationship between the factors of the evaluation matrix. Factors with the causality degree greater than 0 can be called causal factors, and factors with the causality degree less than 0 are called resultant factors. The factors with the causality degree greater than 0 in the evaluation of the quality of elderly care services are ranked as follows: \( S_{19} \succ S_{18} \succ S_{20} \succ S_{17} \succ S_{16} \succ S_{15} \succ S_{14} \succ S_{6} \). These factors include the maintenance management of facilities and equipment, the implementation and evaluation of performance management, the management of knowledge and information, the evaluation and supervision of services, the daily living care services for the elderly, the design of Information system and workflow, the social development services for the elderly, the handling of service exceptions and complaints, the mental comfort services for the elderly, the service feedback and tracking, the accuracy rate of service information transmission. It shows that these 11 evaluation factors have a greater impact on other factors, and the other 9 evaluation factors are called resultant factors.. Centrality degree reflects the importance of various evaluation factors of the quality of elderly care services, and the importance of each decision-making evaluation factor reflected by the score of the centrality degree is ranked as follows: \( S_8 \succ S_{18} \succ S_6 \succ \).
According to the quadrant distribution diagram of the quality of elderly care services, the quality factors of elderly care services are divided into four categories:

Key factors: The centrality degree of the factors located in the first quadrant is greater than the average, and the causality degree > 0 is the key factor of the decision evaluation matrix. The key factors are the accuracy rate of service information transmission ($S_17$), service feedback and tracking ($S_16$), handling of service exceptions and complaints ($S_15$), evaluation and supervision of services ($S_14$), implementation and evaluation of performance management ($S_18$), and the capabilities of service integrator ($S_9$).

Result-oriented factors: The centrality degree of elderly care service quality factors in the second quadrant is higher, that is, the importance is relatively higher, but are greatly affected by other factors. Thus, the factors can be called result-oriented factors, including the satisfaction rate of service outsourcing ($S_7$), and the capabilities of service integrator ($S_9$).

Common factors: The factors in the third quadrant have low degree of causality and centrality. These factors include $S_1, S_2, S_3, S_4, S_5, S_6, S_8, S_{11}$, and $S_{12}$.

Influential factors: The causality degree of factors in the fourth quadrant are greater than 0 and the centrality degree is small. These factors have a great influence on other factors, but their importance is relatively low. These factors are $S_3, S_5, S_{10}, S_{13}, S_{14}, S_{19}$, and $S_{20}$.

According to the above-mentioned factor attribute analysis, the quality factors of customer service and the quality factors of supply in elderly care services should be focused on from the perspective of first-grade indicators. Previous research results suggest that focusing on nursing services and improving the satisfaction of the elderly can improve the quality of elderly care services (Chao et al., 2016). The results of this research propose to focus on customer service quality factors, which is similar to the previous research results. With more and more nodes and participants in the elderly care service supply chain, the outsourcing of elderly care services and equipment will become more and more common. Therefore, the supply quality of elderly care services will affect the service quality of the entire supply chain. This is not mentioned in previous studies. Therefore, from the perspective of the first-grade indicators, the quality factors of supply in elderly care services also need to be focused.

6.2 Analysis and Discussion of the Hierarchical Relationship of Factors

According to the interpretive structure model (ISM), the first structural factors have a direct effect on the quality of elderly care services. These factors include the accuracy rate of service information transmission ($S_17$), capabilities of service integrator ($S_8$), daily living care services ($S_{19}$), elderly rehabilitation services ($S_{12}$), mental comfort services for the elderly ($S_{13}$), social development services for the elderly ($S_{14}$), handling of service exceptions and complaints ($S_{15}$), implementation and evaluation of performance management ($S_{18}$), maintenance management of facilities and equipment ($S_9$), and management of knowledge and information ($S_{10}$). The lowest-level influencing factors do not directly reflect and act on service quality, but indirectly and deeply affect service quality. These factors include the new service development ($S_1$), design of new management and business model ($S_4$), design of Information system and workflow ($S_5$), informatization degree of elderly care services ($S_6$), and evaluation and supervision of services ($S_{17}$).

According to the analysis results, it can be seen that among the top-level factors of the ISM structure model, the factors belonging to the implementation quality and support system quality are the most. Among the factors at the lowest level, the factors that belong to the design quality factors...
(first-grade indicator) are the most. Previous studies paid more attention to basic functional services such as daily living care services, medical services, rehabilitation services, mental comfort services, social development services and other basic functional services (Yi et al., 2021; Yu et al., 2017). These factors belong to the top-level factors in the ISM model and have a direct impact on the quality of elderly care services. In this research, these factors are summarized as the first-level indicators of implementation quality factors from the perspective of the supply chain. According to the evaluation scores of the three elderly care service institutions, the quality factors of implementation attain the highest evaluation score among the first-grade indicators. This shows that the respondents in this survey are still most concerned about the basic services in the elderly care services. The scores of design quality and plan quality in the first-grade indicator scores of the three elderly care institutions are relatively low. This shows that the respondents’ evaluation scores for the lowest influencing factors are not high, and these quality factors need to be improved further.

6.3 Suggestions and Countermeasures

The trend of global aging is becoming more and more obvious. The aging of the Chinese population is accelerating. On average, one out of every four elderly people is in China. The market scale of China’s elderly care service industry is growing rapidly, but China’s elderly care service system and quality supervision system have not yet been established, and the supervision of the quality of elderly care services is very weak. The elderly care service system does not simply provide elderly care services, but includes a multi-faceted organic system such as service design, service supply, quality supervision, and customer service. The identification and evaluation of factors affecting the quality of elderly care services are conducive to building a quality system for elderly care services and guaranteeing the ultimate rights and interests of the elderly. Evaluating the quality factors of elderly care services from the perspective of the supply chain is conducive to the establishment of a quality supervision and evaluation system for the elderly care service industry. Forward-looking research in the field of elderly care service quality is conducive to solving the problem of social transformation of elderly care services, realizing steady economic and social development. The research also provides guiding for the government and elderly care service agencies to build an elderly care service quality supervision and evaluation mechanism.

Based on the attribute analysis of elderly care service quality factors, the quality of elderly care services should pay attention to key factors and more important factors. From the first-grade indicators, these factors are the most subordinate to the quality of elderly care service supply and the quality of customer service. Therefore, on the one hand, it is necessary to improve the evaluation standards of suppliers, select service integrators with greater capabilities, strengthen the evaluation and management of suppliers, improve resource utilization, and eliminate unqualified service outsourcers (Zhao, 2021). On the other hand, it is suggested to emphasize service orientation, focus on service satisfaction, optimize customer service, force service quality improvement, attach importance to service feedback and evaluation, and improve supervision and evaluation of elderly care services so as to improve service quality (Chao et al., 2016). In addition, it is of necessity to use modern information technology to improve the support and feedback for the plan of elderly care service supply chain, the process and internal management, and collect elderly care service information through big data technology to accurately meet the service demand.

According to the logical relationship based on the factor hierarchy, some good jobs can be done to improve the quality of elderly care services from the following aspects. First, it is necessary to improve the level of basic functional services in elderly care services as these factors are the direct and external manifestation of service quality and have a direct impact on service satisfaction. Secondly, the support system and auxiliary management level of elderly care services should be improved, such as the implementation and evaluation of performance management, the maintenance management of facilities and equipment, the management of knowledge and information, and the evaluation and supervision of services, which indirectly affect the quality of elderly care services. In addition, it is
suggested to pay attention to the top-level design of the operating mechanism and operating mode of elderly care services, including the top-level design from the aspects of new service development and the design of new management and business model. Elderly care services should be more innovative in service demand, service mode and service content, and categorize and accurately identify the needs of the elderly in order to adopt more targeted elderly care service measures.

7. CONCLUSION

The supply chain theory was initially applied in the industrial field, and the research on the supply chain of elderly care services is a new topic. With the economic development and changes in the demographic structure, the number of service companies for community and institutional elderly will continue to increase. The development of elderly care service companies is inseparable from the competition and cooperation of upstream and downstream enterprises. The production and operation, service implementation, procurement and after-sales of any elderly care service institution are in the ecological chain and supply chain network structure of elderly care services. The existing literature does not analyze the quality of elderly care services and its factors from the perspective of the supply chain system. Based on the integrated SCOR model, this research constructs indicators for the quality of elderly care services from six aspects, namely, design, planning, supply, implementation, customer service, and the support system, which provides a new research perspective for the research on the quality of elderly care services.

The existing research uses the integrated DEMATEL-ISM method for decision-making analysis, but the DEMATEL-ISM method is often used for analysis and evaluation of various factors of DMU, and can’t evaluate and rank the multiple DMU. Based on the DEMATEL-ISM method, this research proposes a new method, integrated DEMATEL-ISM-TOPSIS method. The integrated DEMATEL-ISM-TOPSIS method simplifies the calculation process and can evaluate not only the factors but also the overall DMU. Integrating the advantages of the three methods, that is, DEMATEL, ISM, and TOPSIS, the scores of the causality degree and the centrality degree of each indicator can be obtained to sort the indicators, and the hierarchical structural relationship of each indicator can also be obtained. The weight of each evaluation factor can be calculated, and the total score of DMU are calculated also.

Based on the survey data of 11 elderly care service supply chains in the Pearl River Delta region, the factors affecting the quality of elderly care services are evaluated and analyzed from the perspective of supply chains. The research pointed out that these factors should be paid more attention, namely, the accuracy rate of service information transmission, service feedback and tracking, handling of service exceptions and complaints, implementation and evaluation of performance management. From the top-level design of elderly care service supply chain, the following factors should be conducted well: new service development, design of new management and business model, design of information system and workflow, informatization of elderly care services, and service evaluation and supervision. Through the overall scoring of the service quality of the three elderly care service institutions, it can be seen that the implementation quality of elderly care services, that is, the service quality of the basic functions of elderly care service, is better from the first-level evaluation indicator, while the quality of design and planning needs to be further improved. The research results show the applicability of the evaluation index system and the scientificity of the research methods, and provide new ideas for the quality management of elderly care services.

Although these research works have great significance, there are still some limitations in this work. There is no authoritative explanation for the elderly care service supply chain. The index system of elderly care service quality factors based on the integrated supply chain may ignore some factors, and the initial evaluation score of the model is very dependent on the ruling of the expert group. All of these can be further explored and improved in the future.
FUNDING

This research was funded by Guangdong Basic and Applied Basic Research Foundation (2019A1515110909), Guangdong Education Science Planning Project (2021GXJK120), and Shenzhen Philosophy and Social Science Planning Project (SZ2020A007), Young Innovative Talents Projects in Ordinary Colleges and Universities in Guangdong Province (2018GWQNCX002).

CONFLICTS OF INTEREST

The authors declare no conflict of interest.
REFERENCES

An, X., Ji, Y., Gu, W., & Kim, D. (2019). The integration of development of information industry and pension service industry using grey relational analysis (GRA): The case study of Handan city, China. *Indian Journal of Science and Technology, 12*(45), 1–11. doi:10.17485/ijst/2019/v12i45/148757

Zhao, J. (2021). Sustainability on the service capacity in elderly healthcare service supply chains: An application of flexible contracts. *IEEE Transactions on Engineering Management, 1*–11. Advance online publication. doi:10.1109/TEM.2021.3071587

Gao, Y., & Zhou, S. (2020). On the cooperation mechanism of elderly service system with different level and cross-Chain. *35th Youth Academic Annual Conference of Chinese Association of Automation, 541-544.* doi:10.1109/YAC51587.2020.9337504

Mandal, S. (2016). A Social-Exchange Perspective on Supply Chain Innovation. *International Journal of Information Systems in the Service Sector, 8*(3), 36–57. doi:10.4018/IJISSS.2016070103

Chang, C. (2006). Application of quality function deployment launches to enhancing nursing home service quality. *Total Quality Management & Business Excellence, 17*(3), 287–302. doi:10.1080/1478360500451291

Fahey, T., Montgomery, A. A., Barnes, J., & Protheroe, J. (2003). Quality of care for elderly residents in nursing homes and elderly people living at home: Controlled observational study. *British Medical Journal, 326*(7389), 580. doi:10.1136/bmj.326.7389.580 PMID:12637404

Heras, I., Cilleruelo, E., & Iradi, J. (2008). Quality management and quality of care in nursing homes. *International Journal of Health Care Quality Assurance, 21*(7), 659–670. doi:10.1108/09526860810910131 PMID:19055274

Lee, W., Chen, C., & Huang, Y. (2018). Establishing the criteria for the quality of elderly medical care from the multiple perspectives. *International Journal of Customer Relationship Marketing and Management, 9*(4), 44–54. doi:10.4018/IJCRMM.2018100103

Naylor, M. D., Hirschman, K. B., Hanlon, A. L., Abbott, K. M., Bowles, K. H., Foust, J., Shah, S., & Zubritsky, C. (2016). Factors associated with changes in perceived quality of Life among elderly recipients of long-term services and supports. *Journal of the American Medical Directors Association, 17*(1), 44–52. doi:10.1016/j.jamda.2015.07.019 PMID:26412018

Leung, M. Y., & Qi, L. (2019). Developing structural facilities management–quality of life models for the elderly in the common areas of public and subsidized housings. *Habitat International, 94*, 102067. doi:10.1016/j.habitint.2019.102067

Supromin, C., & Choonhakhlai, S. (2017). The provision of public services in municipalities in Thailand to improve the quality of life of elderly people. *Kasetsart Journal of Social Sciences.* Advance online publication. doi:10.1016/j.kjss.2017.12.011

Yu, J., Ma, G., & Jiang, X. (2017). Impact of the built environment and care services within rural nursing homes in China on quality of life for elderly residents. *Engineering, Construction, and Architectural Management, 24*(6), 1170–1183. doi:10.1108/ECAM-08-2016-0187

Zhang, Z., Tang, M., Lan, K., & Du, J. (2016). Exploring the service quality of community care for the elderly from multiple perspectives - based on a survey of eastern, middle and western China. *2016 IEEE International Conference on Management of Innovation and Technology, 167-171.* doi:10.1109/ICMIT.2016.7605027

Chao, C., Ku, P., Wang, Y., & Lin, Y. (2016). The effects of job satisfaction and ethical climate on service quality in elderly care: The case of Taiwan. *Total Quality Management & Business Excellence, 27*(3-4), 339–352. doi:10.1080/14783363.2014.982893

Kazemi, A., & Kajonius, P. (2015). User-oriented elderly care: A validation study in two different settings using observational data. *Quality in Ageing and Older Adults, 16*(3), 140–152. doi:10.1108/QAOA-08-2014-0013

Stolt, R., Blomqvist, P., & Winblad, U. (2011). Privatization of social services: Quality differences in swedish elderly care. *Social Science & Medicine, 72*(4), 560–567. doi:10.1016/j.socscimed.2010.11.012 PMID:21167627
International Journal of Information Systems in the Service Sector
Volume 14 • Issue 1

Zhang, C. J. P., Barnett, A., Johnston, J. M., Lai, P. C., Lee, R. S. Y., Sit, C. H. P., & Cerin, E. (2019). Objectively-measured neighbourhood attributes as correlates and moderators of quality of life in older adults with different living arrangements: The ALECS cross-sectional study. *International Journal of Environmental Research and Public Health, 16*(5), 876. doi:10.3390/ijerph16050876 PMID:30857372

Reijula, J., Rosendahl, T., Reijula, K., Roilas, P., & Sepponen, R. (2010). New method to assess service quality in care homes for the elderly. *International Journal on Smart Sensing and Intelligent Systems, 13*(1), 14–26. doi:10.21307/ijssis-2017-376

Siegel, C., Hochgatterer, A., & Dorner, T. E. (2014). Contributions of ambient assisted living for health and quality of life in the elderly and care services - a qualitative analysis from the experts’ perspective of care service professionals. *BMC Geriatrics, 14*(1), 112. doi:10.1186/1471-2318-14-112 PMID:25326149

Xu, L. & Zhang, Y. (2021). Quality improvement of smart senior care service platform in China based on grey relational analysis and Fuzzy-QFD. *Grey Systems: Theory and Application*. 10.1108/GS-05-2020-0068

Ajmal, M. M., Tuomi, V., Helo, P. T., & Sandhu, M. A. (2016). TQM Practices in Public Sector: Case of Finnish Healthcare Organizations. *International Journal of Information Systems in the Service Sector, 8*(1), 35–45. doi:10.4018/IJISSS.2016010103

Al-Hasson, M. A. M., & Abu-Shanab, E. A. (2021). Predicting End-User Satisfaction With Clinical Information Systems. *International Journal of Information Systems in the Service Sector, 13*(3), 18–38. doi:10.4018/IJISSS.2021070102

Djellal, F., & Gallouj, F. (2006). Innovation in care services for the elderly. *Service Industries Journal, 26*(3), 303–327. doi:10.1080/02642060600570943

Choy, K. L. T., Siu, K. Y. P., Ho, T. S. G., Wu, C. H., Lam, H. Y., Tang, V., & Tsang, Y. P. (2018). An intelligent case-based knowledge management system for quality improvement in nursing homes. *VINE Journal of Information and Knowledge Management Systems, 48*(1), 103–121. doi:10.1108/VIJIKMS-01-2017-0001

Kazemi, A., & Kajonius, P. (2020). Understanding client satisfaction in elderly care: New insights from social resource theory. *European Journal of Ageing, 18*(3), 417–425. doi:10.1007/s10433-020-00591-6 PMID:34483805

Liu, X., Zhang, K., Chen, B., Zhou, J., & Miao, L. (2018). Analysis of logistics service supply chain for the one belt and one road initiative of China. *Transportation Research Part E, Logistics and Transportation Review, 23*–39. Advance online publication. doi:10.1016/j.tre.2018.01.019

Hares, J., Dobrzykowski, D. D., & Prohofsky, J. (2021). How policy is shaping the macro healthcare delivery supply chain: The emergence of a new tier of retail medical clinics. *Business Horizons, 64*(3), 333–345. doi:10.1016/j.bushor.2021.02.040

Huang, C. W. (2018). Assessing the performance of tourism supply chains by using the hybrid network data envelopment analysis model. *Tourism Management, 65*, 303–316. doi:10.1016/j.tourman.2017.10.013

Putthinoi, S., Meksamoot, K., Yodmongkol, P., & Chakpitak, N. (2015). Household reverse logistics analysis using the SCOR model to improve home safety of the elderly in the municipality. *International Journal of Logistics Systems & Management, 21*(3), 348. doi:10.1504/IJLSM.2015.069732

Mezouar, H., & Afia, A. E. (2018). Performance analysis model for service supply chains: Case of the retirement supply chain. *IACSIT International Journal of Engineering and Technology, 7*(3), 1429. Advance online publication. doi:10.14419/ijet.v7i3.13929

Kazemi, A., & Elfsstrand Corlin, T. (2021). Linking supportive leadership to satisfaction with care: Proposing and testing a service-profit chain inspired model in the context of elderly care. *Journal of Health Organization and Management, 35*(4), 492–510. doi:10.1108/JHOM-10-2020-0393 PMID:33629577

Yazdi, M., Khan, F., Abbassi, R., & Rusli, R. (2020). Improved DEMATEL methodology for effective safety management decision-making. *Safety Science, 127*(7), 104705. doi:10.1016/j.ssci.2020.104705

Kılıç, H. S., & Yalcın, A. S. (2020). Comparison of municipalities considering environmental sustainability via neutrosophic DEMATEL based TOPSIS. *Socio-Economic Planning Sciences, 6*(3), 100827. doi:10.1016/j.seps.2020.100827
Jingshi He was born in Yongzhou, Hunan, China, in 1984. He is currently working in Business College, Dongguan Polytechnic, China, and was appointed as associate professor. His research interests include service supply chain and knowledge management.