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A multi-criteria decision-making integrated approach for identifying and ranking factors affecting the quality of cosmetic surgery clinic services

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A B S T R A C T

Considering the increasing demand for cosmetic surgery and the number of private cosmetic surgery clinics, it is essential to measure and manage the quality of services provided by these clinics. Obtaining sufficient knowledge about the content perceived by the clients of the quality of services provided by specialized clinics can affect identifying improvement opportunities and criteria that will cause their competitive advantage, and on the other hand, it also prevents wasting resources. For this purpose, this study aims to identify, evaluate, and prioritize the criteria for quality improvement in cosmetic surgery clinics. First, the effective criteria focus on the quality of medical services have been identified by reviewing the research background. Then, the identified criteria in the case study are customized by the Delphi method, and then the DEMATEL-based analytic network process method (DANP) is applied to reveal their causal relationships between criteria and sub-criteria to determine the direct and indirect influences, and finally, all of them are prioritized. In the end, based on the obtained results and knowledge of experienced medical experts in the case study, some managerial solutions are proposed to improve the quality of the provided medical services.

1. Introduction

Currently, the demand for using medical and health services is expanding at a very high speed. In the meantime, one of the important demands of medical services is cosmetic surgery, which currently has a rapidly growing demand and is expected to be in great demand among men and women of different ages in the near future. Service quality is a type of judgment that customers make based on their perception after the process of receiving the service based on comparing with their expectations (Büyüközkan et al., 2011). In the process of providing health and treatment services, according to the majority of patients, the quality means the efforts of the medical staff, including any possible effort to respond patients' expectations to satisfy them, and if the provided services exceed the patients' expectations, the service quality will be excellent (James et al., 2017). The quality of healthcare services includes many factors such as patient safety, effectiveness, efficiency, timely care, etc., and also considering equity and access for demographic subgroups and ensuring responsive, respectful, and coordinated services (Al-Yateem, 2020). To improve the existing problems of the quality of medical care processes, it is necessary to reduce the gap between patients' expectations and what is actually provided in the medical service process (Sauers et al., 2017). The exact description of the service quality is difficult and vague, so there are many definitions for it, including providing the right services to the right people at the right time with the right implementation methods, or the degree of compliance of the provided services with the customer's expectations, so a high-quality healthcare system is customer-oriented, comprehensive, responsive and at an acceptable cost, which includes continuity of care from health promotion to prevention and it's based on the regular assessment of customers' needs and expectations and also monitors its performance based on the philosophy of continuous improvement (Lupo, 2016).

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Understanding customer expectations is a prerequisite for providing better services. The expectations of the patient who refers to healthcare service organizations as a customer are actually opinions about service delivery and these opinions act as reference points and standards when the patient evaluates the performance of the service provider. Since patients compare their perception of performance with these reference points for evaluating the quality of services, it is important and necessary to accurately understand the patient's expectations in order to provide high-quality-quality service, in the other words, a lack of knowledge of what patients want means spending many resources on factors that are not important for patients, which can cause dissatisfaction therefore, patients' satisfaction can be defined as a total evaluation of the experience of receiving services by them over time (García-Madariaga & Rodríguez-Rivera, 2017).

In nowadays challengeable market, marketing activities focus on customers' satisfaction based on creating competitive advantages which obtain by identifying, prioritizing, and also improving key factors which affect their satisfaction despite the limited resources (Dabibi et al., 2016). Since the patients are the main customers of healthcare services, their satisfaction can to some extent indicate the acceptable performance of these services, which can be evaluated by various criteria such as length of hospitalization, readmission, percentage of disease recurrence, etc therefore, the quality of service processes, including medical and health services, is a means to achieve a sustainable competitive advantage, which is a strong factor in the competitive environment (Martins et al., 2015). Improving the quality of services in the healthcare process has received significant attention in recent years, therefore; healthcare process managers and specialists have used a wide range of methods and tools to improve quality and also have created quality indicators in different units of the healthcare sectors (Boulkedid et al., 2018). So hospitals and medical clinics must be informed in time about probable problems in various fields and try to solve them (Aakriti Gupta et al., 2020). Each hospital and specialized medical clinic has a different ability to provide medical services due to the difference in the type of medical equipment and the ability of its treatment staff (Samartzis and Talias, 2020). Additionally decision-making processes in healthcare services have become more complex due to the balance and harmony between quality and efficiency (Brailsford and Vissers, 2011, Hulshof et al., 2012. and Díaz-López et al., 2018) .

With the combination of medical science and aesthetics in recent decades, cosmetic surgery has gradually changed from a luxury operation to an epidemic surgery with a wide range of fans and applicants, so service quality improvement is very important to increase the competitiveness of existing cosmetic clinics. So considering the increase in demand for cosmetic surgeries and the expansion of the number of cosmetic clinics to provide services to clients, the present research is trying to provide a framework to identify the factors affecting the quality of cosmetic surgery clinics using a multi-criteria decision-making approach and also to evaluate the criteria and improve the quality of services provided to clients by providing suggested solutions based on the obtained results so that more patients can come to these clinics for cosmetic procedures. This research aims to answer the following questions:

- What are the most important criteria affecting the quality of medical services in the cosmetic surgery clinic?
- How are the internal relationships between the criteria affecting the quality of medical services in the cosmetic surgery clinic?
- Based on the results obtained, what solutions can be used to improve the quality of medical services in the cosmetic surgery clinic?

To answer the research questions, firstly, in the research background section, by reviewing related researches, the effective criteria on the quality of medical services are identified focusing on hospitals and surgery clinics. Then, using in-depth interviews and the Delphi method, the effective criteria and sub-criteria are identified and customized in the case study, in the next step, to capture the direct and indirect influences among criteria and building their causal relationships and determining their priorities, DANP method is used. At the end, the discussions and managerial implications are proposed based on obtained results and experienced experts in the case study to improve provided quality.

2. Research background review

In the studies carried out in the research literature, most researchers have stated that quality is the distinction between ideal expectations and provided actual performance made by the customer in order to evaluate the performance of the service process (Lupo, 2016). In healthcare services, patients' satisfaction has high importance and their quality of life increases the importance of this issue because the experience of illness and follow-up of the treatment and care process increases the vulnerability of patients and their need for support therefore, in the structure of the healthcare sector and paying attention to the concept of competitive advantages in this sector, patients play the main role in defining the quality of services, and patients and their families must be recognized as consumers of healthcare services and their needs and also their expectations must be considered as the main factor in developing healthcare services. Paying attention to the patient's expectations in service quality assessment enables healthcare organizations to be more responsive to the needs and expectations of a wide range of patients. The quality of healthcare includes the structure or organizing of care, the effect of the structure on the clinical processes of provided services, and ultimately the healthcare outcomes for patients (Kilbourne et al., 2018).

The quality of healthcare services has two dimensions, technical and functional, in the technical dimension, the specialized aspects of healthcare services the correctness and accuracy of procedures and diagnoses are examined, while the procedural and functional aspects are related to the way of service providing, therefore, achieving superior quality of healthcare services

due to its high complexity has become a major concern for all healthcare providers because they face a constant demand to provide high-quality customer-oriented services, so understanding the most important patients' expectations will be an essential issue (Singh and Prasher, 2019). The healthcare system is a process that includes the development of knowledge and improvements in caring through collaboration and expertise, and it is the patient's satisfaction that indicates the correct performance of the expected services in the hospital, a satisfaction that certainly cannot be achieved only because of the using professional services and advanced technologies but a major share of this satisfaction is affected by how these services are provided and how the treatment staff behaves with patients, and more diverse and more acceptable quality services cause more patients' satisfaction (Hopkins et al., 2020). To review previous studies related to healthcare quality assessment, in this section, a summary of the most important related studies is mentioned.

Arasli et al. (2008) analyzed the quality of services in hospitals and 454 people who had received hospital services were selected randomly to respond to the revised version of the SERVQUAL questioner included patient's expectations and perception questions. Their obtained results showed that there is a significant gap between the expectations and perceptions of hospitalized patients. Bakar et al., (2009) presented a research related to the role of patients' expectations in the evaluation of clinical care in teaching hospitals. They showed that the expectation scores were higher than the perception scores, which indicated that paying more attention to the expectations of patients in hospitals led to the improvement of service quality. Boulkedid et al., (2011) reviewed studies related to quality of medical services during a thirty-year period (1978-2008). They used expert panel to customize the identified indicators using Delphi method. They showed that, the evaluation indicators such as cost, skill, innovation, experience, and compensation were the most effective indicators of the quality of medical services. In 2015, Martins et al., assessed the quality of services perceived by female patients in a general hospital in order to evaluate the quality of services perceived when there were no alternative services. The Servperf instrument and the exploratory analysis were used to test the research hypotheses. The findings showed that the assurance gets the most points in the quality perceived by the patients and tangibles had the least impotence, and also availability and educational level affects patients' perception. Li et al., (2015) investigated patients' perception of service quality in hospitals and proposed some solutions for quality improvement using the SERQUAL model. Also, the collected data were analyzed through descriptive statistics, factor analysis, reliability analysis, independent t-test, one-way analysis of variance, and regression analysis. The standard regression coefficient showed that there were statistically significant positive values for all dimensions of SERQUAL model and also empathy and reliability are highly predictive of service quality perception.

In 2015, Handayani et al., investigated the dimensions of quality required in the hospitals to improve services quality focusing on stakeholders (hospital management, academics and patients) and analyzed their needs and expectations. Their research was conducted using a qualitative and quantitative study by interviews and distributing questionnaires. Obtained data were analyzed using the Entropy method. The results showed that human resources, process, procedures and hospital infrastructure were the main dimensions that must be improved in the first step. In 2016, Lupo proposed a framework based on the SERVQUAL model and the Analytic Hierarchy Process (AHP) method to evaluate the dimensions of the healthcare quality. The proposed framework focused on four dimensions including healthcare staff, accountability, support services, and relationships. The results showed that from the managers' patients' viewpoint, accountability was the most important dimension and the healthcare staff and relationships were the least important. Also, according to employees, support services and healthcare staff were of low importance, and accountability and relationships were highly rated.

In 2016, Aliman and Mohammad investigated the relationship between the quality of medical services, patient satisfaction and behavioral intentions in the healthcare industry. In this research, 300 questionnaires were distributed to 300 patients in private hospitals who received medical services in private hospitals in 2010 and 2011. Multiple regression was used to test the research hypotheses. The results showed that dimensions of service quality affect mental behaviors. There are significant positive relationships between all service factors and patient satisfaction. However, only three dimensions of service quality includes communication, assurance, and empathy had a significant relationship with behavioral intention. In addition, content, reliability, and trust had a significant relationship with satisfaction. Reliability highly affects the satisfaction and behavioral attitudes of patients. Satisfaction has a strong positive effect on behavioral intentions. In summary, service quality dimensions and patient satisfaction were positively related to behavioral intention.

In 2016, Budivwan and Effendi analyzed the perception of desirable services among patients who received medical services in the hospital. A qualitative method was used such as interviews to collect data. The findings showed that technical facilities, interpersonal relationships, cost, access, accountability, values, and results contribute the correct understanding of service quality. Vaish et al., (2016) stated that in health and treatment centers, customer relationship management (CRM) methods based on a patient-centered strategy including a combination of patient interaction and hospital relationship management are very effective in achieving patients' expectations. They mentioned that the quality of healthcare services is the main factor of customer attraction and CRM improves service quality but CRM will not make customers satisfy alone unless the services meet customer expectations in this competitive environment.

Kimweri et al., in 2016 investigated effective factors affect quality in health facilities to choose the best place of delivery using a qualitative study. Their statistical sample size was conducted in ten group discussion interviews between five women and five men. In their research, high education and positive attitude of delivery staff, close proximity to the health facility,

availability of providers, and modern equipment were mentioned as effective criteria, and the results showed that efforts to improve quality must be consider technical and non-technical criteria. Meesala and Paul (2016) identified evaluation, credibility, responsiveness, assurance and empathy as critical factors which affect patients' satisfaction and loyalty. The results showed that reliability and responsiveness affect patients' satisfaction and thereupon patients' loyalty to the hospital significantly and also there are no relations between marital status and age and regression weights of the identified variables. Mitropoulos et al., (2017) showed that communication with nurses and physicians is the most important predictor of patients' overall satisfaction using factor analysis and ordinal regression analysis. In addition, some factors such as specific patient characteristics (age and health status), and also structural characteristics of the hospital such as type and location contribute significantly overall patients' perception. Hence, healthcare quality improvement activities must consider critical difference factors among patients' groups and hospital types to more effectively meet patients' needs and preferences. Singh and Prasher (2019) analyzed the quality of medical services using the fuzzy hierarchical analysis technique based on patients' patients' viewpoint. In the mentioned research, fuzzy set theory and SERVQUAL method were used to measure service quality in four hospitals. Fuzzy hierarchical analysis process was used to prioritize the criteria and sub-criteria and also the best hospital was ranked (Thakkar et al., 2017; Tzeng et al., 2007, 2010, Vaish et al., 2016).

Asgari et al., (2020) presented a study in order to accreditation standards for limited surgery facilities to develop framework to improve performance of surgical centers. Firstly, by interviewing twenty specialists of the treatment staff, the effective criteria of the surgery operation process were designed. Then they were asked to evaluate the importance of each criterion qualitatively based on a 5-point Likert scale, and the importance of all criteria was evaluated using the DEMATEL method. The identified main criteria were patient safety, clinical care, and management approach. Discharge and patient safety follow-up had the highest weights, and prevention and management of common surgical complications, infection prevention, continuous care after surgery, emergency care, and surgical care and anesthesia were placed as the next priorities, respectively.

Farhadi et al., (2020) identified and prioritized the effective factors on service quality in the teaching hospitals focusing on all healthcare stakeholders using Fuzzy DEMATEL and ANP methods. Access to healthcare services was the most important factor and must be improved to increase patients' satisfaction. Altuntas et al., (2022) presented a research regarding the evaluation of healthcare quality using the SERVQUAL model and machine learning algorithms in hospitals. They identified effective factors on quality of service in a public hospital. Their obtained results showed that the general physical conditions of the hospital, and food services must be improved because of their significant gap. Gao et al. (2022) focused on creating an index system to evaluate the quality of medical services by "scrutinizing online reviews of medical and healthcare service platforms". His proposed method was a combination of an in-depth review of related studies and running surveys by questionnaire. He applied latent DIRICHLET allocation (LDA) model to identify the effective factors in patients' viewpoint, and then a questionnaire was used to determine the relative importance of identified factors. The most important factors include medical skills and ethics, reception services, surgery side effects, consultation services, drug treatment, diagnosis process and medical equipment.

Al Awadh (2022) applied SERVQUAL model and the analytic hierarchy process (AHP) technique to identify criteria to improve service quality services based on five SERVQUAL dimensions along with 2 dimensions and 31 sub-criteria.in public and private hospitals. They used AHP technique to rank studied hospitals. The results of mentioned study showed that the most important criteria are reliability, tangibles, and security and the least one is consistency, and also the infection prevention and hygiene is the most important sub-criteria between all of them. As mentioned in research background, in the healthcare quality assessment literature, different methods have been applied including statistical analysis and decision-making theory based on qualitative and quantitative criteria and sub-criteria. Table 1 presents the summary of the related studies focusing on methods and criteria.

Table 1
The summary of the related studies focusing on methods and criteria

Method/model	Field	Criteria/sub-criteria	Author(s)(Year)
SERVQUAL model	Hospitals	Empathy, prioritizing the needs of inpatients, relationships between staff and patients, staff professionalism, food, and the hospital environment	Arasli et al., (2008)
Student's t-test, Paired t-test, Pearson's correlation coefficient	Clinical care in teaching hospitals	Reliability, appearance characteristics, responsiveness, trust, empathy	Bakar et al., (2009)
Reviewing paper using Delphi	Medical services	Reliability, concreteness, accountability, assurance, empathy, cost, skill, innovation, experience, and compensation	Boulkedid et al., (2011)
The Servperf instrument and the Exploratory analysis	Focusing on female patients in a general hospital	Tangibility, responsiveness, reliability, assurance, empathy	Martins et al., (2015)
SEERVQUAL model, descriptive statistics, factor analysis, reliability analysis, independent t-test, one-way analysis of variance and regression analysis	Hospitals	Tangibility, responsiveness, reliability, assurance, empathy	Li et al., (2015)

Table 1
The summary of the related studies focusing on methods and criteria (Continued)

Method/model	Field	Criteria/sub-criteria	Author(s)(Year)
Entropy method	Hospitals	Human resources (health care staff), process, procedures and hospital infrastructure	Handayani et al., (2015)
SERVQUAL and Fuzzy hierarchical analysis	Public hospitals	Health care staff, accountability, support services, and relationships	Lupo (2016)
Multiple regression	Private hospitals	Tangibles, assurance and empathy (communication, , content, trustworthiness, stewardship, reliability, and, trust)	Aliman and Mohammad (2016)
Qualitative method (interviews)	Hospital	Technical facilities, interpersonal relationships, cost, access, accountability, values and results	Budivwan and Efendi (2016)
Review study by focusing on CRM	Hospital	Patient interaction and hospital relationship management	Vaish et al., (2016)
Qualitative study (Ten focus group discussions)	Healthcare centers to select place of delivery	High education and positive attitude of delivery staff, close proximity to the health facility, availability of providers, and modern equipment	Kimweri et al., (2016)
Structural Equation Modeling	Hospital	Tangibility, reliability, responsiveness, assurance and empathy	Meesala and Paul (2016)
Confirmatory factor analysis and ordinal regression	Hospital	Communication with nurses, communication with physicians, hospital environment, specific patient characteristics (age and health status) and structural characteristics of the hospital (type and location)	Mitropoulos et al., (2107)
Fuzzy Hierarchical Analysis, and SERVQUAL Method	Hospitals	Tangibility, responsiveness, reliability, assurance, empathy	Singh and Prasher (2019)
Focusing accreditation standards for limited surgery facilities using qualitative interviewing and DIMATEL	Limited surgery centers	Release and follow-up of patient safety, prevention and management of common surgical complications, infection prevention and control, continuous care after surgery, acute and emergency care, surgical and anesthesia care, quality management and patient safety, physical structure, safe facilities and equipment Respect for patient rights and human resource management	Asgari et al., (2020)
Fuzzy DEMATEL and Analytic network process	Teaching hospitals	Tangibility, reliability, responsiveness, assurance, empathy, and access	Farhadi et al., (2020)
SERVQUAL and machine learning algorithms	Hospitals	Being ready to be in the hospital, Adequacy of health care staff, Act ethically, general physical conditions of the hospital, Reliability in services, Accessibility, Food services, Information and communication, Cleaning, and Physical condition of hospital rooms	Altuntas et al., (2022)
Scrutinizing online reviews of medical and healthcare service platforms using latent DIRICHLET allocation (LDA) model	Medical services	Medical skills and ethics, reception services, surgery side effects, consultation services, drug treatment, diagnostic process, and medical equipment	Gao et al., (2022)
AHP and SERVQUAL	Public and private hospitals	Tangibles (Building layout, Equipment, Hygiene, Appearance, Space), Responsiveness (Timeliness, Completeness, Willingness, Accessibility, Promptness), Reliability (Accuracy, Expertise, Image, Skills, Knowledge), Assurance (Effective, Guarantee, Courtesy, Compensation), Empathy (Helpful, Manner, Concern, Understanding, Communication), Constancy (Skill, Honesty, Experience, Innovation), Security (Confidentiality, Personal safety, Hospital's infection safety)	Al Awadh (2022)
Delphi and DANP method	Cosmetic surgical clinics	Criteria and sub-criteria are Identified by reviewing the research background and then customizing by interviewing, and the Delphi method.	Current study

3. Research gap and new aspect of this research

According to the related literature, limited studies have been done regarding the evaluation of the quality of healthcare and medical services focusing on identifying the internal relationships between criteria and sub-criteria. There are rare studies focusing on the quality of surgical operations in hospitals such as Asgari et al., (2020) which focused on accreditation standards for limited surgery facilities using qualitative interviewing and the DEMATL technique. Additionally there is no study to evaluate service quality in cosmetic surgery clinics using the DANP (DEMATEL-based analytic network process) which is an integrated application of the decision making and trial evaluation laboratory (DEMATEL) and the analytic network process (ANP). The important point is that there are different sectors in healthcare and medical services and the criteria and sub-criteria of each sector and their weights can be different. Considering the nature of cosmetic surgeries because of their effect on beauty and appearance directly, the effective criteria can be different. On the other hand, these criteria and sub-criteria are not necessarily independent and their importance needs to be calculated regarding the relationships between them. Also, it seems that the complexity of some methods may create challenges to use by decision-makers of healthcare and medical services, therefore providing accurate and at the same time simple methods can greatly help increase the application of these methods in this field and cause Improve the quality and increase the satisfaction of the applicants. Therefore, due to the increasing demand for cosmetic surgeries in Iran, this study aims to propose an accurate simple model focusing on customized

effective criteria and sub-criteria in cosmetic surgery clinics. This research can be an effective step to improve the existing weaknesses and help to develop future studies in this field.

4. Material and method

Integrated multi-criteria decision-making (MCDM) methodologies as an effective tool provide reliable results to evaluate and analyze healthcare processes based on essential criteria (Karatas et al., 2018). Most of the time the interrelationships between criteria and sub-criteria have a network structure and must be modeled with nonlinear methods like DEMATEL and the analytic network process (ANP) to determine the priorities of them. So in this section, the proposed approach for service quality evaluation based on the Delphi and DANP method in a studied case is explained in detail.

4.1. Define decision group

As mentioned in the literature, in the studies based on paired comparisons of experts, the number of ten experts is sufficient (Saaty, 2002). This study has been run in three cosmetic surgical clinics, and 15 experts including physicians and nurses participated to answer research questionnaires.

4.2. Identify the service quality criteria and sub-criteria

By reviewing the related studies based on research background the all service quality evaluation criteria and sub-criteria related to medical services quality were listed. All criteria and sub-criteria have been presented according to Table 1.

4.3. Customize evaluation criteria and sub-criteria using the Delphi method

The Delphi method is an iterative approach used to summarize experts' opinions, using questionnaires and feedback in several rounds of interviews (Skulmoski et al., 2007). For the first step, a primary interview is performed with four experts to confirm the validity and comprehensiveness of the criteria and sub-criteria list. After that, first, the Delphi questionnaire is designed considering a five-point Likert scale including strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1) determining the relevance of the service quality criteria and sub-criteria and were distributed between experts during several rounds and they were also asked to add their proposed criteria. The criteria are selected based on the mean value (more than 4) in each round and if the difference between the two rounds is less than the threshold value (0.2), then the Delphi is ceased. In the end, the final list containing the screened criteria is then considered for interrelationship analysis in the next step.

4.4. Identify the cause-and-effect relationships of the customized criteria, and determine their weight with the DANP (Dematel Analytical Network Process) method

In traditional ANP, it is implicitly assumed that each cluster has the same weight, although it is clear that the influence of one cluster on other clusters may be different. Therefore, the traditional ANP assumption that the weight of the clusters is the same in creating the balanced super matrix is not reasonable; Subsequently, effective weights of the DANP method can solve this defect. In this method, the results are obtained based on the basic concept of ANP from the complete correlation matrix T_C and T_D which are calculated by DEMATEL. Therefore, the DEMATEL technique is used to build the network structure model for each criterion and dimension, as well as to improve the traditional ANP normalization process (Chiu et al., 2013). This technique is very suitable for real-world problems compared to traditional methods and takes into account the dependence between criteria, and finally, DEMATEL is combined with the ANP method to form DANP in order to determine the effective weights of each dimension and criterion. The network relations using the DEMATEL technique and determining the effective weights of DANP based on the complete connection matrix are described as follows (Chen et al., 2011, Hsu et al., 2012).

4.4.1. Calculate the direct relation matrix

The evaluation of the relationship between criteria (the influence of one criterion on another criterion) is done based on the opinions of research experts using a rating scale of 0 to 4, where 0 means no effect, 1 means little effect, 2 means medium effect, 3 means high impact and 4 means very high impact. Experts are asked to determine the effect of one criterion on another. That is, if they believe that criterion i has an effect on criterion j, they should show it as d_c^{ij}. Therefore, the matrix $D = [d_c^{ij}]$will be obtained from direct correlation.

$$D = \begin{bmatrix} d_c^{11} & \dots & d_c^{1j} & \dots & d_c^{1n} \\ \vdots & & \vdots & & \vdots \\ d_c^{i1} & \dots & d_c^{ij} & \dots & d_c^{in} \\ \vdots & & \vdots & & \vdots \\ d_c^{n1} & \dots & d_c^{nj} & \dots & d_c^{nn} \end{bmatrix} \quad (1)$$

4.4.2. Normalize the direct relation matrix

The direct correlation matrix D is normalized using the following relation and the matrix N is obtained.

$$N= VD;\ V= min\{1/\max_i \sum_{j=1}^{n} d_{ij}\ , 1/\max_j \sum_{i=1}^{n} d_{ij}\}\ , i,j \in \{1,2,\dots,n\} \tag{2}$$

4.4.3. Calculate the total influence/relation matrix

When the D matrix is normalized and the N matrix is obtained, the total relation matrix will be obtained through the following relationship. In this relation, I represents the identity matrix.

$$T= N+ N^2 + \cdots + N^h = N(I-N)^{-1}, when\ h \to \infty \tag{3}$$

The total relation matrix can be quantified by the criteria denoted by T_C:

$$T_c = \begin{array}{c} \\ D_1 \\ \vdots \\ D_i \\ \vdots \\ D_n \end{array} \begin{array}{c} \begin{array}{cccccc} D_1 & & D_j & & D_n \\ c_{11} \dots c_{1m_1} & \cdots & c_{j1} \dots c_{jm_j} & \cdots & c_{n1} \dots c_{nm_n} \end{array} \\ \begin{bmatrix} T_c^{11} & \cdots & T_c^{1j} & \cdots & T_c^{1n} \\ \vdots & & \vdots & & \vdots \\ T_c^{i1} & \cdots & T_c^{ij} & \cdots & T_c^{in} \\ \vdots & & \vdots & & \vdots \\ T_c^{n1} & \cdots & T_c^{nj} & \cdots & T_c^{nn} \end{bmatrix} \end{array} \tag{4}$$

4.4.4. Determine the causal parameters through Eqs. (5), (6) and (7)

In this step, the sum of the rows and columns of the total relation matrix is calculated separately according to the following equation.

$$T = [t_{ij}] \quad i,j \in \{1,2,\dots,n\} \tag{5}$$

$$r = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \tag{6}$$

$$d = [d_j]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \tag{7}$$

Index r_i indicates the row sum and d_j indicates represents the column sum. The $(r_i + d_j)$ index known as ''centrality degree'' is obtained from the sum of the ith row and the jth column (i=j). This index shows the importance of the ith criterion n the entire system. And also, the difference (ri− di) known as ''cause degree'' indicates the net effect of that factor i contribute to the system (Sufiyan et al, 2019). In general, if $(r_i - d_j)$ is positive, the ith criterion is causal or effective criterion. Moreover, if $(r_i - d)$ is negative, the ith criterion is an influential criterion. Causal diagram can be drawn based on the mentioned two indicators, which is known as network relationship map. According to this map, it is possible to decide how the dimensions and criteria can be improved.

4.4.5. Normalize the total dimension relation matrix ($T_D^{\propto}$)

The matrix T_D is formed by averaging T_C^{ij}. This matrix is normalized according to the following method, in such a way that the sum of each row is calculated and each element is divided by the sum of the elements of its corresponding row. The normalized total relation matrix T_D is shown as $\boldsymbol{T_D^{\propto}}$.

$$T_D = \begin{bmatrix} t_{11}^{D_{11}} & \text{L} & t_{1j}^{D_{1j}} & \text{L} & t_{1m}^{D_{1m}} \\ \text{M} & \text{M} & \text{M} & \text{M} & \text{M} \\ t_{i1}^{D_{i1}} & \text{L} & t_{ij}^{D_{ij}} & \text{L} & t_{im}^{D_{im}} \\ \text{M} & \text{M} & & \text{M} & \text{M} \\ t_{m1}^{D_{m1}} & \text{L} & t_{mj}^{D_{mj}} & \text{L} & t_{mm}^{D_{mm}} \end{bmatrix} \begin{array}{l} \longrightarrow d_1 = \sum_{j=1}^{m} t_{1j}^{D_{1j}} \\ \\ \longrightarrow d_i = \sum_{j=1}^{m} t_{ij}^{D_{ij}}\ , d_i = \sum_{j=1}^{m} t_{ij}^{D_{ij}}, i = 1,\dots,m \\ \\ \longrightarrow d_m = \sum_{j=1}^{m} t_{mj}^{D_{mj}} \end{array} \tag{8}$$

4.4.6. Normalize the total relation matrix of criteria ($T_C^{\propto}$)

The normalization of T_C with the total degree of influence and effectiveness of all criteria and dimensions to acquire $\boldsymbol{T_C^{\propto}}$ is as follows

$$d_{ci}^{11} = \sum_{j=1}^{m_1} t_{cij}^{11}\ , i = 1,2,\dots,m_1 \tag{9}$$

$$\boldsymbol{T_C^{\propto 11}} = \begin{bmatrix} t_{c11}^{11}/d_{c1}^{11} & \cdots & t_{c1j}^{11}/d_{c1}^{11} & \cdots & t_{c1m1}^{11}/d_{c1}^{11} \\ \vdots & & \vdots & & \vdots \\ t_{ci1}^{11}/d_{ci}^{11} & \cdots & t_{cij}^{11}/d_{ci}^{11} & \cdots & t_{cim1}^{11}/d_{ci}^{11} \\ \vdots & & \vdots & & \vdots \\ t_{cm11}^{11}/d_{cm1}^{11} & \cdots & t_{cm1j}^{11}/d_{cm1}^{11} & \cdots & t_{cm1m1}^{11}/d_{cm1}^{11} \end{bmatrix} = \begin{bmatrix} t_{c11}^{\propto 11} & \cdots & t_{c1j}^{\propto 11} & \cdots & t_{c1m1}^{\propto 11} \\ \vdots & & \vdots & & \vdots \\ t_{ci1}^{\propto 11} & \cdots & t_{cij}^{\propto 11} & \cdots & t_{cim1}^{\propto 11} \\ \vdots & & \vdots & & \vdots \\ t_{cm1\,1}^{\propto 11} & \cdots & t_{cm1j}^{\propto 11} & \cdots & t_{cm1m1}^{\propto 11} \end{bmatrix} \tag{10}$$

4.4.6. Develop the initial/unweighted supermatrix W

In this step, the transpose of the total relation matrix is normalized, $T_C^{\propto}$ is calculated and the W matrix is obtained. For example, a matrix such as the W^{11}matrix is empty or zero, it means that the related matrices are independent.

$$\boldsymbol{W} = (\boldsymbol{T}_c^{\alpha})' = \begin{array}{c} \\ D_1 \\ \\ \\ D_j \\ \\ \\ D_n \\ \\ \end{array} \begin{array}{c} \begin{array}{cccc} D_1 & & D_i & & D_n \end{array} \\ \begin{bmatrix} \boldsymbol{W}^{11} & \mathrm{L} & \boldsymbol{W}^{i1} & \mathrm{L} & \boldsymbol{W}^{n1} \\ \mathrm{M} & & \mathrm{M} & & \mathrm{M} \\ \boldsymbol{W}^{1j} & \mathrm{L} & \boldsymbol{W}^{ij} & \mathrm{L} & \boldsymbol{W}^{nj} \\ \mathrm{M} & & \mathrm{M} & & \mathrm{M} \\ \boldsymbol{W}^{1n} & \mathrm{L} & \boldsymbol{W}^{in} & \mathrm{L} & \boldsymbol{W}^{nn} \end{bmatrix} \end{array} \tag{11}$$

4.4.7. Develop the weighted supermatrix

In order to develop the weighted supermatrix, the normalized total relation matrix $T_D^{\propto}$ is transposed and multiplied by the unbalanced supermatrix.

$$\boldsymbol{W^{\propto}} = \boldsymbol{T_D^{\propto}}\boldsymbol{W} = \begin{bmatrix} t_D^{\propto 11} \times W^{11} & \cdots & t_D^{1i1} \times W^{i1} & \cdots & t_D^{\propto n1} \times W^{n1} \\ \vdots & & \vdots & & \vdots \\ t_D^{\propto 1j} \times W^{1j} & \cdots & t_D^{\propto ij} \times W^{ij} & \cdots & t_D^{\propto nj} \times W^{nj} \\ \vdots & & \vdots & & \vdots \\ t_D^{\propto 1n} \times W^{1n} & \cdots & t_D^{\propto in} \times W^{in} & \cdots & t_D^{\propto nn} \times W^{nn} \end{bmatrix} \tag{12}$$

4.4.8. Raise the weighted supermatrix to the limit power

In so doing, the matrix will converge to a stable situation, where the local and global weights, as well as the priority vectors, can be extracted. The output of this step will be DANP effective weights.

$$\lim_{Z\to\infty}(W^{\propto})^{Z} \tag{13}$$

5. Case illustration and results

5.1. Define decision group

Demographic information of knowledgeable experts in studied cosmetic surgery clinics, including their role, gender, age, and years of working experience are summarized according to Table 2.

Table 2
Demographic information of informants

Number	Role in cosmetic surgery clinics	Gender	Age (year)	Working experience (year)
1	Anesthesiologist	Male	50	15
2	Specialist surgeon	Male	54	16
3	Plastic surgeon specialist	Male	72	30
4	Ear, nose and throat surgeon	Female	48	10
5	Plastic surgeon specialist	Male	68	26
6	Plastic surgeon specialist	Male	69	28
7	Ear, nose and throat surgeon	Male	52	15
8	Nurse	Female	65	35
9	Plastic surgeon specialist	Male	49	9
10	Specialist surgeon	Male	58	20
11	Anesthesiologist	Female	54	21
12	General practitioner and emergency room	Male	49	15
13	Nurse	Male	43	5
14	Ear, nose and throat surgeon	Male	47	9
15	Breast surgery specialist	Male	51	11

5.2. Identify the service quality criteria and sub-criteria

Based on the previous related studies for evaluating the quality of medical and healthcare services, criteria and sub-criteria were explored and summarized according to Table 1.

5.3. Customize evaluation criteria and sub-criteria using the Delphi method

At first, a primary interview was performed with four key informants including a specialist surgeon, plastic surgeon specialist, and two nurses to confirm the validity and comprehensiveness of the criteria and sub-criteria. A questionnaire of the Delphi method was developed using identified criteria and sub-criteria. The Delphi method was applied in four rounds based on the consensus of key informants' opinions. According to experts' opinion sub-criteria with a score below 4 were removed. Therefore 42 sub-criteria in four classes/ criteria were customized in studied cosmetic surgery clinics according to Table 3.

Table 3
Customized criteria and sub-criteria

Criterion	Sub- criterion		Average
Healthcare staff (C1)	High surgical skills and understanding the patients' requirements	S11	4.4
	Staff availability	S12	4.2
	Readiness and tendency for teamwork	S13	4.533
	Reliability of employees due to experience	S14	4.667
	Neat and tidy appearance of staff and surgeons	S15	4.4
Responsiveness (C2)	Fast registration and admission process	S21	4.467
	Quality and accuracy of administrative affairs	S22	4.267
	Waiting time for test results	S23	4.333
	Waiting time for medical records	S24	4.4
	Motivation and willingness to help patients	S25	4.533
	Detailed notification system regarding the service delivery time	S26	4.467
	Accurately informing people to obtain consent before surgery	S27	4.6
	Fast responding to patients' requirements	S28	4.467
	Attention to suggestions and complaints of patients and their relatives	S29	4.4
Relationships between staff and patients/Connections (C3)	Cooperation and ability of administrative staff	S31	4.533
	Attention to patients according to their requirements by nurses and surgeons	S32	4.467
	Open to criticism about probable problems	S33	4.467
	Equal attention to all patients	S34	4.667
Support Services (C4)	Modern equipment and facilities	S41	4.6
	Feeling safe in the clinics	S42	4.533
	Clean environment in clinics	S43	4.733
	Quality of food and drink for patients	S44	4.467
	Adequacy of additional service units (dining room, lobby, etc.)	S45	4.533
	Suitable place for patients' relatives before meeting time	S46	4.667

5.4. Results of the DANP method

5.4.1. Calculate the direct relation matrix

At first, the direct relation between the criteria and sub-criteria are calculated based on Eq. (1) (the effect of one criterion on another one) by using experts' opinions and a range of 0 to 4 (0 = no effect, 1 = low effect, 2 = medium effect, 3 = high effect, and 4= very high effect). The matrix of direct relationship matrix has been presented in Appendix A.

5.4.2. Normalize the direct relation matrix

Normalized direct relation matrix is formed based on Eq. (2). This matrix has been presented in Appendix B.

5.4.3. Calculate the total influence/relation matrix

Finally the total influence/relation matrix is calculated according to Eq. (3) and Eq. (4). This matrix is given in Table 4.

Table 4
Total relation matrix (TC)

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.449	0.485	0.479	0.493	0.481	0.512	0.500	0.513	0.491	0.481	0.460	0.473	0.471	0.471	0.470	0.473	0.479	0.470	0.488	0.492	0.484	0.503	0.508	0.489
S12	0.429	0.391	0.431	0.428	0.421	0.453	0.434	0.442	0.433	0.423	0.405	0.417	0.421	0.411	0.418	0.407	0.415	0.417	0.426	0.427	0.427	0.434	0.439	0.425
S13	0.451	0.451	0.411	0.460	0.454	0.467	0.454	0.468	0.458	0.454	0.419	0.439	0.439	0.436	0.445	0.441	0.436	0.433	0.456	0.454	0.441	0.457	0.465	0.450
S14	0.444	0.447	0.454	0.420	0.449	0.471	0.461	0.475	0.463	0.447	0.424	0.434	0.443	0.437	0.428	0.445	0.438	0.441	0.447	0.450	0.448	0.456	0.464	0.450
S15	0.458	0.451	0.450	0.467	0.410	0.476	0.465	0.475	0.464	0.445	0.425	0.428	0.445	0.433	0.445	0.438	0.455	0.438	0.458	0.461	0.447	0.455	0.456	0.452
S21	0.454	0.456	0.444	0.463	0.451	0.434	0.460	0.472	0.456	0.448	0.425	0.432	0.440	0.437	0.438	0.437	0.438	0.445	0.449	0.455	0.450	0.460	0.467	0.445
S22	0.441	0.446	0.440	0.445	0.432	0.468	0.412	0.466	0.448	0.443	0.413	0.428	0.422	0.430	0.426	0.431	0.429	0.433	0.435	0.446	0.444	0.458	0.453	0.449
S23	0.444	0.440	0.434	0.446	0.438	0.462	0.452	0.425	0.452	0.450	0.420	0.426	0.429	0.426	0.439	0.426	0.430	0.426	0.444	0.453	0.436	0.446	0.457	0.443
S24	0.456	0.458	0.451	0.464	0.450	0.480	0.467	0.476	0.422	0.457	0.428	0.440	0.440	0.443	0.441	0.437	0.439	0.437	0.454	0.463	0.452	0.456	0.462	0.446
S25	0.468	0.464	0.458	0.468	0.459	0.492	0.470	0.500	0.476	0.425	0.442	0.450	0.448	0.446	0.451	0.456	0.466	0.454	0.472	0.464	0.459	0.471	0.479	0.460
S26	0.460	0.461	0.457	0.467	0.444	0.484	0.473	0.474	0.461	0.458	0.394	0.441	0.450	0.442	0.437	0.439	0.445	0.446	0.451	0.458	0.448	0.462	0.463	0.452
S27	0.502	0.498	0.500	0.501	0.489	0.524	0.500	0.513	0.501	0.484	0.467	0.435	0.475	0.474	0.476	0.479	0.476	0.469	0.486	0.498	0.498	0.498	0.505	0.489
S28	0.460	0.464	0.455	0.475	0.454	0.482	0.469	0.476	0.468	0.455	0.434	0.445	0.410	0.439	0.444	0.446	0.455	0.456	0.459	0.455	0.442	0.461	0.464	0.457
S29	0.472	0.461	0.457	0.479	0.459	0.484	0.469	0.483	0.471	0.465	0.434	0.449	0.457	0.409	0.445	0.453	0.449	0.447	0.458	0.465	0.465	0.466	0.473	0.463
S31	0.450	0.449	0.444	0.450	0.437	0.474	0.452	0.468	0.449	0.439	0.422	0.430	0.440	0.430	0.396	0.434	0.434	0.431	0.450	0.445	0.446	0.441	0.460	0.445
S32	0.456	0.458	0.445	0.468	0.462	0.475	0.463	0.474	0.461	0.454	0.428	0.430	0.439	0.435	0.446	0.403	0.435	0.443	0.444	0.465	0.444	0.459	0.464	0.454
S33	0.457	0.460	0.456	0.461	0.452	0.478	0.465	0.481	0.465	0.466	0.439	0.441	0.449	0.447	0.442	0.452	0.409	0.444	0.451	0.461	0.449	0.458	0.466	0.454
S34	0.449	0.451	0.448	0.456	0.436	0.467	0.457	0.474	0.446	0.438	0.424	0.427	0.444	0.423	0.433	0.434	0.441	0.399	0.460	0.448	0.442	0.455	0.457	0.447
S41	0.456	0.445	0.459	0.467	0.439	0.483	0.463	0.475	0.460	0.452	0.427	0.448	0.448	0.439	0.442	0.444	0.448	0.461	0.416	0.456	0.444	0.464	0.467	0.464
S42	0.453	0.440	0.449	0.454	0.442	0.466	0.451	0.471	0.452	0.450	0.425	0.431	0.438	0.424	0.434	0.436	0.443	0.437	0.446	0.412	0.445	0.445	0.456	0.441
S43	0.432	0.428	0.434	0.433	0.423	0.455	0.441	0.448	0.437	0.426	0.405	0.422	0.427	0.420	0.419	0.419	0.416	0.422	0.424	0.443	0.391	0.431	0.439	0.429
S44	0.457	0.446	0.454	0.461	0.443	0.466	0.462	0.468	0.453	0.445	0.427	0.435	0.437	0.437	0.436	0.436	0.435	0.430	0.448	0.449	0.459	0.416	0.457	0.441
S45	0.452	0.446	0.448	0.456	0.447	0.472	0.451	0.473	0.465	0.449	0.422	0.437	0.435	0.433	0.438	0.436	0.441	0.435	0.440	0.453	0.448	0.465	0.421	0.445
S46	0.435	0.433	0.432	0.431	0.434	0.453	0.431	0.450	0.441	0.429	0.411	0.410	0.420	0.413	0.422	0.417	0.415	0.416	0.428	0.424	0.429	0.435	0.450	0.392

5.4.4. Determine the causal parameters through Eqs. (5), (6) and (7)

The cause and effect diagrams are also given in Fig. 1, which show the internal relationships between the criteria and their mutual effects. The vertical line shows (r-d) whereas the horizontal line demonstrates (r+d).

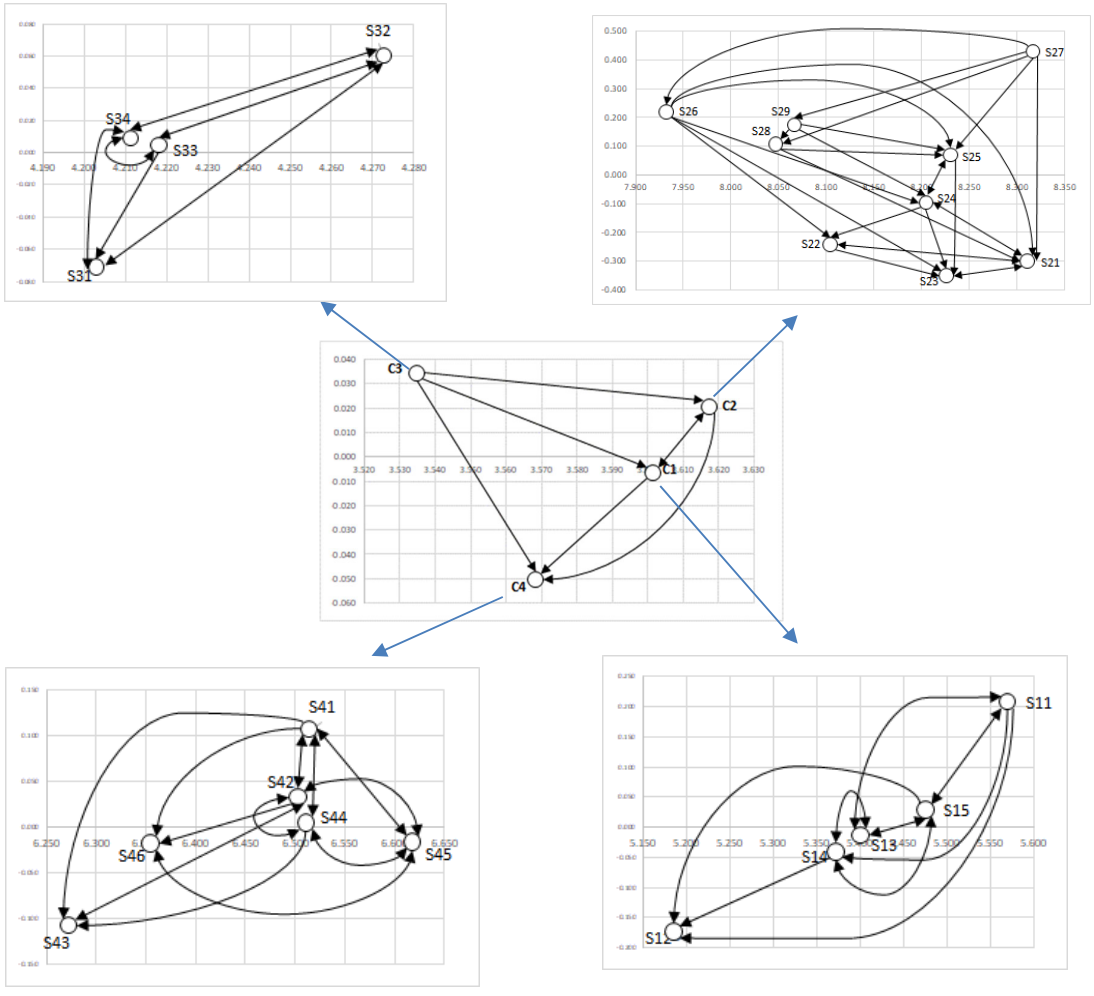

Fig. 1. Causal diagram of the criteria

Based on Table 5 and 6, the overall effects of sub-criteria and the overall effects of the main criteria are analyzed.

Table 5
General effects of the sub-criteria

	D	R	D+R	D-R
S11	2.386	2.230	4.617	0.156
S12	2.100	2.226	4.326	-0.125
S13	2.227	2.225	4.452	0.002
S14	2.215	2.267	4.482	-0.053
S15	2.235	2.215	4.451	0.020
S21	4.004	4.309	8.313	-0.305
S22	3.930	4.172	8.103	-0.242
S23	3.942	4.285	8.227	-0.343
S24	4.053	4.154	8.207	-0.101
S25	4.147	4.084	8.231	0.063
S26	4.076	3.858	7.934	0.218
S27	4.372	3.945	8.318	0.427
S28	4.077	3.970	8.048	0.107
S29	4.121	3.945	8.067	0.176
S31	1.694	1.717	3.411	-0.022
S32	1.728	1.723	3.450	0.005
S33	1.747	1.720	3.466	0.027
S34	1.707	1.717	3.424	-0.010
S41	2.711	2.602	5.313	0.109
S42	2.645	2.636	5.281	0.008
S43	2.556	2.616	5.172	-0.060
S44	2.669	2.657	5.326	0.013
S45	2.673	2.690	5.362	-0.017
S46	2.559	2.612	5.171	-0.052

Table 6
General effects of the main criteria

	D	R	D+R	D-R
C1	1.797	1.803	3.600	-0.005
C2	1.819	1.798	3.617	0.021
C3	1.785	1.749	3.534	0.035
C4	1.759	1.809	3.568	-0.051

5.4.5. Normalize the total dimension relation matrix ($T_D^{\propto}$)

The normalized total dimension relation matrix as shown in Table 7 is obtained by using equation (8)

Table 7
Normalized total dimension relation matrix

	C1	C2	C3	C4
C1	0.248	0.253	0.253	0.253
C2	0.252	0.249	0.252	0.252
C3	0.246	0.245	0.241	0.246
C4	0.254	0.253	0.254	0.250

5.4.6. Normalize the total relation matrix of criteria ($T_C^{\propto}$)

The normalized total relation matrix of criteria is formed according to equations (9)and (10). In this regards, appendix (C) shows the ($T_C^{\propto}$) matrix.

5.4.7. Develop the initial/unweighted supermatrix W

The initial/unweighted supermatrix W is obtained using equation (11). The results has been shown in Appendix (D).

5.4.8. Develop the weighted supermatrix

The developed weighted supermatrix is obtained from the unweighted supermatrix using Eq. (12) and places as Appendix E.

5.4.9. Raise the weighted supermatrix to the limit power

The final weights of criteria and sub-criteria are obtained directly from the steady-state values of limiting weighted supermatrix (Appendix F). Table 8 shows the calculated weights of the criteria and sub-criteria

Table 8
Final weights of criteria and sub-criteria

Criterion		Total weight	Rank
Healthcare staff (C1)	0.20449		
High surgical skills and understanding the patients' requirements		0.06128	1
Staff availability		0.02848	18
Readiness and tendency for teamwork		0.02938	16
Reliability of employees due to experience		0.04295	10
Neat and tidy appearance of staff and surgeons		0.0424	11
Responsiveness (C2)	0.42458		
Fast registration and admission process		0.06102	3
Quality and accuracy of administrative affairs		0.0422	12
Waiting time for test results		0.06099	4
Waiting time for medical records		0.05014	8
Motivation and willingness to help applicant		0.05111	5
Detailed notification system regarding the service delivery time		0.02839	19
Accurately informing people to obtain consent before surgery		0.06105	2
Fast response to patients' requirements		0.02786	20
Attention to suggestions and complaints of patients and their relatives		0.04182	13
Relationships between staff and patients/ Connections (C3)	0.12539		
Cooperation and ability of administrative staff		0.02931	17
Attention to patients according to their requirements by nurses and surgeons		0.04176	14
Criticism of personnel against the probable problems		0.02735	21
Equal attention to all patients		0.02697	23
Support services (C4)	0.24555		
Modern equipment and facilities		0.05053	6
Feeling safe in the clinics		0.04156	15
Clean environment in clinics		0.027	22
Quality of food and drink for patients		0.05027	7
Adequacy of additional service units (dining room, lobby, etc.)		0.04975	9
Suitable place for patients' relatives before the meeting time		0.02644	24

5. Discussion and managerial implementations

Improving service quality in healthcare service processes is a strategic and key issue. Identifying key criteria that affect healthcare service quality and computing their importance from patients' point of view as well as analyzing their expectations regarding each of these criteria, is the first step to improving service quality therefore for this purpose, it needs to utilize quantitative and precise methods. Providing patients' desired and expected services in specialized surgery clinics is a vital issue to survive in the current competitive and challenging market. Therefore, in order to survive in this competitive market, managers of clinics have changed their attitude toward continuous improvement to increase patients' satisfaction. In this regard, identifying and ranking the effective factors for improving the quality of treatment services according to the needs of patients is the first strategic step to realize this goal. In this section some managerial solutions based on of the results and achievements of the current study are presented to analyze and improve these factors.

According to the obtained results, responsiveness is the most effective criterion that affects service quality in cosmetic clinics. After that support services, healthcare staff, and relationships between staff and patients/ connections are effective criteria respectively. Considering that in the service processes, the quality assessment is done during the process of providing services, by contacting a person the service process begins and it is an opportunity to create trust and satisfaction or lack of satisfaction, the employees' behavior has a significant effect on people's mental perception of the service quality.

The interesting result of this study is that the most important sub-criterion affecting the quality of services of beauty clinics is high surgical skills and understanding the patients' requirements which is among the criteria of healthcare staff. Considering the nature of cosmetic surgeries because of their affecting beauty and appearance directly, it is very important for people to ensure the level of high surgical skills and expertise of the cosmetic specialist physician, as well as to fully understand the patients' requirements and expectations. According to the existing approach, people first based on the positive advertisements about cosmetic specialist physicians (Word-of-mouth advertising) and scrutinizing their previous surgeries, select their desired specialist physician, go to their office, and are hospitalized where the specialist physician performs cosmetic surgery, therefore the obtained results of this research are approved. Since selecting a clinic is greatly affected by selecting desired cosmetic specialist physicians by people, therefore, to be more competitive in this market, the managers of the cosmetic clinics must coagulate a work contract with famous physicians who have many patients and create the necessary facilities to attract them.

Additionally, accurately informing people to obtain consent before surgery is the most effective sub-criteria in the responsiveness criterion. Considering the nature of cosmetic surgeries and their effect on the appearance of people, a full explanation and documentation including simulated photos of the operated organ after the surgery operation and informing about the cost of surgery harms which cause the patients' dissatisfaction, is important.The fast registration and admission process is the next effective criterion, so having an accurate information system regarding the time of providing services to clients can improve service quality. Due to a large number of requests for various cosmetic procedures and the busyness of beauty surgeons in several different clinics, it needs precise scheduling for the time of surgery and responding to applicants. On one hand, different cosmetic surgeries, and different periods of needed care for each one, cause increasing waiting time and long delays in the scheduled time of cosmetic surgery and service delivery which sometimes takes several months of delay and successive postponements, therefore applicants may select other competitor clinics. And also waiting time for test results is concluded as an important criterion that confirms that responsiveness affects applicants' satisfaction.

Due to the fact that there is no laboratory in some cosmetic clinics, the needed pre-operative tests are performed in the contracted acceptable specialized laboratories, which are limited in number. The lack of mechanized relations between these clinics and laboratories and the speed of conducting and sending the results of the tests are accompanied by a long delay. Setting up a laboratory in specialized clinics is one of the feasible solutions to reduce the waiting time for test results, and even by cooperating with other specialized clinics and hospitals can gain more satisfaction. Another solution is to create an administrative automation system between laboratories and surgical clinics to speed up responsiveness and speed up surgical procedures.
Based on mentioned limitations, it seems that one of the solutions can be to establish some special clinics for only one or two cosmetic surgeries in order to plan more precisely and enhance the applicants' satisfaction. Establishment applicant data registration system to utilize real data and accurate methods such as statistical methods to forecast the demand of applicants for receiving surgical services, can help managers to plan more accurately. As mentioned by Wehde (2019) moving towards Healthcare 4.0 in the healthcare service process and the use of new technologies will improve performance and as a result, increase patient satisfaction and create a competitive advantage.

Hiring high-quality and experienced staff and increasing the salaries, causes more motivation and willingness to improve their performance and help applicants, additionally enhancing their work reliability. So applicants' satisfaction is achieved to a large extent. Modern equipment and facilities is the next key criterion. Awareness of the existence of modern and high-quality medical equipment, causes applicants will have a lot of peace of mind to perform surgery. In this regard, it is very important to apply related software systems for simulating the operated organ before surgery and to inform applicants about the appearance of the operated organ.

Modern equipment and facilities is the next key criterion. Awareness of the existence of modern and high-quality medical equipment, causes applicants will have a lot of peace of mind to perform surgery. In this regard, it is very important to apply related software systems for simulating the operated organ before surgery and to inform applicants about the appearance of the operated limb. The obtained result by Marinelli (2020) confirms this issue. The higher the D + R value shows the more interaction of criterion with others. So according to Table 7, responsiveness and healthcare staff are the most effective criteria. D-R value shows how much a criterion is affected by others. More value of D-R presents the criterion is more impressionable. Managers by improving these two criteria based on the mentioned solutions are able to improve support services and relationships between staff and patients/connections as causal criteria or dependent criteria.

Based on the mentioned results in Table 5, sub-criteria of responsiveness such as fast registration and admission process, waiting time for test results, and quality and accuracy of administrative affairs are the most impressionable ones. Managers are able to enhance responsiveness to applicants by improving other criteria. As mentioned before, this criterion has the most interaction with others. The results of this research are different from other results of researches which was conducted on effective criteria affect healthcare quality such as Asghari et al., (2020) which focused on surgeries process in a hospital. As a notable result, it is concluded that according to the kind of healthcare services, the quality evaluation criteria are different from the patient's point of view and the managers of medical centers must be aware of it.

6. Conclusions

Today, organizations providing healthcare services have realized that the satisfaction of applicants and patients will play a key role in their long-term success, survival, and competitive advantage. The satisfaction of applicants and patients is not accidental and requires the identification and improvement of factors affecting the desirability of service quality. The present research aims to provide a quality assessment model for cosmetic surgery services in the studied specialized clinics. One of the characteristics of the research is that the quality assessment criteria have been explained based on applicants' requirements and can be used in an effective manner in clinics and hospitals. In this research, a combined decision-making method of network analysis processes based on the DEMATEL technique is used. Considering that the criteria affecting the service quality are not independent, the importance of these criteria and the extent of their influence on each other have been calculated using the DANP method. In the following, areas that can be improved in the studied clinics were identified and solutions were suggested.

The results of this research can be used to analyze and improve service quality in healthcare service organizations. Translation of patients' expectations including reinforcing effective criteria in order to create more value for them can provide high-quality healthcare services (Marinelli, 2020). It is also suggested that the importance of the executive and detailed criteria presented in this research be analyzed and compared based on real data using data science methods. The lack of complexity of the proposed methods must also be considered to facilitate to use of them by healthcare service managers.

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Appendices

Appendix A- Direct relation matrix.

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0	2.47	2.13	2.47	2.53	2.73	2.93	2.93	2.4	2.33	2.47	2.67	2.27	2.6	2.33	2.53	2.8	2.27	2.8	2.73	2.6	3.27	3.27	2.87
S12	2.27	0	2.6	1.93	2.2	2.67	2.27	2.07	2.27	2.13	2.27	2.53	2.53	2.13	2.47	1.73	2.13	2.33	2.27	2.13	2.47	2.47	2.47	2.27
S13	2.27	2.47	0	2.53	2.93	2.13	2.13	2.27	2.47	2.73	1.87	2.6	2.33	2.47	2.8	2.53	2.07	2	2.87	2.47	2	2.53	2.67	2.47
S14	1.87	2.2	2.73	0	2.6	2.4	2.6	2.73	2.8	2.27	2.2	2.27	2.6	2.53	1.73	2.8	2.27	2.53	2.27	2.2	2.47	2.47	2.67	2.47
S15	2.6	2.27	2.33	2.87	0	2.53	2.73	2.6	2.73	2	2.13	1.73	2.53	2.07	2.67	2.2	3.2	2.2	2.87	2.8	2.27	2.27	1.93	2.47
S21	2.47	2.73	2	2.73	2.73	0	2.47	2.47	2.33	2.33	2.2	2.07	2.33	2.47	2.33	2.27	2.2	2.73	2.33	2.47	2.53	2.67	2.8	2.13
S22	2.13	2.6	2.33	2.13	2	2.73	0	2.67	2.33	2.53	1.93	2.4	1.67	2.53	2.07	2.4	2.13	2.53	2	2.47	2.67	3.07	2.4	2.93
S23	2.33	2.2	1.93	2.13	2.4	2.27	2.53	0	2.6	3	2.4	2.2	2.13	2.27	2.93	2.07	2.2	2	2.53	2.87	2.13	2.27	2.67	2.53
S24	2.4	2.73	2.33	2.6	2.47	2.73	2.8	2.6	0	2.73	2.27	2.47	2.2	2.67	2.4	2.07	2.07	2.07	2.53	2.87	2.53	2.27	2.27	2
S25	2.53	2.4	2.07	2.2	2.4	2.8	2.27	3.4	2.73	0	2.47	2.47	2	2.2	2.33	2.67	3.2	2.47	3	2.2	2.27	2.53	2.67	2.27
S26	2.6	2.73	2.6	2.73	1.93	2.87	3.07	2.33	2.33	2.67	0	2.4	2.73	2.53	2	2.13	2.4	2.53	2.2	2.4	2.13	2.53	2.2	2.27
S27	3.13	3	3.27	2.73	2.73	3.2	2.6	2.6	2.73	2.2	2.67	0	2.2	2.47	2.4	2.6	2.27	1.93	2.33	2.8	3.27	2.67	2.73	2.53
S28	2.4	2.8	2.33	3.07	2.47	2.6	2.67	2.33	2.67	2.33	2.4	2.53	0	2.2	2.33	2.4	2.87	3.07	2.6	2.07	1.6	2.27	2.13	2.47
S29	2.93	2.33	2.2	3.07	2.53	2.47	2.4	2.47	2.6	2.73	2.13	2.53	2.73	0	2.14	2.6	2.2	2.2	2.27	2.4	2.87	2.33	2.47	2.6
S31	2.53	2.6	2.4	2.2	2.13	2.87	2.33	2.6	2.2	2.07	2.33	2.33	2.67	2.33	0	2.4	2.27	2.13	2.8	2.2	2.67	1.8	2.67	2.47
S32	2.47	2.73	2	2.93	3.27	2.47	2.6	2.47	2.53	2.6	2.27	1.87	2.13	2.2	2.73	0	1.87	2.53	1.87	3	2	2.47	2.47	2.6
S33	2.27	2.6	2.47	2.2	2.4	2.4	2.47	2.67	2.53	3.13	2.8	2.33	2.53	2.73	2.2	2.87	0	2.33	2.13	2.53	2.13	2.13	2.33	2.33
S34	2.4	2.67	2.53	2.53	2	2.33	2.53	2.87	1.93	1.87	2.4	2	2.8	1.8	2.27	2.27	2.67	0	3.33	2.27	2.33	2.6	2.4	2.47
S41	2.27	1.73	2.73	2.67	1.6	2.87	2.4	2.4	2.27	2.27	2.07	2.87	2.6	2.33	2.33	2.4	2.6	3.53	0	2.27	1.87	2.67	2.47	3.07
S42	2.67	1.93	2.67	2.4	2.4	2.33	2.2	2.73	2.33	2.73	2.47	2.33	2.47	1.87	2.33	2.47	2.8	2.47	2.47	0	2.53	2	2.33	2.13
S43	2.27	2.13	2.6	2	2.07	2.6	2.53	2.2	2.33	2.13	2.07	2.67	2.67	2.53	2.27	2.27	1.93	2.47	1.93	2.93	0	2	2.2	2.27
S44	2.8	2.2	2.8	2.73	2.33	2.13	2.8	2.4	2.27	2.27	2.47	2.4	2.27	2.6	2.33	2.33	2.13	1.93	2.47	2.2	3.27	0	2.27	2
S45	2.4	2.2	2.4	2.4	2.53	2.53	2	2.67	3	2.47	2.13	2.53	2.13	2.33	2.47	2.27	2.53	2.2	1.87	2.47	2.53	3.13	0	2.27
S46	2.47	2.47	2.53	1.93	2.8	2.47	1.87	2.4	2.6	2.33	2.47	1.87	2.27	2.13	2.53	2.2	1.93	2.07	2.2	1.73	2.47	2.33	3	0

Appendix B

Normalized direct relation matrix

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.000	0.040	0.035	0.040	0.041	0.045	0.048	0.048	0.039	0.038	0.040	0.044	0.037	0.043	0.038	0.041	0.046	0.037	0.046	0.045	0.043	0.054	0.054	0.047
S12	0.037	0.000	0.043	0.032	0.036	0.044	0.037	0.034	0.037	0.035	0.037	0.041	0.041	0.035	0.040	0.028	0.035	0.038	0.037	0.035	0.040	0.040	0.040	0.037
S13	0.037	0.040	0.000	0.041	0.048	0.035	0.035	0.037	0.040	0.045	0.031	0.043	0.038	0.040	0.046	0.041	0.034	0.033	0.047	0.040	0.033	0.041	0.044	0.040
S14	0.031	0.036	0.045	0.000	0.043	0.039	0.043	0.045	0.046	0.037	0.036	0.037	0.043	0.041	0.028	0.046	0.037	0.041	0.037	0.036	0.040	0.040	0.044	0.040
S15	0.043	0.037	0.038	0.047	0.000	0.041	0.045	0.043	0.045	0.033	0.035	0.028	0.041	0.034	0.044	0.036	0.052	0.036	0.047	0.046	0.037	0.037	0.032	0.040
S21	0.040	0.045	0.033	0.045	0.045	0.000	0.040	0.040	0.038	0.038	0.036	0.034	0.038	0.040	0.038	0.037	0.036	0.045	0.038	0.040	0.041	0.044	0.046	0.035
S22	0.035	0.043	0.038	0.035	0.033	0.045	0.000	0.044	0.038	0.041	0.032	0.039	0.027	0.041	0.034	0.039	0.035	0.041	0.033	0.040	0.044	0.050	0.039	0.048
S23	0.038	0.036	0.032	0.035	0.039	0.037	0.041	0.000	0.043	0.049	0.039	0.036	0.035	0.037	0.048	0.034	0.036	0.033	0.041	0.047	0.035	0.037	0.044	0.041
S24	0.039	0.045	0.038	0.043	0.040	0.045	0.046	0.043	0.000	0.045	0.037	0.040	0.036	0.044	0.039	0.034	0.034	0.034	0.041	0.047	0.041	0.037	0.037	0.033
S25	0.041	0.039	0.034	0.036	0.039	0.046	0.037	0.056	0.045	0.000	0.040	0.040	0.033	0.036	0.038	0.044	0.052	0.040	0.049	0.036	0.037	0.041	0.044	0.037
S26	0.043	0.045	0.043	0.045	0.032	0.047	0.050	0.038	0.038	0.044	0.000	0.039	0.045	0.041	0.033	0.035	0.039	0.041	0.036	0.039	0.035	0.041	0.036	0.037
S27	0.051	0.049	0.054	0.045	0.045	0.052	0.043	0.043	0.045	0.036	0.044	0.000	0.036	0.040	0.039	0.043	0.037	0.032	0.038	0.046	0.054	0.044	0.045	0.041
S28	0.039	0.046	0.038	0.050	0.040	0.043	0.044	0.038	0.044	0.038	0.039	0.041	0.000	0.036	0.038	0.039	0.047	0.050	0.043	0.034	0.026	0.037	0.035	0.040
S29	0.048	0.038	0.036	0.050	0.041	0.040	0.039	0.040	0.043	0.045	0.035	0.041	0.045	0.000	0.035	0.043	0.036	0.036	0.037	0.039	0.047	0.038	0.040	0.043
S31	0.041	0.043	0.039	0.036	0.035	0.047	0.038	0.043	0.036	0.034	0.038	0.038	0.044	0.038	0.000	0.039	0.037	0.035	0.046	0.036	0.044	0.029	0.044	0.040
S32	0.040	0.045	0.033	0.048	0.054	0.040	0.043	0.040	0.041	0.043	0.037	0.031	0.035	0.036	0.045	0.000	0.031	0.041	0.031	0.049	0.033	0.040	0.040	0.043
S33	0.037	0.043	0.040	0.036	0.039	0.039	0.040	0.044	0.041	0.051	0.046	0.038	0.041	0.045	0.036	0.047	0.000	0.038	0.035	0.041	0.035	0.035	0.038	0.038
S34	0.039	0.044	0.041	0.041	0.033	0.038	0.041	0.047	0.032	0.031	0.039	0.033	0.046	0.029	0.037	0.037	0.044	0.000	0.055	0.037	0.038	0.043	0.039	0.040
S41	0.037	0.028	0.045	0.044	0.026	0.047	0.039	0.039	0.037	0.037	0.034	0.047	0.043	0.038	0.038	0.039	0.043	0.058	0.000	0.037	0.031	0.044	0.040	0.050
S42	0.044	0.032	0.044	0.039	0.039	0.038	0.036	0.045	0.038	0.045	0.040	0.038	0.040	0.031	0.038	0.040	0.046	0.040	0.040	0.000	0.041	0.033	0.038	0.035
S43	0.037	0.035	0.043	0.033	0.034	0.043	0.041	0.036	0.038	0.035	0.034	0.044	0.044	0.041	0.037	0.037	0.032	0.040	0.032	0.048	0.000	0.033	0.036	0.037
S44	0.046	0.036	0.046	0.045	0.038	0.035	0.046	0.039	0.037	0.037	0.040	0.039	0.037	0.043	0.038	0.038	0.035	0.032	0.040	0.036	0.054	0.000	0.037	0.033
S45	0.039	0.036	0.039	0.039	0.041	0.041	0.033	0.044	0.049	0.040	0.035	0.041	0.035	0.038	0.040	0.037	0.041	0.036	0.031	0.040	0.041	0.051	0.000	0.037
S46	0.040	0.040	0.041	0.032	0.046	0.040	0.031	0.039	0.043	0.038	0.040	0.031	0.037	0.035	0.041	0.036	0.032	0.034	0.036	0.028	0.040	0.038	0.049	0.000

Appendix C

Normalized total relation matrix of criteria ($T_C^{\propto}$).

.	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.188	0.203	0.201	0.206	0.202	0.117	0.114	0.117	0.112	0.110	0.105	0.108	0.108	0.108	0.248	0.250	0.253	0.248	0.165	0.166	0.163	0.170	0.171	0.165
S12	0.204	0.186	0.205	0.204	0.201	0.118	0.113	0.115	0.113	0.110	0.105	0.109	0.110	0.107	0.252	0.246	0.250	0.251	0.165	0.166	0.165	0.169	0.170	0.165
S13	0.202	0.203	0.185	0.206	0.204	0.116	0.112	0.116	0.113	0.112	0.104	0.109	0.109	0.108	0.253	0.251	0.248	0.247	0.168	0.167	0.162	0.168	0.171	0.165
S14	0.201	0.202	0.205	0.190	0.203	0.116	0.114	0.117	0.114	0.110	0.105	0.107	0.109	0.108	0.244	0.254	0.250	0.252	0.165	0.166	0.165	0.168	0.171	0.166
S15	0.205	0.202	0.201	0.209	0.183	0.117	0.115	0.117	0.114	0.110	0.105	0.106	0.110	0.107	0.250	0.247	0.256	0.247	0.168	0.169	0.164	0.167	0.167	0.166
S21	0.200	0.201	0.196	0.204	0.199	0.108	0.115	0.118	0.114	0.112	0.106	0.108	0.110	0.109	0.249	0.249	0.249	0.253	0.165	0.167	0.165	0.169	0.171	0.163
S22	0.200	0.202	0.200	0.202	0.196	0.119	0.105	0.119	0.114	0.113	0.105	0.109	0.107	0.109	0.248	0.251	0.249	0.252	0.162	0.166	0.165	0.170	0.169	0.167
S23	0.202	0.200	0.197	0.202	0.199	0.117	0.115	0.108	0.115	0.114	0.107	0.108	0.109	0.108	0.255	0.248	0.250	0.247	0.166	0.169	0.163	0.166	0.171	0.166
S24	0.200	0.201	0.198	0.203	0.197	0.118	0.115	0.118	0.104	0.113	0.106	0.109	0.109	0.109	0.252	0.249	0.250	0.249	0.166	0.170	0.165	0.167	0.169	0.163
S25	0.202	0.200	0.197	0.202	0.198	0.119	0.113	0.120	0.115	0.102	0.106	0.109	0.108	0.107	0.247	0.250	0.255	0.248	0.168	0.165	0.163	0.168	0.171	0.164
S26	0.201	0.201	0.200	0.204	0.194	0.119	0.116	0.116	0.113	0.112	0.097	0.108	0.110	0.108	0.247	0.249	0.252	0.252	0.165	0.168	0.164	0.169	0.169	0.165
S27	0.202	0.200	0.201	0.201	0.196	0.120	0.114	0.117	0.114	0.111	0.107	0.100	0.109	0.108	0.250	0.252	0.250	0.247	0.163	0.167	0.168	0.168	0.170	0.164
S28	0.199	0.201	0.197	0.206	0.197	0.118	0.115	0.117	0.115	0.111	0.106	0.109	0.100	0.108	0.247	0.247	0.252	0.253	0.168	0.166	0.161	0.168	0.169	0.167
S29	0.203	0.198	0.196	0.206	0.197	0.118	0.114	0.117	0.114	0.113	0.105	0.109	0.111	0.099	0.248	0.252	0.250	0.249	0.164	0.167	0.167	0.167	0.170	0.166
S31	0.202	0.201	0.199	0.202	0.196	0.118	0.113	0.117	0.112	0.110	0.105	0.108	0.110	0.107	0.234	0.256	0.256	0.254	0.167	0.166	0.166	0.164	0.171	0.166
S32	0.199	0.200	0.195	0.204	0.202	0.117	0.114	0.117	0.114	0.112	0.105	0.106	0.108	0.107	0.258	0.233	0.252	0.257	0.163	0.170	0.163	0.168	0.170	0.166
S33	0.200	0.201	0.200	0.202	0.198	0.116	0.113	0.116	0.113	0.113	0.106	0.107	0.109	0.108	0.253	0.259	0.234	0.254	0.165	0.168	0.164	0.167	0.170	0.166
S34	0.200	0.201	0.200	0.204	0.195	0.117	0.114	0.118	0.112	0.109	0.106	0.107	0.111	0.106	0.254	0.254	0.259	0.233	0.170	0.165	0.163	0.168	0.169	0.165
S41	0.201	0.197	0.203	0.206	0.194	0.118	0.113	0.116	0.112	0.110	0.104	0.109	0.109	0.107	0.246	0.247	0.250	0.257	0.154	0.168	0.164	0.171	0.172	0.171
S42	0.202	0.196	0.201	0.203	0.198	0.116	0.113	0.118	0.113	0.112	0.106	0.108	0.109	0.106	0.248	0.249	0.253	0.250	0.169	0.156	0.168	0.168	0.172	0.167
S43	0.201	0.199	0.202	0.201	0.197	0.117	0.114	0.115	0.113	0.110	0.104	0.109	0.110	0.108	0.250	0.250	0.248	0.252	0.166	0.173	0.153	0.169	0.172	0.168
S44	0.202	0.197	0.201	0.204	0.196	0.116	0.115	0.116	0.112	0.110	0.106	0.108	0.108	0.108	0.251	0.251	0.250	0.248	0.168	0.168	0.172	0.156	0.171	0.165
S45	0.201	0.198	0.199	0.203	0.199	0.117	0.112	0.117	0.115	0.111	0.105	0.108	0.108	0.107	0.251	0.249	0.252	0.248	0.165	0.170	0.168	0.174	0.158	0.167
S46	0.201	0.200	0.200	0.199	0.200	0.117	0.112	0.117	0.114	0.111	0.106	0.106	0.109	0.107	0.253	0.250	0.249	0.249	0.167	0.166	0.168	0.170	0.176	0.153

Appendix D

Initial/unweighted supermatrix

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.188	0.204	0.202	0.201	0.205	0.200	0.200	0.202	0.200	0.202	0.201	0.202	0.199	0.203	0.202	0.199	0.200	0.200	0.201	0.202	0.201	0.202	0.201	0.201
S12	0.203	0.186	0.203	0.202	0.202	0.201	0.202	0.200	0.201	0.200	0.201	0.200	0.201	0.198	0.201	0.200	0.201	0.201	0.197	0.196	0.199	0.197	0.198	0.200
S13	0.201	0.205	0.185	0.205	0.201	0.196	0.200	0.197	0.198	0.197	0.200	0.201	0.197	0.196	0.199	0.195	0.200	0.200	0.203	0.201	0.202	0.201	0.199	0.200
S14	0.206	0.204	0.206	0.190	0.209	0.204	0.202	0.202	0.203	0.202	0.204	0.201	0.206	0.206	0.202	0.204	0.202	0.204	0.206	0.203	0.201	0.204	0.203	0.199
S15	0.202	0.201	0.204	0.203	0.183	0.199	0.196	0.199	0.197	0.198	0.194	0.196	0.197	0.197	0.196	0.202	0.198	0.195	0.194	0.198	0.197	0.196	0.199	0.200
S21	0.117	0.118	0.116	0.116	0.117	0.108	0.119	0.117	0.118	0.119	0.119	0.120	0.118	0.118	0.118	0.117	0.116	0.117	0.118	0.116	0.117	0.116	0.117	0.117
S22	0.114	0.113	0.112	0.114	0.115	0.115	0.105	0.115	0.115	0.113	0.116	0.114	0.115	0.114	0.113	0.114	0.113	0.114	0.113	0.113	0.114	0.115	0.112	0.112
S23	0.117	0.115	0.116	0.117	0.117	0.118	0.119	0.108	0.118	0.120	0.116	0.117	0.117	0.117	0.117	0.117	0.116	0.118	0.116	0.118	0.115	0.116	0.117	0.117
S24	0.112	0.113	0.113	0.114	0.114	0.114	0.114	0.115	0.104	0.115	0.113	0.114	0.115	0.114	0.112	0.114	0.113	0.112	0.112	0.113	0.113	0.112	0.115	0.114
S25	0.110	0.110	0.112	0.110	0.110	0.112	0.113	0.114	0.113	0.102	0.112	0.111	0.111	0.113	0.110	0.112	0.113	0.109	0.110	0.112	0.110	0.110	0.111	0.111
S26	0.105	0.105	0.104	0.105	0.105	0.106	0.105	0.107	0.106	0.106	0.097	0.107	0.106	0.105	0.105	0.105	0.106	0.106	0.104	0.106	0.104	0.106	0.105	0.106
S27	0.108	0.109	0.109	0.107	0.106	0.108	0.109	0.108	0.109	0.109	0.108	0.100	0.109	0.109	0.108	0.106	0.107	0.107	0.109	0.108	0.109	0.108	0.108	0.106
S28	0.108	0.110	0.109	0.109	0.110	0.110	0.107	0.109	0.109	0.108	0.110	0.109	0.100	0.111	0.110	0.108	0.109	0.111	0.109	0.109	0.110	0.108	0.108	0.109
S29	0.108	0.107	0.108	0.108	0.107	0.109	0.109	0.108	0.109	0.107	0.108	0.108	0.108	0.099	0.107	0.107	0.108	0.106	0.107	0.106	0.108	0.108	0.107	0.107
S31	0.248	0.252	0.253	0.244	0.250	0.249	0.248	0.255	0.252	0.247	0.247	0.250	0.247	0.248	0.234	0.258	0.253	0.254	0.246	0.248	0.250	0.251	0.251	0.253
S32	0.250	0.246	0.251	0.254	0.247	0.249	0.251	0.248	0.249	0.250	0.249	0.252	0.247	0.252	0.256	0.233	0.259	0.254	0.247	0.249	0.250	0.251	0.249	0.250
S33	0.253	0.250	0.248	0.250	0.256	0.249	0.249	0.250	0.250	0.255	0.252	0.250	0.252	0.250	0.256	0.252	0.234	0.259	0.250	0.253	0.248	0.250	0.252	0.249
S34	0.248	0.251	0.247	0.252	0.247	0.253	0.252	0.247	0.249	0.248	0.252	0.247	0.253	0.249	0.254	0.257	0.254	0.233	0.257	0.250	0.252	0.248	0.248	0.249
S41	0.165	0.165	0.168	0.165	0.168	0.165	0.162	0.166	0.166	0.168	0.165	0.163	0.168	0.164	0.167	0.163	0.165	0.170	0.154	0.169	0.166	0.168	0.165	0.167
S42	0.166	0.166	0.167	0.166	0.169	0.167	0.166	0.169	0.170	0.165	0.168	0.167	0.166	0.167	0.166	0.170	0.168	0.165	0.168	0.156	0.173	0.168	0.170	0.166
S43	0.163	0.165	0.162	0.165	0.164	0.165	0.165	0.163	0.165	0.163	0.164	0.168	0.161	0.167	0.166	0.163	0.164	0.163	0.164	0.168	0.153	0.172	0.168	0.168
S44	0.170	0.169	0.168	0.168	0.167	0.169	0.170	0.166	0.167	0.168	0.169	0.168	0.168	0.167	0.164	0.168	0.167	0.168	0.171	0.168	0.169	0.156	0.174	0.170
S45	0.171	0.170	0.171	0.171	0.167	0.171	0.169	0.171	0.169	0.171	0.169	0.170	0.169	0.170	0.171	0.170	0.170	0.169	0.172	0.172	0.172	0.171	0.158	0.176
S46	0.165	0.165	0.165	0.166	0.166	0.163	0.167	0.166	0.163	0.164	0.165	0.164	0.167	0.166	0.166	0.166	0.166	0.165	0.171	0.167	0.168	0.165	0.167	0.153

Appendix E

Weighted supermatrix.

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.047	0.051	0.050	0.050	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.050	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
S12	0.051	0.046	0.050	0.050	0.050	0.051	0.051	0.050	0.051	0.051	0.051	0.051	0.051	0.050	0.051	0.051	0.051	0.051	0.050	0.050	0.050	0.050	0.050	0.051
S13	0.050	0.051	0.046	0.051	0.050	0.049	0.050	0.050	0.050	0.050	0.050	0.051	0.050	0.050	0.051	0.049	0.051	0.051	0.051	0.051	0.051	0.051	0.050	0.050
S14	0.051	0.051	0.051	0.047	0.052	0.052	0.051	0.051	0.051	0.051	0.052	0.051	0.052	0.052	0.051	0.052	0.051	0.052	0.052	0.051	0.051	0.052	0.051	0.050
S15	0.050	0.050	0.051	0.050	0.046	0.050	0.050	0.050	0.050	0.050	0.049	0.050	0.050	0.050	0.050	0.051	0.050	0.049	0.049	0.050	0.050	0.050	0.050	0.051
S21	0.029	0.030	0.029	0.029	0.030	0.027	0.030	0.029	0.029	0.030	0.030	0.030	0.029	0.029	0.030	0.029	0.029	0.029	0.030	0.029	0.030	0.029	0.029	0.030
S22	0.029	0.028	0.028	0.029	0.029	0.029	0.026	0.029	0.029	0.028	0.029	0.028	0.029	0.028	0.028	0.029	0.028	0.029	0.028	0.028	0.029	0.029	0.028	0.028
S23	0.030	0.029	0.029	0.029	0.029	0.029	0.030	0.027	0.029	0.030	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.030	0.029	0.030	0.029	0.029	0.029	0.029
S24	0.028	0.028	0.029	0.029	0.029	0.028	0.028	0.029	0.026	0.029	0.028	0.029	0.029	0.029	0.028	0.029	0.028	0.028	0.028	0.028	0.028	0.028	0.029	0.029
S25	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.026	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
S26	0.026	0.027	0.026	0.026	0.026	0.026	0.026	0.027	0.026	0.027	0.024	0.027	0.027	0.026	0.027	0.027	0.027	0.027	0.026	0.027	0.026	0.027	0.026	0.027
S27	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.025	0.027	0.027	0.027	0.027	0.027	0.027	0.028	0.027	0.027	0.027	0.027	0.027
S28	0.027	0.028	0.027	0.028	0.028	0.027	0.027	0.027	0.027	0.027	0.028	0.027	0.025	0.028	0.028	0.027	0.027	0.028	0.028	0.028	0.028	0.027	0.027	0.027
S29	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.025	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
S31	0.061	0.062	0.062	0.060	0.062	0.061	0.061	0.062	0.062	0.060	0.061	0.061	0.060	0.061	0.056	0.062	0.061	0.061	0.061	0.061	0.061	0.062	0.062	0.062
S32	0.061	0.060	0.062	0.062	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.062	0.061	0.062	0.062	0.056	0.062	0.061	0.061	0.061	0.061	0.062	0.061	0.061
S33	0.062	0.062	0.061	0.061	0.063	0.061	0.061	0.061	0.061	0.062	0.062	0.061	0.062	0.061	0.062	0.061	0.056	0.062	0.061	0.062	0.061	0.062	0.062	0.061
S34	0.061	0.062	0.061	0.062	0.061	0.062	0.062	0.061	0.061	0.061	0.062	0.060	0.062	0.061	0.061	0.062	0.061	0.056	0.063	0.061	0.062	0.061	0.061	0.061
S41	0.042	0.042	0.043	0.042	0.043	0.042	0.041	0.042	0.042	0.043	0.042	0.041	0.042	0.042	0.042	0.041	0.042	0.043	0.038	0.042	0.041	0.042	0.041	0.042
S42	0.042	0.042	0.042	0.042	0.043	0.042	0.042	0.043	0.043	0.042	0.042	0.042	0.042	0.042	0.042	0.043	0.043	0.042	0.042	0.039	0.043	0.042	0.042	0.041
S43	0.041	0.042	0.041	0.042	0.042	0.042	0.042	0.041	0.042	0.041	0.041	0.042	0.041	0.042	0.042	0.041	0.042	0.041	0.041	0.042	0.038	0.043	0.042	0.042
S44	0.043	0.043	0.043	0.043	0.042	0.043	0.043	0.042	0.042	0.043	0.043	0.042	0.043	0.042	0.042	0.043	0.042	0.043	0.043	0.042	0.042	0.039	0.043	0.042
S45	0.044	0.043	0.043	0.043	0.042	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.039	0.044
S46	0.042	0.042	0.042	0.042	0.042	0.041	0.042	0.042	0.041	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.043	0.042	0.042	0.041	0.042	0.038

Appendix F

Limiting supermatrix.

	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S29	S31	S32	S33	S34	S41	S42	S43	S44	S45	S46
S11	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613	0.0613
S12	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285
S13	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294
S14	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430
S15	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
S21	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610
S22	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422
S23	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610	0.0610
S24	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501
S25	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511
S26	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284	0.0284
S27	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611
S28	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279
S29	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418
S31	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
S32	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418	0.0418
S33	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274
S34	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270
S41	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505	0.0505
S42	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416
S43	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270	0.0270
S44	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503	0.0503
S45	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498	0.0498
S46	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264