


Economic, Cultural, and Political Requirements for Medical Tourism Development in Iran: Insights from a Fuzzy Analytical Hierarchy Process Method

Ali Sarabi Asiabar¹, Aziz Rezapour¹, Behzad Raei², Ali Tahernezhad³, Vahid Alipour¹, Masoud Behzadifar⁴, Zahra Sohrabi Anbohi¹, Pezhman Atefi Manesh⁵, Pir Hossein Kolivand⁶, Nicola Luigi Bragazzi⁷, Samad Azari^{8,1*} 

Received: 24 May 2021

Published: 31 Dec 2021

Abstract

Background: According to the World Bank, the medical tourism industry in 2016 generated more than \$100 billion revenue turnover for the destination countries. This study aims to investigate the developmental requirements of medical tourism industry in Iran to identify sustainable development strategies within this sector.

Methods: The present study was an applied-analytical study performed in a cross-sectional manner. A total of 25 experts, including policy experts, decision-makers, and managers with over 10 years of experience in the health system and familiar with the process of attracting medical tourists from foreign countries were asked to compare options for the development of the medical tourism. Expert opinions were analyzed using a fuzzy analytical hierarchy process using the open-source R Studio software.

Results: Out of the 5 items included in the questionnaire, the criterion of "government policy making and related entities" was ranked the first in terms of importance and prioritization for medical tourism development (0.249) through attracting domestic and foreign investments followed by advertising and marketing (0.241). Also, the criteria of "destination characteristics" and "facilities and status of service capacities with 0.111 and 0.185 weights had the lowest weight among the 5 items, respectively.

Conclusion: In general, governments play a key role in marketing and promoting the nascent medical tourism industry. Experts in the field believe that the role of government, policy and decision-makers in medical tourism can be an advantage for its prosperity and development.

Keywords: Medical tourism, AHP, Fuzzy, Iran

Conflicts of Interest: None declared

Funding: This study was part of a research project funded by the Health Management and Economics Research Center affiliated to Iran University of medical sciences (Grant no: 95-04-163-29806 and ethical code: IR.IUMS.REC. 1395.95-04-163-29806).

***This work has been published under CC BY-NC-SA 1.0 license.**

Copyright© Iran University of Medical Sciences

Cite this article as: Sarabi Asiabar A, Rezapour A, Raei B, Tahernezhad A, Alipour V, Behzadifar M, Sohrabi Anbohi Z, Atefi Manesh P, Kolivand PH, Bragazzi NL, Azari S. Economic, Cultural, and Political Requirements for Medical Tourism Development in Iran: Insights from a Fuzzy Analytical Hierarchy Process Method. *Med J Islam Repub Iran*. 2021 (31 Dec);35:199. <https://doi.org/10.47176/mjiri.35.199>

Introduction

Globalization and liberalization of the health services trade, expanding access to the Internet and to the latest

technological advancements, improving standards of care in most countries, and facilitating international travelling

Corresponding author: Dr Samad Azari, azari.sa@iums.ac.ir

¹ Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran

² Department of Health Management & Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

³ Health Management Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

⁴ Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

⁵ Cellular and Molecular Research Center, Iran University of Medical Sciences, Tehran, Iran

⁶ Department of Health Economics, Shahed University, Tehran, Iran

⁷ Laboratory for Industrial and Applied Mathematics (LIAM), Department of Mathematics and Statistics, York University, Toronto, Canada

⁸ Hospital Management Research Center, Iran University of Medical Sciences, Tehran, Iran

↑What is "already known" in this topic:

Very few studies in the respective literature have been performed on health tourism and they often have restrictions in the identification of affecting factors, and thus could not take account of the weights of determinant drivers related to health tourism industry.

→What this article adds:

This was the first study in Iran to be conducted using a method of fuzzy analytic hierarchy process (AHP) to quantify the contribution of factors in improving the climate of health tourism industry in the country. Our findings revealed that the role of Iran's government can be the most crucial drive in the tourism boom.

from developed countries characterized by rising costs of medical services to developing countries, in which healthcare provisions are more affordable, have led to the development of medical tourism in developing countries (1).

According to the "World Tourism Organization" (WTO), medical tourists can be defined as the delivery of healthcare services that improve or enhance physical, psychological health, and well-being by a variety of medical interventions in a place outside the individual's residence and lasting for more than 24 hours (2, 3).

By creating an inflow of resources into the country, medical tourism can inject surplus resources into the health sector and increase the health sector's share of gross domestic product (GDP) (4). It can also prevent the migration of medical personnel, especially specialists, and reduce the phenomenon of brain drain (5, 6). According to reliable international reports by organizations such as the World Bank and the "Medical Tourism Association" (MTA), the medical tourism industry in 2016 generated more than \$100 billion revenue turnover for the destination countries. According to the reports, more than 11 million tourists have travelled for receiving medical services. Financially, the industry is experiencing 25% annual growth (7). According to the medical tourism studies, each tourist brings about \$5,000 into the country, and a fixed job can be created for every \$7,000. It has also been estimated that each medical tourist on average generates foreign currency earnings 3 times more than the ordinary tourist (8), which has made this industry the fourth largest income generator in the world.

In terms of GDP share of direct revenues from travel and tourism, Iran was ranked 37th out of 184 countries with \$10.1 billion in 2012 (9), while statistics for 2007 showed that only 12% of THE total tourism industry revenues were derived from health care services. According to Iran's 20-year vision plan, Iran aims at being ranked first in the area of health tourism and becoming the major center of health and medical needs of the Eastern Mediterranean Regional Office (EMRO) area. By the end of 2020, Iran is expected to attract about 5 million international tourists and, consequently, 2 billion foreign currency earnings (10). In a study aimed at assessing medical tourists and its challenges in Iran, results showed that this country, despite adequate medical tourism capacities and several advantages, faces numerous problems and issues, such as the lack of advertising, marketing, a comprehensive insurance coverage, specialist doctors, compliance with international standards and information technology (IT) infrastructure (11). Moreover, Iran is suffering from political instability and has to compete with other countries, such as Thailand, Malaysia, Singapore, India, and Turkey to increase its share in the medical tourism industry.

Results of a study by Kazemi (2008) on factors and determinants affecting medical tourism attraction in Iran showed that cross-sectoral participation at the macroeconomic and operational levels, development of human resources and medical infrastructure (12, 13), adoption of international standards in medical centers, as well as medical equipment and visa issuance are the most important

factors impacting the development and growth of medical tourism industry in Iran (13). Another study showed that Iran has a great potential to attract health tourists, both from an economic point of view and from the human resources perspective (14-16). Iran's capacity to attract medical tourists, which may not be viewed positively from a macroeconomic perspective, is due to the lower value of the Rial compared with foreign currencies such as US dollar, Euro, and even the currencies of the Persian Gulf countries. This capacity creates an incentive for medical tourists to travel to Iran, preferring it to the neighboring countries of the EMRO region because of the high purchasing power of their currencies, thus receiving affordable but high-quality medical services (17).

Given the importance of medical tourism industry for the economy of developing countries and the increasing competition to attract medical tourists, this study aimed at investigating the development requirements of this industry in Iran. By identifying sustainable development strategies and focusing on priorities in the decision-making process, optimal allocation and use of resources, Iran can gain and maintain competitive advantages in this sector.

Methods

The next paragraphs briefly overview the multistep methodology adopted in the present applied analytical study. The first step consisted in searching for relevant documents, through a comprehensive library research and study evaluation, enabling to identify the major requirements and determinants affecting medical tourism services (Several scholarly databases were searched, including PubMed/MEDLINE, Embase, ISI/Web of Science). This step was preliminary to the development of an ad hoc open-ended questionnaire, which was sent to a sample of 25 medical professors and practitioners for expert opinion and initial appraisal. The checklist was reviewed in-depth by 22 experts, and their feedbacks and comments on items were collected. Subsequently, all requested modifications were applied and, as a result, some items were removed, added or modified, accordingly. After making corrections, the modified closed-ended questionnaire was sent back to the expert panel for a final confirmation of its validity and reliability. These psychometric properties were verified by means of content validity and Cronbach alpha coefficient (0.89), respectively. Participants in the study included managers and heads of hospitals of Tehran University of Medical Sciences and Iran University of Medical Sciences, experts in medical tourism affairs at the Ministry of Health and Medical Education, and staff members of the International Patients Unit of several Iranian hospitals.

These 2 steps (literature search and Delphi method) led to the final identification of the requirements and determinants affecting medical tourism industry.

The questionnaire consists of 2 parts. The first part contains demographic data and the second part deals with questions related to medical tourism development requirements. The second part of the questionnaire consists of 5 categories of questions: namely, (i) the impact of government policies and related entities on attracting medical tourists from foreign countries; (ii) the impact of ad-

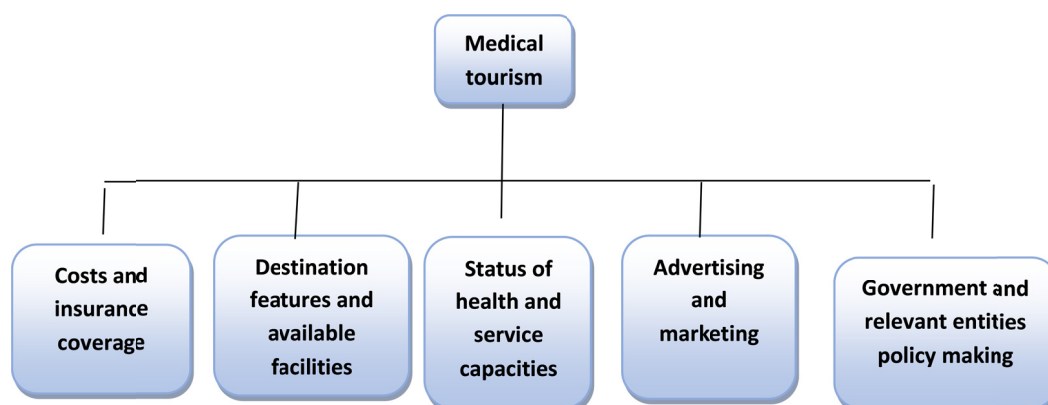


Fig. 1. Hierarchical structure of medical tourism development requirements

vertising and marketing; (iii) the impact of state medical and service capacities; (iv) the impact on insurance costs and coverage; and (v) the impact of characteristics and feature of destination countries (attractions, tourism, and medical facilities, etc.).

The purpose of this questionnaire was to weight the requirements and determinants of medical tourism attraction according to experts' view. Experts scored factors on a 5-point Likert scale and the scores given to medical tourism development items were converted to triangular fuzzy numbers. When decision- and policy-makers encounter uncertain and complex issues and express their comparative judgments in terms of "almost twice as important" or "between 2 to 4 times less important," the standard "analytic hierarchy process" (AHP) steps and, in particular, the special vector prioritization approach, cannot be considered as the right approaches (18).

A modified AHP method, called the "Fuzzy AHP" (FAHP), is more statistically robust, using triangular fuzzy numbers to weight experts' opinions and determine the weights of criteria and options. According to the FAHP approach, the problem of finding and rating the determinants and requirements of medical tourism industry is broken down into smaller elements and components to enable a better understanding of the relationships and concepts involved in the process of decision-making (Fig. 1).

After drawing the hierarchical structure, a paired-comparison questionnaire was provided to experts who were asked to compare the options in pairs. Linguistic words and triangular fuzzy numbers were used to compare options: the paired comparisons provided by experts were used to obtain decision matrices to compute the hierarchy of preferences and the final weights of options. The open-source R Studio software was used for calculation and analysis.

Full details of the mathematical and statistical procedures are reported in Appendix 1.

Results

Most of the studied administrators were men (75%), in the > 40 age group (80%), top executives (79.3%), with more than 10 years of work experience (86.4%), and a PhD degree (73.4%) (Table 1).

The final weights of the factors potentially impacting

medical tourism industry in Iran are reported in Table 2.

Data in Table 2 showed that, according to experts in the field of medical tourism, out of the 5 items considered in the questionnaire and based on the FAHP fuzzy logic analysis, the government and related entities policies had the highest weight in terms of importance and priority in attracting domestic and foreign investment (0.249), followed by advertising and marketing (0.241). The results also showed that the lowest weights were for destination characteristics, features, and tourism facilities in attracting medical tourists (0.111), and the status of medical services and capacities (0.185), respectively. Results of the present study showed that the government and related entities policies were the most important factors influencing the development and attraction of medical tourists and also maintaining the competitiveness in this field.

Discussion

Results of the current study are consistent with the conclusions of a literature review of studies regarding popular medical tourism destinations, such as India and Thailand, which showed that government policies in various fields, including offering a wide range of exemptions, incentives, lower import duty rates, and higher depreciation rates on medical equipment, can be used to encourage the growth of health tourism (19).

Table 1. Demographic Characteristics of the Studied Administrators

Characteristic	Frequency	%
Age (years)		
30–40	3	20
>40	12	80
Sex		
Male	10	66.6
Female	5	33.4
Education		
MSc degrees	4	26.6
Ph.D. degrees	11	73.4
Management Experience (years)		
5–10	2	13.3
>10	13	86.4
Organizational Position		
Managing	12	80
General	3	20

Table 2. Items Weighted According to the Fuzzy Logic Method

Factor/determinant	Weight
Role of the government and related entities policies in attracting medical tourists from foreign countries	0.249
Role of advertising and marketing in attracting medical tourists from foreign countries	0.241
Role of insurance costs and coverage in attracting medical tourists from foreign countries	0.214
Role of the status of medical services and capacities in attracting medical tourists from foreign countries	0.185
Role of destination characteristics, features, and tourism facilities in attracting medical tourists from foreign countries	0.111

To develop and support the medical tourism industry to attract domestic and foreign investors and to be recognized as a medical tourism destination, the Malaysian government has offered tax incentives for the construction of medical facilities along with a 100% tax exemption for a 5-year period for equipping and renovating hospitals, which has been exploited to provide health care settings with state-of-the-art medical technology and equipment as well as for offering training and continuing medical education to the medical personnel (20).

Economic factors represent another major component impacting the medical tourism industry, including low health care service costs that help patients save money for other procedures, together with high-quality of health services, easy access to services and facilities, cultural and religious solidarity, political climate, reputation of service providers, and travel services provided to patients along with the clinical care. All this contributes to making the destination country particularly attractive for patients (21, 22).

In this regard, results of a study conducted in Malaysia in 2015 showed that hospital status and specialty of medical personnel were the most important factors influencing the choice of medical tourists. In addition, factors, such as national conditions, providing tourist services along with health services, cost savings, and insurance status, were in the next ranks (23). These results partly corresponded with the findings of the current study. In general, on the one hand, governments play a key role in advertising, marketing, and promotion of the medical tourism industry, given its enormous potential economic benefits.

On the other hand, at the national level, there could be some contradictions between the development of the medical tourism industry and public health coverage for national citizens (5). Although studies have emphasized the importance of governments' role in the development of the medical tourism industry, the goals of the various ministries involved in this regard are not always explicitly addressed. Despite that economic growth and facilitation of international trades are among the most important priorities of organizations supporting the health tourism industry, the Ministry of Health's goal is to improve and maintain the health of its citizens and ensure them a fair access to services. Health systems around the world are working to maximize allocation and use of public resources for citizens and impose strict requirements on immigrants to access publicly funded health care.

However, it seems that medical tourism policies in Iran, which are regulated by the Office of Tourism Planning and Support, have also affected, at least partially, the activities of the Ministry of Health, which has decided to establish committees and units to promote health facilities for foreign patients.

Similar actions have been taken in various countries, including Malaysia, where initially the development of the medical tourism industry was not part of its national health programs as a strategic goal, and only one committee within the Ministry of Health had the task of developing health and medical tourism (24).

The interaction between different actors and stakeholders suggests that the development of the medical tourism industry largely depends on historical, geographical, and cultural characteristics, types of governments, and health systems so that the expectations of the actors in this field determine the type and direction of the planning (25).

Considering the role of governments in medical tourism industry planning, it is important to note that developing this sector represents a great opportunity for governments in terms of time and manpower devoted to planning, regulating, and providing facilities. This means that a significant portion of resources allocated to citizens' health needs is utilized for the development and investment in the medical tourism industry. For example, acquiring international standards and accreditation licenses to attract medical tourists requires high costs from the government and the private sector: if a country does not have a strong capacity to attract the tourists or if the number of tourists is not enough, scale economies will not be achieved (26).

Therefore, it is possible that tourism organizations may pursue the medical tourism industry primarily as an economic development plan rather than a health system development. Although the Ministry of Health's support for the industry can also lead to the strengthening of the health system itself, it should be noted that the role of the Ministry of Health in developing and regulating the industry can negatively affect its main tasks and goals, namely, improving and maintaining its own citizens' health (27). Experts in the present study emphasized that the role of the government in providing regulatory structures to ensure the quality, safety, and sustainability of the health system is crucial.

The existing analysis showed that identifying policy implications in medical tourism is the key for developing and strengthening this area. Although governments support the tourism industry and even invest in it (5), it should be noted that development programs and policies in each country are influenced by the nature of governments themselves and their political ideologies, which directly impacts the planning system, upstream documents, strategic plans, and their content. More precisely, the process of policy-, decision-making, and the formulation of major strategic plans in each country are the product of the political environment, values, ideology, and institutional principles of that country.

Accordingly, tourism as a new, recent, emerging phenomenon has a particular nature, with its own dimension

and meanings that may differ within various political systems and countries. The tourism industry in its essence implies the free-flow of capital, information, human resources and thoughts, being one of the most important aspects of globalization.

Limitations

Several limitations of our study are worth mentioning. First, the analysis was based on expert opinion, which is subjective and may be biased. Second, we could not employ clear criteria impaired comparison of options.

Conclusion

Five requirements and determinants of the development of Iran's medical tourism industry were identified in the present study. Of these 5 dimensions, the most important was given by the health tourism-related policies, with this dimension being the strongest predictor for both overall satisfaction and future growth of the sector. Although there are undoubtedly hurdles and challenges that would need to be addressed, policy- and decision-making could be an important and powerful tool in responding to some of the key concerns associated with medical tourism in the country. In addition, regulatory bodies in the context of medical tourism should work closely with the Ministry of Cultural Heritage, Tourism, and Handicraft Organization of Iran to ensure that policy decisions are appropriately informed by the latest scientific and clinical developments in the field and are properly and effectively implemented.

The interactions between various actors in Iran demonstrate that the development of medical tourism is highly context-specific and is greatly influenced by culture, government, and health system development, among other drivers. Governments and industry players, by properly managing and informing the process of policy- and decision-making, can facilitate the development and growth of this industry and bring economic benefits to the country, including additional resources and revenues for investment in health care.

Acknowledgment

The authors would like to thank all those who helped in revising the article, including members of the health management and Economics Research Center those in the affiliated to Iran University of medical sciences for financial support.

Conflict of Interests

The authors declare that they have no competing interests.

References

- Garcia AG, Besinga CA. Challenges and opportunities in the Philippine medical tourism industry. *SVG Rev.* 2006;4(1):41-55.
- Nasiripour AA, Salmani L. The Role of Tehran's Hospitals Capability in Development of Medical Tourism. *J Hosp.* 2011;9.
- Olya H, Hashemi Nia T. The medical tourism index and behavioral responses of medical travelers: a mixed-method study. *J Travel Res.* 2021;60(4):779-98.
- Hadian M, Jabbari A, Mousavi SH, Sheikhbardsiri H. Medical tourism development: A systematic review of economic aspects. *Int J Healthcare Manage.* 2021;14(2):576-82.
- Pocock NS, Phua KH. Medical tourism and policy implications for health systems: a conceptual framework from a comparative study of Thailand, Singapore and Malaysia. *Globa Health.* 2011;7(1):12.
- Moslehi S, Atefmanesh P, Asgharnejad Farid A. The relationship between problem-focused coping strategies and quality of life in schizophrenic patients. *Med J Islam Repub Iran.* 2015;29:288.
- medical tourism industry valuation 2017 [Available from: <https://www.medicaltourismindex.com/tag/report/>].
- Davoodi AA, S. Health tourism in iran and world 2015.
- Kadkhodamanesh A, Varahrami V, Zarei L, Peiravian F, Hadidi M, Yousefi N. Investigation the determinants of pharmaceutical expenditure share of GDP in Iran and selected OECD countries. *J Pharm Policy Pract.* 2021;14(1):82.
- Izadi M, Ayoobian A, Nasiri T, Joneidi N, Fazel M, Hosseinpourfard M. Situation of health tourism in Iran opportunity or threat. *J Mil Med.* 2012;14(2):69-75.
- Amouzagar S, Mojaradi Z, Izanloo A, Beikzadeh S, Milani M. Qualitative examination of health tourism and its challenges. *Int J Travel Med Glob Health.* 2016;4(3):88-91.
- Moslehi S, Manesh PA, Asiabar AS. Quality measurement indicators for Iranian Health Centers. *Med J Islam Repub Iran.* 2015;29:177.
- Rokni L, Park SH. Medical Tourism in Iran, Reevaluation on the New Trends: A Narrative Review. *Iran J Public Health.* 2019;48(7):1191-1202.
- Mahdavi Y, Mardani S, Hashemidehaghi Z, Mardani N. The factors in development of health tourism in Iran. *Int J Travel Med Glob Health.* 2013;1(2):113-8.
- Asiabar AS, Biglar M, Manesh PA, Moslehi S. Job satisfaction and development of a human resource management policy. *Manage Strateg J.* 2013;21(3):27-32.
- Moslehi S, Atefmanesh P, Asiabar AS, Ahmadzadeh N, Kafaeimehr M, Emamgholizadeh S, et al. Does outsourcing paramedical departments of teaching hospitals affect educational status of the students?. *Med J Islam Repub Iran.* 2016;30:404.
- Why Iran? 2016 [Available from: <http://www.medicaltourismiran.com/why-iran/Why-iran>].
- Samanlioglu F. Evaluation of Influenza Intervention Strategies in Turkey with Fuzzy AHP-VIKOR. *J Healthc Eng.* 2019;2019:9486070.
- Samadbeik M, Asadi H, Mohseni M, Takbiri A, Moosavi A, Garavand A. Designing a Medical Tourism Website: A Qualitative Study. *Iran J Public Health.* 2017;46(2):249-257.
- Shalbafian A. Health tourism in a comprehensive approach. Tehran, Mahkame Publishers (In Persian); 2015.
- Ramamonjiravelo Z, Martin DS, Martin WS. The determinants of medical tourism intentions: Applying the theory of planned behavior. *Health mark Q.* 2015;32(2):165-79.
- Bulatovic I, Iankova K. Barriers to Medical Tourism Development in the United Arab Emirates (UAE). *Int J Environ Res Public Health.* 2021;18(3):1365.
- Abd Manaf NH, Hussin H, Jahn Kassim PN, Alavi R, Dahari Z. Country perspective on medical tourism: the Malaysian experience. *Leadersh in Health Serv (Bradford Engl).* 2015;28(1):43-56.
- Leng CH. Medical tourism and the state in Malaysia and Singapore. *Glob Soc Policy.* 2010;10(3):336-57.
- Johnston R, Crooks VA, Snyder J, Whitmore R. "The Major Forces that Need to Back Medical Tourism Were... in Alignment" Championing Development of Barbados's Medical Tourism Sector. *Int J Health Serv.* 2015;45(2):334-52.
- Snyder J, Crooks VA, Johnston R, Cerón A, Labonte R. "That's enough patients for everyone!": Local stakeholders' views on attracting patients into Barbados and Guatemala's emerging medical tourism sectors. *Glob Health.* 2016;12(1):60.
- Johnston R, Crooks VA, Ormond M. Policy implications of medical tourism development in destination countries: revisiting and revising an existing framework by examining the case of Jamaica. *Glob Health.* 2015;11(1):29.

Appendix 1

Figure 1 shows the fuzzy triangular number = (l, m, u) M.

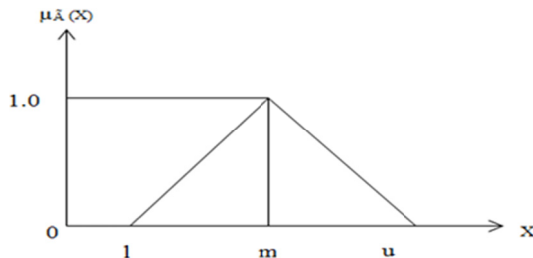


Fig. 1. The representation of a triangular fuzzy number

In this study, the fuzzy analytical hierarchy process method proposed by Chang was used to weight the criteria and sub-criteria of medical tourism development. The general process of fuzzy analytical hierarchy is as follows:

- 1) Drawing a hierarchical graph
- 2) Defining fuzzy numbers for pairwise comparisons
- 3) Forming paired comparisons matrix (\tilde{A}) using fuzzy numbers

$$\tilde{A} = \begin{bmatrix} 1 & M_{12} & \dots & M_{1n} \\ M_{21} & 1 & \dots & M_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ M_{n1} & M_{n2} & \dots & 1 \end{bmatrix} \quad (1)$$

- 4): Calculating S_i for each row of paired comparisons

$$S_i = \sum_{j=1}^m M_{gi}^j \times \left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} \quad (2)$$

In this equation, i, j and M_{gi}^j are the column number, row number and fuzzy numbers of the paired matrix, respectively.

$\sum_{j=1}^m M_{gi}^j$, $\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j$ and $\left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1}$ were computed by the following equations:

$$\sum_{j=1}^m M_{gi}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right) \quad (3)$$

$$\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right) \quad (4)$$

$$\left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (5)$$

- 5) Calculating the degree of S_i magnitude relative to each other.

If $S_1 = (l_1, m_1, u_1)$ and $S_2 = (l_2, m_2, u_2)$ are two triangular fuzzy numbers, the degree of possibility of $S_2 \geq S_1$ is defined by the following equations:

$$V(S_2 \geq S_1) = hgt(S_2 \cap S_1) = \mu_{S_1}(d) = \begin{cases} 1 & \text{if } m_2 \geq m_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \frac{l_1 - u_1}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases} \quad (6)$$

Where d represents the intersection point of $\mu_M 1$ and $\mu_M 2$.

On the other hand, the magnitude of one triangular fuzzy number from other K triangular fuzzy number is obtained using the following equation.

$$V(S_2 \geq S_1, S_2, \dots, S_K) = V[(S \geq S_1) \text{ and } (S \geq S_2) \text{ and } \dots \text{ and } (S \geq S_K)] = \min V(S \geq S_i), i = 1, 2, 3, \dots, k \quad (7)$$

- 6) Calculating the weight of criteria and options in paired comparison matrices

The following relation is used for this purpose:

$$d'(A_i) = \min V(S_i \geq S_k) \quad k = 1, 2, \dots, n, \quad k \neq i \quad (8)$$

Therefore, the non-normalized weight vector is as follows:

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T \quad A_i (i = 1, 2, \dots, n) \quad (9)$$

- 7) Calculating the final weight vector

To calculate the final weight vector, we have to normalize the weight vector calculated in the previous step, so the final weight can be obtained from the following equation:

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (10)$$