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Research Article

A DEMATEL-based causal model for understanding the key determinants of physician migration

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Abstract

This study aims to determine the reasons for the migration of physicians and to reveal their impact levels. Migration has critical effects on both receiving and sending countries, leading to a decrease in the quality of health care, loss of qualified employment, decreased productivity and health inequality. The push factors leading to physician migration are low salaries, poor working conditions and political insecurity, while the pull factors are higher living standards, career opportunities and personal development opportunities. In the study, critical success factors were determined by using the DEMATEL method. Based on the opinions of specialized physicians, 6 main criteria and 50 sub-criteria were determined. The main criteria are economic, political-social, educational and career-related, social-cultural, health-related, labor and working conditions-related criteria. The criteria and the relationships between them are visualized with diagrams. According to the analysis, the most influential main criterion on physician migration was found to be work and working conditions, while the least influential criterion was found to be social and cultural factors. According to the degree of influence, economic reasons and education-career opportunities are the most influential criteria. In the sub-criteria dimension, "low salaries", "violence", "lack of career development" and "political insecurity" are the most prominent criteria. The findings reveal that the migration decision is shaped in a multidimensional structure and the impact of different criteria. In this study, physician migration is analyzed with the MCDM. With the results of the research, strategic recommendations are developed for health policy makers. It is emphasized that to ensure the return of physicians, the problem should be viewed from a health inequality perspective. To prevent migration, it is emphasized that working conditions should be improved, career and educational opportunities should be increased, economic incentives should be provided, and social security should be ensured.

Keywords Brain drain, DEMATEL, multi-criteria decision making, international migration, physician migration, reasons for migration

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1. Introduction

Physicians leaving their home countries to practice medicine in other countries is a global health problem. While international migration of physicians causes significant losses for the sending country, it is considered as a gain of qualified labor for the receiving countries. In this context, physician migration affects the capacity in health care delivery and causes differences between countries (Buchan, 2008; Saluja et al., 2020). Medical education, clinical internships, specialty training and continuing professional development programs have been provided for many years to train physicians. Although there is no return in terms of public resources, investments and expenses, it creates additional costs for new physicians to be trained. At the end of the process, the migration of physicians to other countries negatively affects the health system from the perspective of the physician training countries. Therefore, it is important to understand the reasons for migration for the sending country to reduce the loss of physicians (Davda et al., 2021; Morley et al., 2017; Murataj et al., 2022).

Physician migration leads to disruptions in health services in origin countries. With the migration of physicians, the gap in specialized areas reduces the quality of health care. The lack of physicians creates an excessive workload on other health professionals in the destination country and significantly affects the health system (Byrne et al., 2021). In addition, with the decrease in the number of physicians, patients' access to health care is restricted and inequality in health emerges. In the long run, it can have an impact on the planning of health policies and cause instability in the health system, leading to a system that is dependent on external resources. These situations also undermine social trust and can become a political pressure factor (Dohlman et al., 2019; Humphries et al., 2019).

Factors related to why physicians migrate from their home countries are divided into two categories: attractive and repulsive factors. Repulsive factors, as an important reason for brain drain in undeveloped and developing countries, include health professionals' discomfort with unfavorable conditions in their home countries. Attractive factors, on the other hand, are defined as advantages such as better working conditions, higher living standards and higher salaries in the countries they intend to migrate to (Adovor et al., 2021). Economic factors, working conditions, lack of professional satisfaction, political and social insecurity stand out among the reasons why physicians migrate (Ebeye & Lee, 2023; Obinna et al., 2022; Vujicic et al., 2004). In addition to excessive workload, the increasing number of physical and emotional violence against doctors has a significant impact on the decision to migrate (Kadaifci et al., 2024). Depending on the family, the decision to migrate can change in terms of economic, career, education, etc., and reasons such as personal development opportunities, including self-realization of physicians, affect the decision (Becker & Teney, 2020). In addition, after those who leave with physician migration, there is a feeling of motivational burnout for the physicians who stay (Sweileh, 2024).

The number of physicians per capita in the world varies among countries. The average number of physicians per capita in OECD countries is 3.7% (OECD, 2023). According to the World Health Statistics report, the number of physicians per ten thousand people between 2014 and 2021 is 36.6 in the European region, 24.5 in the USA, 20.9 in the Western Pacific, 11.2 in the Eastern Mediterranean, 7.7 in South East Asia and 2.9 in Africa (WHO, 2023). This inequality creates great differences in access to health services. Looking at the literature, physician migration is common in countries such as India, Nigeria, Lebanon, Romania, and South Africa (Botezat & Moraru, 2020; Onah et al., 2022; Tankwanchi et al., 2021).

According to OECD (2021) statistics, 19% of physicians in OECD countries received their first medical education in other countries. According to the Turkish Medical Association (2021) study report, the number of physicians applying to migrate in Türkiye increased 15-fold from 2012 to 2020 (Karatuzla, 2024).

Most studies on physician migration examine the effects of economic, social and professional factors on migration (Apostu et al., 2022; Dubas-Jakóbczyk et al., 2020; Hadley, 2024; Okeke et al., 2014). Goštautaitė et al. (2023) examined the impact of physician migration on health systems and made different recommendations on how to prevent it. Apostu et al. (2022) studied the factors affecting physicians in Romania. Teney (2019) analyzed the reasons for the migration of highly qualified professionals from European Union countries to Germany. Domagala et al. (2022) examined the reasons for migration of health professionals in Poland and found that the push factors for migration are inadequate salaries, lack of favorable working conditions and lack of support for personal development and education. Attractive factors were identified as rising standard of living, lack of salary inequality and easy access to emerging technologies. These factors lead to a decrease in the number of qualified personnel in the health system and a decrease in the quality of patient care.

The aim of this study is to examine the reasons affecting physician migration and to determine the effects of these reasons. The movement of physician migration was analyzed using the DEMATEL (Decision-making Trial and Evaluation Laboratory) method and critical success factors were identified. The following research questions were formulated in line with this purpose:

RQ1. What are the opinions of physicians towards the phenomenon of international migration?

RQ2. What are the most dominant reasons that push physicians towards international migration?

RQ3. What are the levels of importance and relationship between the reasons that push physicians to the phenomenon of migration?

In line with the purpose of the study, when the relevant literature is examined, Multi-Criteria Decision Making (MCDM) techniques, which are frequently preferred and examine criteria using both qualitative and quantitative data at the same time, come to the fore. MCDM methods are widely used to evaluate different criteria and factors in complex decision-making processes (Gokler & Boran, 2024; Komasi et al., 2023). DEMATEL, one of the MCDM techniques, is an effective method that analyzes the relationships between system factors and visualizes this structure through cause-effect relationship maps. It has been widely used in various fields such as health, economy, tourism, management, engineering (Agarwal & Kapoor, 2022; Aka & Yavuz, 2024; Braga, 2021; Che et al., 2022; Gedam et al., 2021; Gokler & Boran, 2024; Parmar & Desai, 2020). The method not only transforms the interdependencies of factors into cause-and-effect relationships, but also identifies the critical components of a system with the help of influence relationship diagrams. In this direction, the DEMATEL technique was preferred in the study to determine the critical factors related to physician migration.

The contribution of this study to literature can be listed as follows:

- Providing a framework that addresses the factors that cause physician migration in a broad and detailed manner.
- Identifying which factors are the dominant factors among the factors that cause physician migration.

- To reveal the importance and relationship levels of the factors that cause physician migration.
- Provide broad recommendations to health decision makers or policy makers in light of the findings
- Contributing to the lack of such an approach in the literature by addressing the issue using the DEMATEL technique, one of the MCDM techniques.

The rest of the paper is organized as follows: In the next section, the authors present the methodology of this study; the third section discusses the implementation of the study and the findings. The fourth section presents a broad discussion in line with the findings of the study. Finally, the study concludes with a conclusion.

2. Research Methodology

Multi-criteria decision-making tools are frequently preferred for solving problems with multiple criteria. Among these tools, DEMATEL, which is used in the simplified analysis of complex problems, attracts attention (Parmar & Desai, 2020). It was developed by Gabus and Fontela in 1972 and is used to identify and visualize the relationship between criteria in a system (Agarwal & Kapoor, 2022; Farooque et al., 2020). Thanks to this method, an improvement in a criterion that is important and affects other criteria can lead to a similar improvement in other criteria (Celikbilek & Ozdemir, 2020).

DEMATEL analyzes the cause and effect relationship between the criteria and produces a diagram of the relationship between the criteria. In the diagram, the magnitude of the relationship between the criteria is expressed in numerical values. In this way, it enables decision makers to better interpret the criteria (Braga, 2021). The stages of the DEMATEL method are as follows (Gedam et al., 2021; Shieh et al., 2010):

Step 1: Creating a Direct Relationship Matrix

The first step of the DEMATEL method is the creation of a direct relationship matrix. The values in this matrix indicate the direct relationship of variable (i) with variable (j). The direct relationship matrix is shown in equation (1):

$$\mathrm{D} = [\mathrm{d_{ij}}]_{\mathrm{nxn}} \quad (1)$$

The variables studied are mutually dependent. Each is assigned a score to indicate the degree of influence. Experts made their ratings according to the 0-4 scale. In the scale used; '0' means zero effect, '1' means moderately low effect, '2' means moderately high effect, '3' means high effect and '4' means very high effect.

Step 2: Creating the Normalization Matrix

Each row and column value in the direct relationship matrix is summed for normalization. All values in the matrix are divided by the largest value obtained from the sum. Eqs. (2) and (3) are used for the normalization process.

$$\mathrm{X} = \mathrm{s}.\mathrm{D}. \quad (2)$$

$$\mathrm{s} = \min\left[\frac{1}{\left(\max_i \sum_{j=1}^{n} |\mathrm{d_{ij}}|\right)}, \frac{1}{\left(\max_j \sum_{j=1}^{n} |\mathrm{d_{ij}}|\right)}\right] \quad (3)$$

Step 3: Creating the Total Impact Matrix

The normalized direct relationship matrix is transformed into the total influence matrix shown in Eq. (5) using Eq. (4). The normalized direct relationship matrix is subtracted from the unit matrix and inverted. The resulting matrix is then multiplied by itself to find the total influence matrix.

$$T = X + X^2 + X^3 + \cdots + X^h = X(I - X)^{-1} \quad (4)$$

$$T = [t_{ij}]_{nxn} \quad (5)$$

Step 4: Identification of Affecting and Affected Variables

After calculating the sum of rows (D_i) and columns (R_j) of the total influence matrix with Eq. (6) and Eq. (7), $D_i + R_j$ and $D_i - R_j$ values are found.

$$D = (r_i)_{nx1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{nx1} \quad (6)$$

$$R = (c_j)_{1xn} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1xn} \quad (7)$$

Step 5: Calculation of Criteria Weights and Drawing the Influence Diagram

Weight values for the criterion are calculated as the average of the squares of D_i+R_j and D_i-R_j. With this step, the criteria with priority importance are determined.

$$w_i = \sqrt{(D_i + R_j)^2 + (D_i - R_j)^2} \quad (8)$$

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \quad (9)$$

The influence diagram is drawn with $D_i + R_j$ values on the horizontal axis and $D_i - R_j$ values on the vertical axis. This diagram shows the relationship between the criteria and is therefore important.

3. Application of the Study

In this section, the main and sub-criteria affecting physician migration, data collection and the findings obtained by applying the DEMATEL approach are presented. The application of the study is based on Türkiye. In addition, in this section, the reasons for migration of physicians are evaluated under the main dimensions.

Determination of Criteria

In this study, a literature review was conducted to identify the critical main and sub-factors affecting the brain drain of physicians. After the research, six main factors and their sub-criteria were identified: economic factors, political and social factors, factors related to education and career, social and cultural factors, factors related to health, factors related to work and environmental conditions (Supplementary file 1). The list of these factors is presented in Table 1.

Table 1. Sub-criteria affecting the migration of physicians

Economic Factors (C1)	**Political and Social Factors (C2)**	**Education and Career Related Factors (C3)**	**Social and Cultural Factors (C4)**	**Health-Related Factors (C5)**	**Work and Working Conditions Related Factors (C6)**
High Unemployment Rate **(C11)**	Political Rights and Civil Freedoms **(C21)**	Inadequate Research and Development Studies **(C31**)	Unfavourable Conditions for Family Building **(C41)**	Resource Deficiencies in the Health System **(C51)**	Feelings of Inadequacy due to Job Dissatisfaction **(C61)**
Wage Differentials **(C12)**	Bad Political Climate **(C22)**	Existence, Adequacy, Superiority of the School **(C32)**	Cultural Mentality **(C42)**	Governance and Management Deficiencies in Health Services **(C52)**	Unsatisfactory Working Conditions **(C62)**
Low Salaries **(C13)**	Management Dissatisfaction **(C23)**	Opportunity to develop knowledge and skills **(C33)**	Personal Safety and Security Needs **C43)**	Access to Health Services **(C53)**	Violence Against Physicians **(C63)**
High Costs of Living **(C14)**	Racism **(C24)**	Education Curriculums **(C34)**	Social Intolerance **C(44)**	Fear of Infectious Disease (HIV, COVID-19) **(C54)**	Job Dissatisfaction **(C64)**
Economic Collapse **(C15)**	Ethnic, Religious and Political Tensions **(C25)**	Similarity of Professional Qualifications **(C35)**	Desire to Recognise New Culture **(C45)**	Access to Clean Water Sanitation **(C55)**	High Stress Level at Work **(C65)**
	Human Rights Violations (**C26)**	Similarity and Mutual Recognition of the Language of Education **(C36)**	Sexual Preferences **C(46)**	Stress Levels **(C56)**	Heavy Work Load **(C66)**
	Human Favouritism **(C27)**	Limited Funding for Medical Research **(C37)**	Religious and Political Beliefs **(C47)**		Inadequacy of Technological Infrastructure **(C67)**
	Need for Freedom of Expression **(C28)**	Lack of Opportunities for Career Development **(C38)**	Facilities such as housing, car, pension provisions **(C48)**		
	Crime Rates and Corruption **(C29)**	Desire to Gain Experience **(C39)**	Cultural Affinity **(C49)**		
			Size of Social Networks **(C410)**		
			Housing Problems **(C411)**		
			Proximity (Distance between two countries) **(C412)**		
			Transport **(C413)**		
			Family Existence **(C414)**		

Identification of Experts and Collection of Data

The data of the study were collected from 12 physicians who are experts in their fields and actively working in public hospitals in Türkiye. Face-to-face interviews of 15-30 minutes were conducted with specialists in the fields of Obstetrics and Gynecology, Medical Genetics, General Surgery, Neurology, Cardiology, Psychiatry, Skin and Venereal Diseases and Internal Medicine.

Application of the DEMATEL Approach

In this section, the data obtained from the experts are presented in the findings by applying the steps of the DEMATEL technique.

Step 1: Creating the Direct Relationship Matrix

A Direct Relationship Matrix was created by taking the arithmetic mean of the scores of the 12 physicians participating in the study in the main criteria section of the DEMATEL form (Table 2). After the direct relationship matrix, the highest value was determined by calculating the row and column sums in the matrix (Table 2).

Table 2. Direct relationship matrix

MAIN CRITERIA	C1	C2	C3	C4	C5	C6	TOTAL
C1	0	2.583	2.916	2.083	2.666	3.5	13.75
C2	1.75	0	2.583	2.333	2.833	3.333	12.833
C3	2.75	2.166	0	2.916	3.25	3.333	14.416
C4	2.166	2.833	2.166	0	3	2.666	12.833
C5	2.166	3	2.833	1.916	0	2.166	12.083
C6	3.5	2.916	2.75	2.583	2.416	0	14.166
TOTAL	12.333	13.5	13.25	11.833	14.166	**15**	

Step 2: Creating the Normalization Matrix

After the Direct Relationship Matrix, a normalized Direct Relationship Matrix was created (Table 3). In Table 2, the numbers in the direct relationship matrix are divided by the value "15", which is the maximum of the sum of the numbers in the rows and columns, to obtain the value "z=0.0666". The "z" value obtained was multiplied by the direct relationship matrix values to form a normalized direct relationship matrix.

Table 3. Normalization matrix

MAIN CRITERIA	C1	C2	C3	C4	C5	C6
C1	0	0.172	0.194	0.138	0.127	0.233
C2	0.116	0	0.172	0.155	0.188	0.222
C3	0.183	0.144	0	0.194	0.216	0.222
C4	0.144	0.188	0.144	0	0.2	0.177
C5	0.144	0.2	0.188	0.127	0	0.144
C6	0.233	0.194	0.183	0.172	0.161	0

Step 3: Creating the Total Impact Matrix and Identification of Influencing Variables and Affected Variables

The normalized direct relationship matrix is subtracted from the unit matrix and first inverted. Then, the resulting matrix is multiplied by itself and the total influence matrix is calculated. The unit matrix (I) required for the formation of the total influence matrix is given in Table 4.

Table 4. Unit Matrix of main criteria

MAIN CRITERIA	C1	C2	C3	C4	C5	C6
C1	1	0	0	0	0	0
C2	0	1	0	0	0	0
C3	0	0	1	0	0	0
C4	0	0	0	1	0	0
C5	0	0	0	0	1	0
C6	0	0	0	0	0	1

To construct the total impact matrix, the normalized matrix (N) was subtracted from the unit matrix (Table 5).

Table 5. Extraction of identity matrix of main criteria from normalized relationship matrix (I-N)

MAIN CRITERIA	C1	C2	C3	C4	C5	C6
C1	1	-0.172	-0.194	-0.138	-0.127	-0.233
C2	-0.116	1	-0.172	-0.155	-0.188	-0.222
C3	-0.183	-0.144	1	-0.194	-0.216	-0.222
C4	-0.144	-0.188	-0.144	1	-0.2	-0.177
C5	-0.144	-0.2	-0.188	-0.127	1	-0.144
C6	-0.233	-0.194	-0.183	-0.172	-0.161	1

The inverse of the resulting matrix was then taken as $(I-N)^{-1}$ (Table 6).

Table 6. $(I-N)^{-1}$ matrix

MAIN CRITERIA	C1	C2	C3	C4	C5	C6
C1	2.190	1.423	1.421	1.262	1.473	1.580
C2	1.222	2.198	1.327	1.204	1.400	1.485
C3	1.387	1.450	2.303	1.343	1.549	1.620
C4	1.234	1.352	1.301	2.063	1.402	1.447
C5	1.183	1.304	1.280	1.130	2.180	1.366
C6	1.406	1.468	1.442	1.312	1.493	2.424

The matrix was then multiplied by the normalized direct relationship matrix to form the total relationship matrix $T = N(I - N)^{-1}$ (Table 7). The sum of rows and columns of the total relationship matrix was calculated.

Table 7. $T = N(I - N)^{-1}$, the total effect matrix

MAIN CRITERIA	C1	C2	C3	C4	C5	C6	TOTAL
C1	1.190	1.423	1.421	1.262	1.473	1.580	8.351
C2	1.222	1.198	1.327	1.204	1.400	1.485	7.839
C3	1.387	1.450	1.303	1.343	1.549	1.620	8.654
C4	1.234	1.352	1.301	1.063	1.402	1.447	7.801
C5	1.183	1.304	1.280	1.130	1.180	1.366	7.445
C6	1.406	1.468	1.442	1.312	1.493	1.424	8.547
TOTAL	7.626	8.197	8.076	7.316	8.499	8.924	

Step 4: Calculating Criteria Weights

The sum of D_i+R_j is used to determine the importance of the criteria, while the D_i-R_j value is used to determine their influence status. If the D_i-R_j value is negative, it is influenced by other criteria, i.e. it is in the position of receiver, and if the D_i-R_j value is positive, it is in the position of cause, i.e. it has an impact on other criteria. As a result, relationships and effects between criteria were determined (Table 8).

Table 8. Weighting of Relationship direction and importance of main factors

D_i+R_j	D_i-R_j	Group	w_i	W_i
15.977	0.725	cause	15.993	0.164
16.036	-0.357	**effect**	16.040	0.164
16.730	0.577	cause	16.740	0.171
15.117	0.484	cause	15.125	0.155
15.945	-1.053	effect	15.980	0.164
17.471	-0.376	effect	17.475	0.179
	Total			97.355

As a result of the calculations, the total relationship matrix of the main criteria (Table 9) was created.

Table 9. Total relationship matrix of main criteria $T = N(I - N)^{-1}$

MAIN CRITERIA	C1	C2	C3	C4	C5	C6
C1	1.190	1.423	1.421	1.262	1.473	**1.580**
C2	1.222	1.198	1.327	1.204	1.400	**1.485**
C3	1.387	1.450	1.303	1.343	**1.549**	**1.620**
C4	1.234	1.352	1.301	1.063	1.402	1.447
C5	1.183	1.304	1.280	1.130	1.180	1.366
C6	1.406	1.468	1.442	1.312	**1.493**	1.424

In order to determine the interaction, a threshold value (1.48) was calculated by summing the mean and standard deviation. The cells above this value are highlighted in bold in Table 9. According to the

research findings, among the main factors affecting the reasons for physicians to migrate, the most important criterion is C6 with D_i+R_j = 17.47 and the least important criterion is C4 with D_i+R_j = 15.11. When the D_i-R_j values are analyzed, the factors that are affected by other criteria are C2, C5 and C6, and the most affected factor is determined to be criterion C6. When the factors affecting the other criteria more than the other criteria are examined, C1 and C3 criteria are identified, and C1 is the factor affecting more than the other with a value of D_i-R_j = 0.7251.

Step 5: Drawing the Impact Diagram

The interaction between the criteria is better understood by drawing the influence diagram. The influence directional graph diagram is constructed with the points D_i+R_j and D_i-R_j positioned D_i+R_j on the horizontal axis and D_i-R_j on the vertical axis. The horizontal axis represents the degree of importance of the criteria and the vertical axis represents the degree of influence of the criteria. The influence diagram is important in terms of showing the variables that affect and are affected by each other. The influence directional graph diagram is shown in Figure 1.

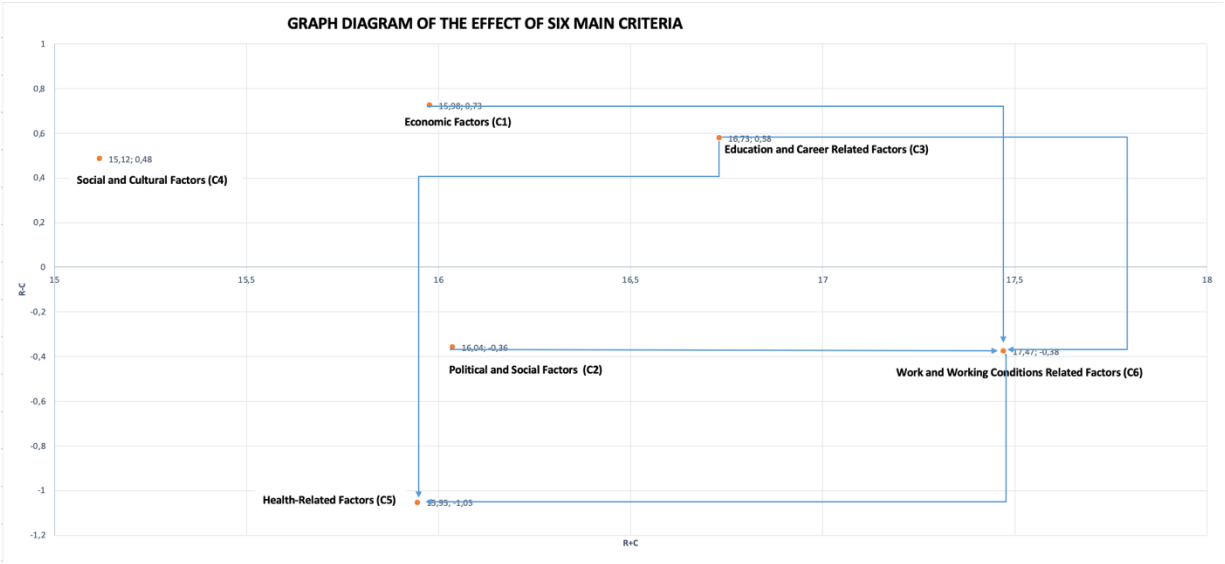

Figure 1. Impact-direction graph diagram of main criteria

Accordingly, criteria C1 and C2 are effective on criterion C6. Criterion C3 is effective on criteria C5 and C6. Criteria C4 and C5 criteria are not effective. Criteria C1, C2, C3, and C4 are not influenced by any criteria. Criterion C5 is influenced by criteria C3 and C6; C6 is influenced by criteria C1, C2 and C3.

Analysis of Economic Factors Dimension with DEMATEL

The sub-criteria for the economic factors dimension are given in Table 9. Analyses related to these criteria are given in the Supplementary File. Impact-Way Graph Diaphragm of Economic Criteria is given in Figure 2.

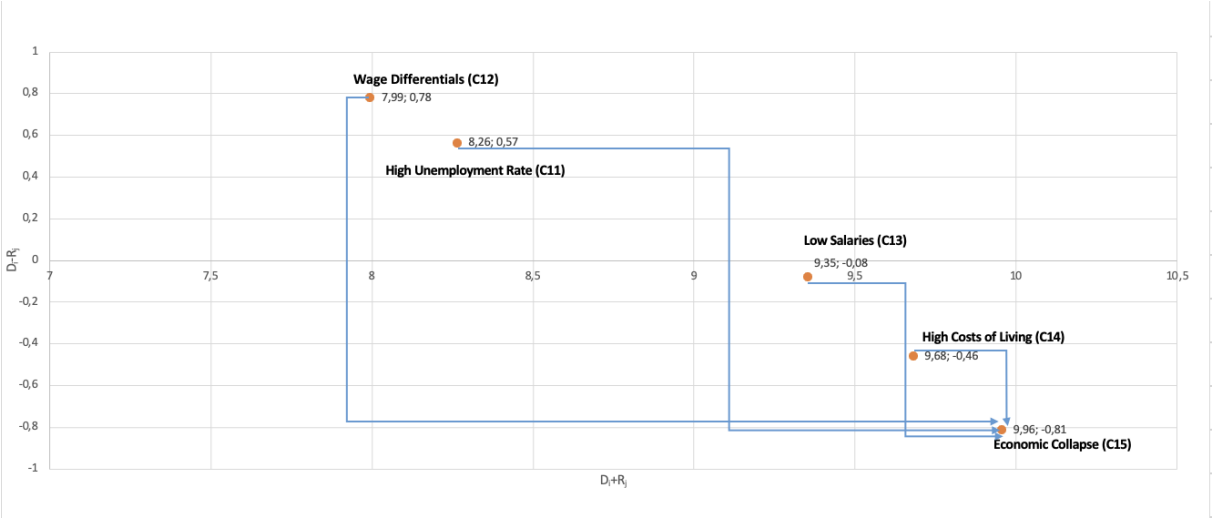

Figure 2. Impact-way graph diaphragm of economic criteria

According to the findings related to C1, it was determined that C15 was the most determinant factor among the factors affecting physicians' reasons for migration, while C12 was the least effective. When the D_i-R_j values are analyzed, it is determined that C13, C14 and C15 are the factors that are influenced by the other criteria, and C15 is the one that is most influenced by the other criteria. The criteria that affect the other factors more are C11 and C12, and C12 is the most determining factor. According to Figure 3; C11, C12, C13 and C14 criteria are found to be effective on C15. C15 is not effective on other criteria.

Analysis of Political and Social Factors Dimension with DEMATEL

The sub-criteria for C2 are given in Table 9. Analyses related to these criteria are given in the Supplementary File. The Influence-Directional Graph Diagram of Criterion C2 is given in Figure 3.

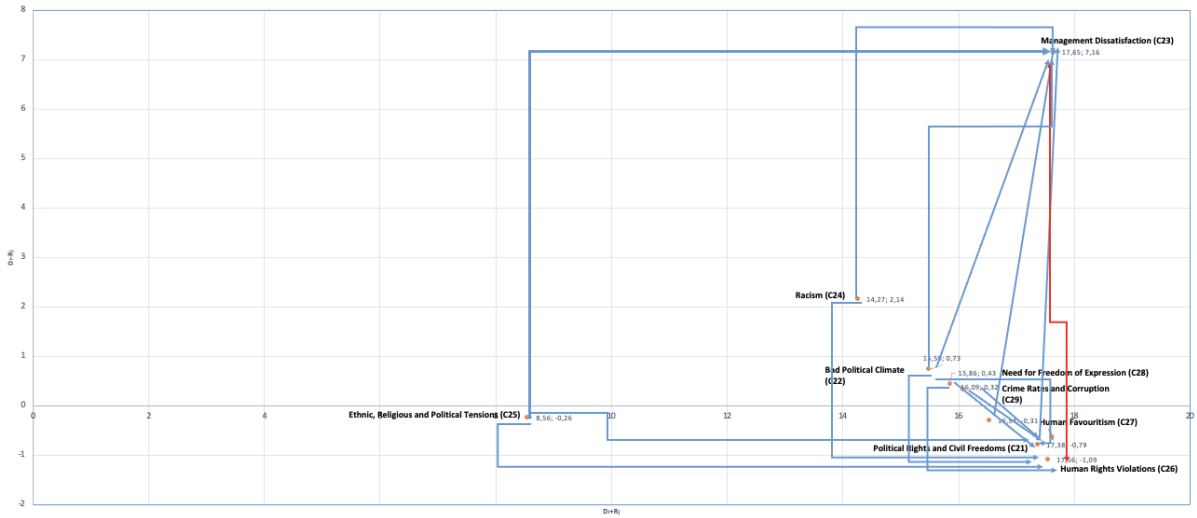

Figure 3. Influence-way graph diaphragm of C2

According to the findings related to C2, among the factors affecting the reasons for physicians to migrate, C23 was found to be the most determinant and C25 was the least important. When the D_i-R_j value is analyzed, it is determined that the factors affected by other criteria are C21, C22, C25, C26 and

the most affected factor is C26. The factors that affect other factors more are C23, C24 and the most affected factor is C23.

Figure 3 shows that C21 affects C23 and C26 criteria; C22 affects C23 and C26 criteria; C24 affects C26 criteria; C25 affects C21 and C26 criteria; C27 affects C23 and C26 criteria; C24 affects C23 criteria; C28 affects C21 criteria; C29 affects C23 and C26 criteria. C23 and C26 are criteria that are affected by each other.

Analysis of Education and Career Related Factors Dimension with DEMATEL

The sub-criteria for C3 are given in Table 9. Analyses related to these criteria are given in the Supplementary File. The Influence-Directional Graph Diagram of Criterion C3 is given in Figure 4.

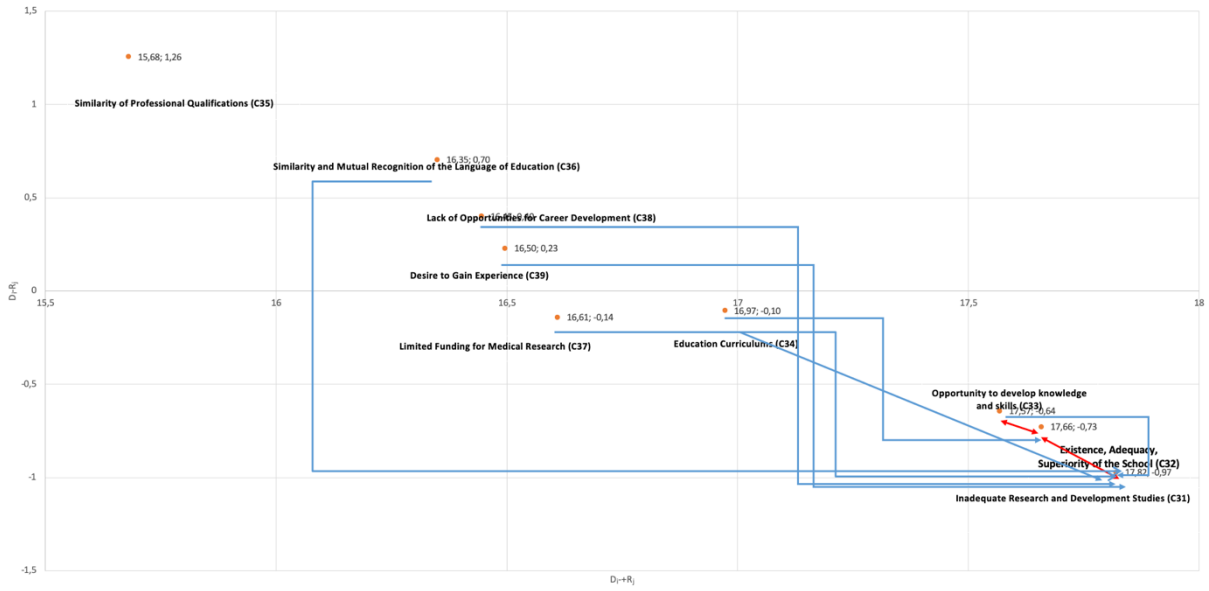

Figure 4. Effect-way graph diaphragm of C3

According to the findings related to C3, among the factors affecting the reasons for physicians to migrate, C31 is the most determinant factor, while C35 is the least important factor. According to the D_i-R_j value, among the factors that are influenced by other criteria; C32, C33, C34, and C37 criteria; it is noteworthy that C37 criterion is the factor that is influenced more than others. The factors with a higher power to influence other factors are C35 and C36, and the criterion with the highest power to influence others is C35.

According to Figure 4, C31 and C32 and C32 and C33 have mutual influence on each other. Criterion C31 influenced criterion C33; criterion C33 influenced criterion C31; criterion C34 influenced criteria C31 and C32; criterion C35 influenced criteria C31 and C33; criterion C36 influenced criteria C31 and C32; criterion C37 influenced criterion C31; criterion C38 influenced criteria C31 and C33; criterion C39 influenced criteria C31 and C32.

Analysis of Social and Cultural Factors Dimension with DEMATEL

The sub-criteria for C4 are given in Table 9. Analyses related to these criteria are given in the Supplementary File. The Influence-Directional Graph Diagram of Criterion C4 is given in Figure 5.

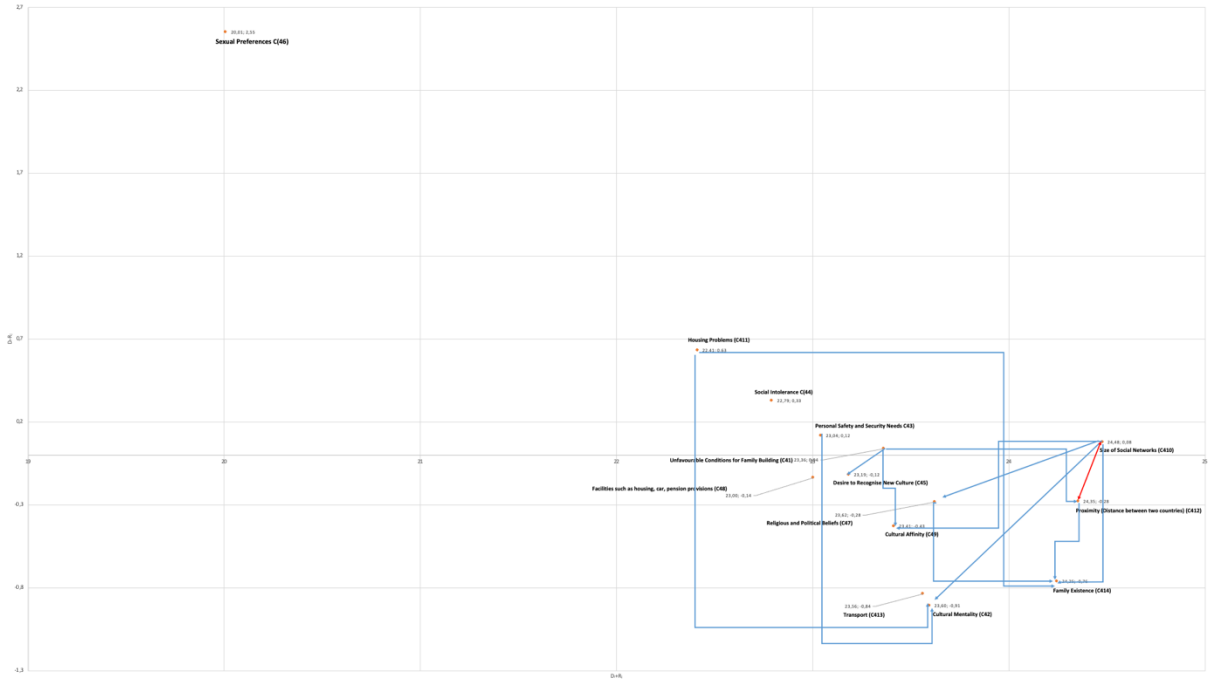

Figure 5. Influence-directional graph diaphragm of C4

According to the findings related to C4, it was determined that the most determinant factor among the factors affecting the reasons for physicians to migrate is C410, while the least important factor is C46. When analyzed according to the D_i-R_j value, among the factors influenced by other criteria; there are factors such as C42, C45, C47, C48, C49, C412, C413, C414. Among these factors, C42 is the most influential factor. The factors with a higher power to influence other factors are C41, C43, C44, C45, C410, C411. Among these, the factor with the highest influencing power on others is C46 since its D_i-R_j value is 2.55. According to Figure 5, criterion C41 influenced criteria C42 and C412, and criterion C410 influenced criteria C47 and C49. C42, C43, C44, C45 and C46 did not affect any criteria.

Analysis of Health Related Factors Dimension with DEMATEL

The sub-criteria for C5 are given in Table 9. Analyses related to these criteria are given in the Supplementary File. The Influence-Directional Graph Diagram of C5 Criteria is given in Figure 6.

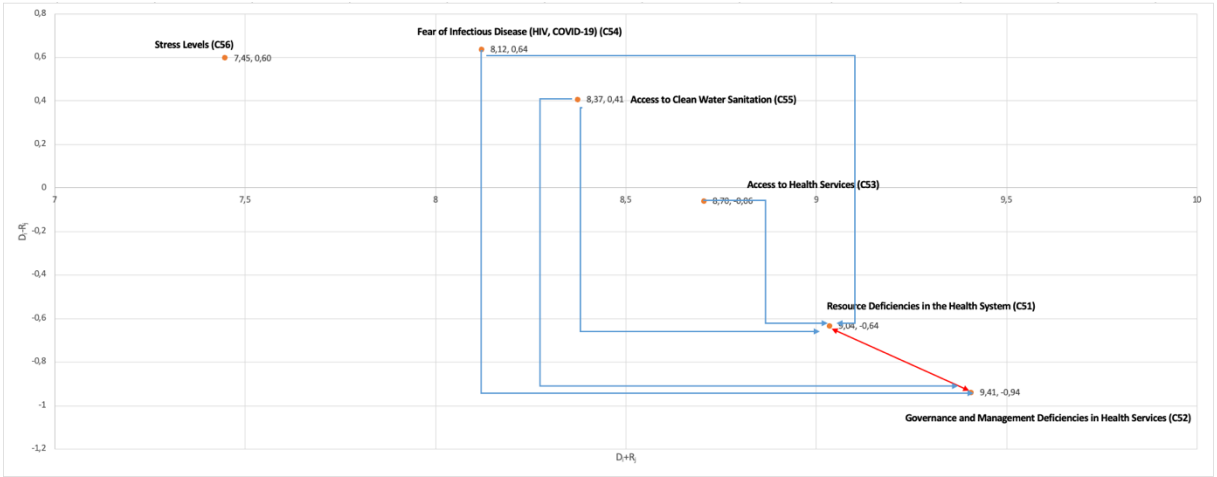

Figure 6. Influence-way graph diaphragm of C5

According to the findings related to C5, the most important factor affecting physicians' reasons for migration is C51, while the least important factor is C56. When analyzed according to the Di-Rj value, among the factors influenced by other criteria; there are factors such as C52 and C53. Among these factors, the most influential factor is C51. The factors with a higher power to influence other factors are C54 and C56. Among these two factors, the factor with the highest influence power on others is C54 since its D_i-R_j value is 0.63. According to Figure 7; C51 and C52 mutually influenced each other. Criterion C53 influenced criterion C51; C54 influenced criteria C51 and C52; C55 influenced criteria C51 and C52. Criterion C56 did not affect any criterion.

Analysis of the Factors Related to Work and Working Conditions Dimension with DEMATEL

The sub-criteria for C6 are given in Table 9. Analyses related to these criteria are given in the Supplementary File. The Influence-Directional Graph Diagram of Criterion C6 is given in Figure 7.

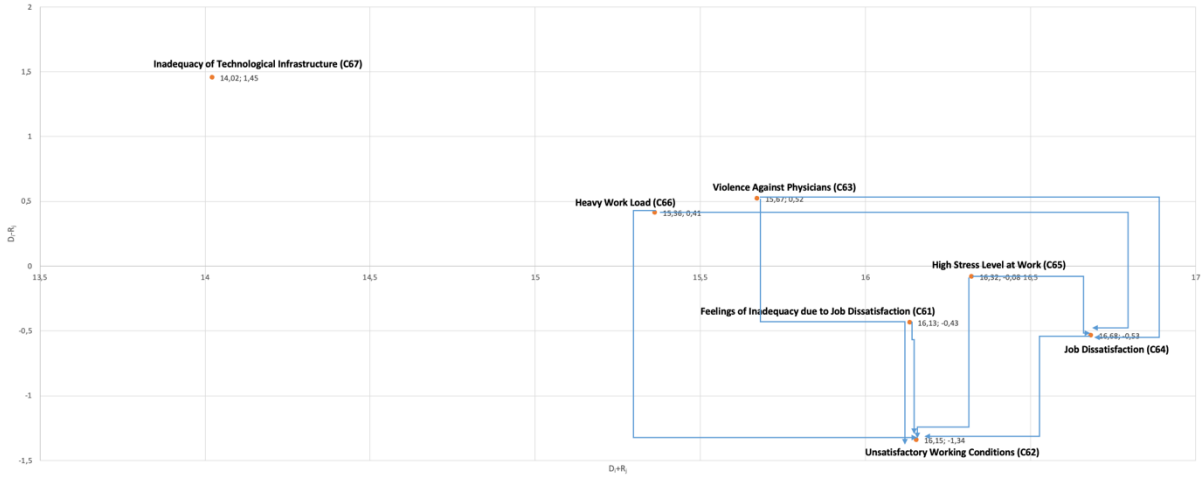

Figure 7. Influence-way graph diagram of C6

According to the findings related to C6, the most important factor affecting physicians' reasons for migration is C64, while the least important factor is C67. When analyzed according to the D_i-R_j value, the factors influenced by other criteria include C61, C62, C64 and C65. The most influential factor among these is C62. The factors with a higher power to influence other factors are C63 and C67. Among these two factors, C67 has the highest influence on others. According to Figure 8; C61 criterion influenced C62 criterion; C63 criterion influenced C62 and C64 criteria; C64 criterion influenced C62 criterion; C65 criterion influenced C62 and C64 criteria; C66 criterion influenced C64 criterion. C67 and C62 did not affect any criteria.

4. Discussion

The structuring and analysis of the research is based on a solid theoretical foundation of the DEMATEL methodology. This methodology requires less effort and cost than structural analysis models in terms of data acquisition, less involvement and computational simplicity (Agarwal & Kapoor, 2022). DEMATEL is a method that does not require the large number of participants required in structural models. Based

on 12 experts' opinions, the analysis yielded similar results to previous studies. Therefore, it is seen that the method used provides advantages in terms of time and convenience.

This study was conducted to determine the causes of the physician brain drain and to examine the prioritization of these causes using the DEMATEL method. The importance levels of the main criteria that cause the migration of physicians were determined as: factors related to work and working conditions, factors related to education and career, political and social factors, economic factors, factors related to health, social and cultural factors. When considering the main factors that cause the brain drain phenomenon of physicians, significant and meaningful results were obtained in relation to the literature in terms of importance and priority.

Push-attract factors affecting health worker migration encompass a range of economic, professional and environmental considerations. Economic incentives, poor working conditions and lack of career progression emerge as important push factors (Sweileh, 2024). Studies reveal that better working conditions are an important factor in keeping physicians in the country of origin (Bidwell et al., 2014). It has been found that physicians who do not migrate experience burnout as non-migrating physicians take on the workload of migrating physicians. Burnout and workload overload among physicians also negatively affect health system delivery and reduce the quality of care (Ebeye & Lee, 2023). Limited opportunities for career development, promotion and professional advancement in their home countries lead health professionals to seek better prospects abroad (Castro-Palaganas et al., 2017). In a study of 1129 medical students in 2021, it was found that 52% of the students planned to go abroad after graduation (Uzun, 2021). A study on migrants by Adeniyi et al. (2022) found that early-career physicians migrate for better postgraduate education and salaries. Although some estimates vary from country to country, it is generally reported that approximately 100,000 Euros are spent annually to train a physician (Saluja et al., 2020).

In general, health professionals in developing countries migrate to countries with strong health systems and more opportunities for progress (Glinos et al., 2014; WHO, 2022). The migration of health professionals has increased with the migration of highly skilled specialists and the changing structure of the European Union (OECD, 2019). Labonte et al. (2015) note that in South Africa, this process has been addressed politically, with various initiatives contributing to reducing the shortage of health professionals. The countries' reputation for corruption at the government level, lack of accountability, limited health systems and inadequate legal systems are cited as driving factors for migration. It has been determined that physicians migrate because they do not want to take part in sociopolitical unrest that affects their personal and family security (Karan et al., 2016). Humphries et al. (2017) stated that Australia is an attractive migration location with both language suitability and recruitment policies. Both sending and receiving countries need to make political interventions by implementing appropriate retention strategies, improving working conditions, and encouraging international cooperation (Sweileh, 2024).

It has been noted that professionals often tend to reduce their dissatisfaction with their salary or working conditions by engaging in a dual practice in both the private and public sectors, and when they fail to do so, it becomes a reason for migration (Russo et al., 2018). Apostu et al. (2022) found that salary supplements without other measures had a low impact on the retention of migrant physicians in

Romania. It is estimated that low- and middle-income countries lose USD 15.86 billion annually due to physician migration (Saluja et al., 2020). It has been found that the remuneration policies of physicians are not sufficient to provide both personal and family livelihoods, and in this case, the social lives of physicians are negatively affected. It has been stated that they migrate with better prospects for their families and themselves (Karan et al., 2016; Ossa et al., 2020).

Latukha et al. (2021) emphasize the importance of talent management in their study on how to reverse brain drain and make gains. Goštautaitė et al. (2023) suggest focusing on human resource practices and ensuring equal opportunities to reduce physician migration. It is thought that increasing the number of other health professionals working in health institutions and organizing their duties will have a significant impact on alleviating the workload of doctors and increasing the number of doctors. In addition, it is suggested that incentives for research grants, personal development training, congresses, courses and other activities of physicians who migrate for educational purposes should be developed.

5. Conclusions

It is recommended that countries and policymakers develop a system to be aware of emerging migration and labor force trends and develop policies accordingly. Emphasis should be placed on why physicians migrate and what incentives can be developed to encourage them to return. These can be incentives such as improving overtime wages, providing guidance on housing and transportation, improving salaries, personal development opportunities, and educational support. In addition, in order to prevent health workers from preferring to go to rural areas, they can be directed to regions where health services are limited with appropriate incentives. It is thought that increasing the number of other health professionals working in health institutions and organizing their duties will have a significant impact on alleviating the workload of doctors and increasing the number of doctors. In addition, it is suggested that incentives for research grants, personal development training, congresses, courses and other activities of physicians who migrate for educational purposes should be developed.

Brain drain of physicians is a global health problem. Therefore, both high-income countries and low- and middle-income countries, in other words, both sending and receiving countries, need to address this problem mutually. This problem should be viewed from a health inequality perspective and national and regional strategies should be developed. It is thought that it would be valuable to examine each of the effective factors from a separate political perspective after determining the order of importance and to develop solutions accordingly.

In the study, the DEMATEL method was used to determine the factors related to physician migration. In the DEMATEL method, the opinions of experts are accepted with the same weight. Depending on the experience of the experts, a different method can be preferred to determine their weights. To deepen this issue, it is thought that conducting research by utilizing different MCDM techniques will contribute to the literature.

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Conflict of Interests

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Declaration of Conflicting Interests

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Ethical Aspects of the Research

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Council of Sakarya University of Applied Sciences (11.11.2023).

Supplementary

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