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DETERMINATION OF A FIELD HOSPITAL LOCATION WITH MCDM TECHNIQUES FOR COVID-19 AND ANY OTHER PANDEMICS IN FUTURE

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ABSTRACT

This study was carried out to improve, develop and support the health services that are insufficient in the rapid virus spread between the European Union countries. In this study, it is aimed to determine the location of a field hospital that will serve the patients of the European Union countries, especially the population most affected by the pandemic, in the case of the COVID-19 pandemic and the possible pandemics that may occur. A multi criteria decision model was proposed with 5 main and 20 sub-criteria in order to determine the location of a potential field hospital and six candidate European Union countries were evaluated according to these sub-criteria. In the solution phase of the problem two multi-criteria decision making methods are used in a sequence, firstly the importance weights of the selection criteria were determined with SWARA method and secondly the alternative countries were evaluated and ranked with EDAS method.

Keywords: *COVID-19, pandemic, field hospital location, SWARA, EDAS.*

COVID-19 VE GELECEKTEKİ DİĞER PANDEMİLER İÇİN ÇKKV TEKNİKLERİYLE BİR SAHRA HASTANESİNİN YERİNİN BELİRLENMESİ

ÖZET

Bu çalışma, Avrupa Birliği ülkeleri arasındaki hızlı virüs yayılımında yetersiz kalan sağlık hizmetlerinin iyileştirilmesi, geliştirilmesi ve desteklenmesi amacıyla yapılmıştır. Bu çalışmada, başta Avrupa Birliği ülkeleri olmak üzere COVID-19 pandemisi ve gelecekte olabilecek pandemi durumlarında pandemiden en çok etkilenen nüfusa hizmet verecek bir sahra hastanesinin yerinin belirlenmesi amaçlanmıştır. Potansiyel bir sahra hastanesinin yerini belirlemek için 5 ana ve 20 alt kriterli çok kriterli bir karar modeli önerilmiş ve altı aday Avrupa Birliği ülkesi bu alt kriterlere göre değerlendirilmiştir. Problemin çözüm aşamasında iki adet çok kriterli karar verme yöntemi sırayla kullanılmış, öncelikle SWARA yöntemi ile seçim kriterlerinin önem ağırlıkları belirlenmiş ve ikinci olarak EDAS yöntemi ile alternatif ülkeler değerlendirilmiş ve sıralanmıştır.

Anahtar Kelimeler: *COVID-19, pandemi, sahra hastanesi konumu, SWARA, EDAS.*

1. Introduction

Considering the researchers conducted in previous years and the reports published by scientists, it was predicted years ago that there will be more pandemics in the globalizing world and that these diseases will affect all societies indiscriminately. The severity of pandemics, where it is not possible to predict from which source, when and how they will arise due to their nature, is determined by how

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political decision-making mechanisms manage the situation and which health management tools they use.

With Covid-19, it has been seen that the countries', which are among the strongest in the world in terms of economic, social and military opportunities, power are in fact fragile in the face of any pandemic. In particular, according to health-based research, many countries that are highly confident in health systems and are expected to perform well due to this pandemic have brought into a question that how much they are reliable the existing health systems are with their performance. It is probable that in the post-pandemic period, all countries around the world will have to redesign their health systems and renew their planning based on their experiences in this process [1].

At this point, the inadequacy of existing health institutions, especially against the rapid virus spread in the COVID-19 pandemic, has revealed the need for a field hospital that will quickly protect especially the elderly population in this and future pandemics. This study was carried out to solve the problem of which of the European Union member countries this field hospital should be built in such a planning.

For the solution of the problem, a multi-criteria model consisting of 5 main and 20 sub-criteria was proposed based on literature research and expert opinions and with this proposed model 6 alternative European Union member countries were evaluated in terms of their suitability to this field hospital. The solution of the proposed research model within the scope of the study was carried out with Stepwise Weight Assessment Ratio Analysis (SWARA) and Evaluation Based on Distance from Average Solution (EDAS) methods, which have rapidly expanded their usage in solving multi criteria decision making (MCDM) problems.

The SWARA method, which is used especially in the criterion prioritization of location selection problems, was combined with the EDAS method for the same problem type in this study. When the studies in the literature are examined there are several location selection problems that used SWARA method: such as Agarwal et al. [2], Mostafaeipour et al. [3], Shao et al. [4], Ulutas et al. [5], and Popovic et al. [6]. Besides these, SWARA and EDAS methods has been used together in a similar subject only one study that was conducted by Mostafaeipour et al. [7].

On the other hand, studies in which solution methods are used together can be listed as follows in different research fields: Supciller and Toprak [8] selected the wind turbines, Dahooie et al. [9] identified and prioritized cost reduction solutions in supply chain management, Ghorabaee et al. [10] evaluated the construction equipment, Juodagalviene et al. [11] determined the house's plan shape and Ghorabaee et al. [12] evaluated the airlines service quality.

In the literature, it is possible to come across MCDM applications both for the pandemic and especially for the selection of facility location in the health sector. Samanlıoğlu and Kaya [13] evaluated the COVID-19 intervention strategies with hesitant F-AHP, Gül [14] used fermatean fuzzy set extensions of SAW, ARAS, and VIKOR in COVID-19 testing laboratory selection problem, Moradian et al. [15] selected the field hospital site with a Delphi consensus study and Aydın and Şeker [16] determined the location of isolation hospitals for COVID-19 via Delphi-based MCDM method. Moreover, according to Gül and Güneri [17] research AHP, GIS and ANP are the most used MCDM tecginques for selection of the hospital location.

All researches conducted show that this study will contribute to the literature for the problem of selection a field hospital location in terms of the proposed research model it and the solution methods it uses. The study with this purpose will start with the COVID-19 pandemic and the latest situation of the pandemic in Europe, and will be concluded with information about the problem, solution methods and solution phase, respectively.

2. COVID-19 Pandemic and the Latest Situation in Europe

Pandemics or pandemic diseases are the general name given to pandemic diseases that spread and show their effects in a wide area such as a continent or even the whole world.

The new coronavirus is a type of virus that was detected with the symptoms of fever, cough and shortness of breath seen in a person in Wuhan, China in December 2019 and was declared as a result of researches as the Covid-19 pandemic on March 11, 2020 by World Health Organization [18]. Until the first quarter of 2021 the whole world struggled against COVID-19 for more than a year and still this struggle continues.

The coronavirus, which shows the feature of scattering through droplets that occur due to sneezing and cough, is passed from person to person by respiration and contact. With this rapid spreading feature, the virus spread to many countries around the world in a short time due to the high active population and international travels. According to the data of the World Health Organization, in the whole world there are 401,179,821 confirmed cases and 5,782,796 people who have died due to coronavirus [19].

The COVID-19 pandemic, as a health crisis, has negatively affected life almost all over the world and these negative effects still continue. Countries have postponed their summits, sports events, competitions, scientific congresses, educational activities and many other social events. People have stopped leaving their homes to avoid the virus pandemic. Despite all these preventions, the COVID-19 pandemic, unlike other pandemics in history, directly affected the elderly, 65 years of age and over, and continues to affect. Especially in countries where the average population age is high, health services have been insufficient due to the high rate of hospitalization and the loss of life has increased considerably for this reason.

Investigating at the death statistics due to the COVID-19 pandemic in some European countries, it is seen that the most people who lost their lives were 60 years and over. Until to March 15, 2021 the death of 60 years old and over rate is 93.29% in Italy, 96.35% in Germany, 92% in France, 71.5% in Poland, 96.47% in Sweden and 77.79% in Belgium [20].

Especially in European countries, the establishment of a field hospital that can serve all EU countries in order to prevent this high rate of loss of elderly population and to prevent insufficient health care is an essential need for COVID-19 and any other pandemics in the future.

3. Research Problem

For more than a year, the whole world has been fighting against the COVID-19 pandemic that has affected it. In this struggle, some countries have not been able to defend successfully themselves due to both their insufficient health infrastructure and the wrong strategies they have implemented, and a lot of lives have been lost in their countries because of COVID-19.

With the travel opportunities that have become easier in parallel with the globalization of the world, it is clear that any virus anywhere in the world can easily spread to the whole world in the coming years. For this reason, the aim of this study is to choose the right place for a field hospital that can be established in Europe for providing an adequate and complete health services and preventing loss of life because of COVID-19 or any different pandemics that may occur in coming years.

3.1 Problem Model

The model established within the scope of the research was based on literature research and expert opinions and within the scope of the model, 5 main and 20 sub-criteria were determined to evaluate 6 alternative countries. The established research model is shown in Fig. 1.

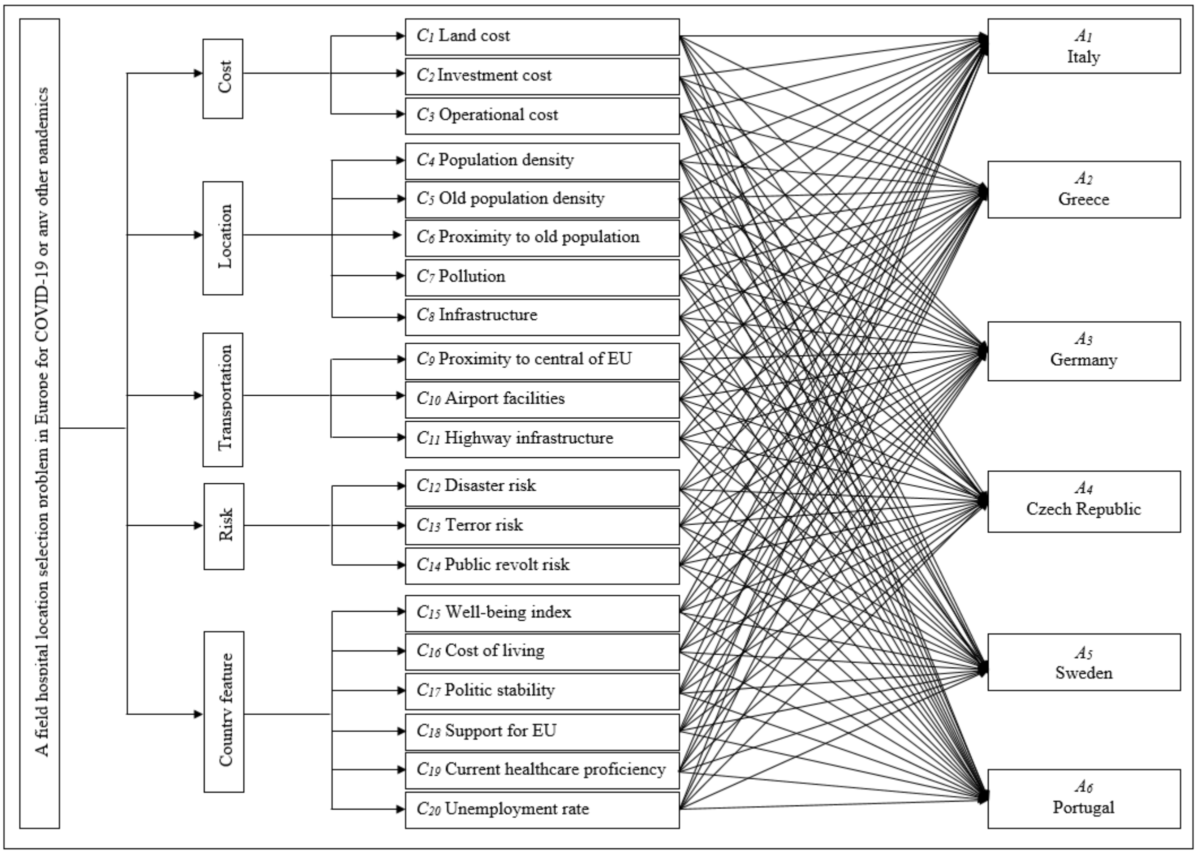


Figure 1. Established MCDM model

3.2 Problem Criteria

Within the scope of the research, 20 decision criteria were determined in the proposed model for the evaluation of alternatives. While some of the criteria are derived from existing studies in the literature, the criteria that are not referenced are the authors' contributions to the literature while creating the model they propose. The criteria taken from the literature were chosen considering their effectiveness in the selection of hospital location. Differ from the literature, the original criteria in the proposed criteria set were added in order to determine the elderly population most affected by COVID-19, to evaluate easy transportation from any region of the European Union, and to determine the distinguishing features of alternative countries among each other.

While 10 of these decision criteria are benefit-based criteria that should be maximized by the alternatives, the remaining 10 criteria are cost-based criteria that should be minimized by the alternatives. The research criteria are as follow:

Criteria about *Cost:*

- C_1 Land cost: This is the one time cost that includes only land price [21, 22, 23].
- C_2 Investment cost: This is the one time cost that includes construction and machine-material costs [21, 23].
- C_3 Operational cost: This cost includes the annual labor and ongoing activities costs [21].

Criteria about *Location:*

- C_4 Population density: The population of country should be high in EU [22, 24, 25].

- C_5 Old population density: The number of 65 years old and over people should be high in country.
- C_6 Proximity to old population: The selected country should be near to old population for serving health treatments quickly.
- C_7 Pollution: The pollution level (air, water...etc.) should be low [23, 25].
- C_8 Infrastructure: The selected country should has high-level infrastructure [22, 25, 26].

Criteria about *Transportation:*

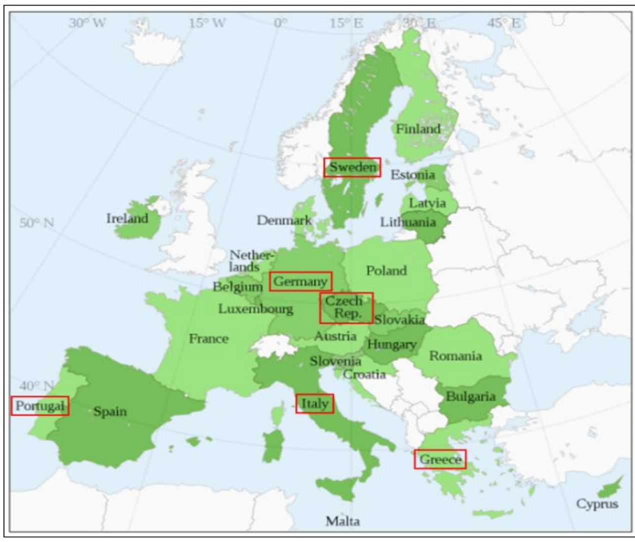
- C_9 Proximity to central of EU: The selected country should be near the center of EU for serving many people quickly.
- C_{10} Airport facilities: The selected country should has effective airport facilities.
- C_{11} Highway infrastructure: The selected country should has high-level highway infrastructure for quick transportation [21, 23, 24, 26, 27].

Criteria about *Risk:*

- C_{12} Disaster risk: The possibility of disaster in country [25].
- C_{13} Terror risk: The possibility of terror attack to country.
- C_{14} Public revolt risk: The possibility of public revolt risk in country.

Criteria about *Country feature:*

- C_{15} Well-being index: High well-being index of the selected country affects employee engagement, motivation and performance positively.
- C_{16} Cost of living: Healthcare professionals prefer to come to selected country if it has cheaper living cost.
- C_{17} Politic stability: It affects predictability, future decisions and sustainability.
- C_{18} Support for EU: The number of supporter that happy to be a member of EU should be high.
- C_{19} Current healthcare proficiency: The current healthcare proficiency should be high [26].
- C_{20} Unemployment rate: If unemployment rate is high, the government in selected country will support this investment.



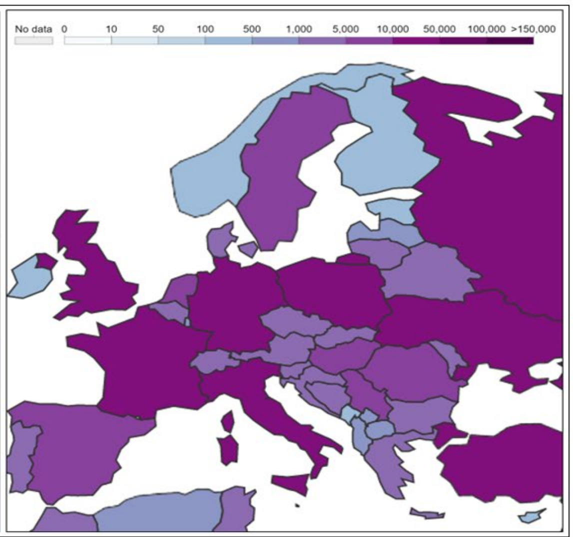


Figure 2[a]. The locations of alternatives **Figure 2[b].** New cases (in average of 7 days)

3.3 Problem Alternatives

Within the scope of the research, 6 European Union member countries were determined for the establishment of a field hospital that will provide fast and effective response for the increased health demands because of COVID-19 and other possible pandemics. The reasons for determining these countries as an alternative are that they are in different locations in Europe as seen in Fig. 2[a], and the average number of new COVID-19 cases for 7 days is still very high in these countries, as seen in Fig. 2[b].

Alternative countries shown in Fig. 2[a] can be listed as follows with their advantageous and disadvantageous features:

- A_1 Italy: Approximately 60.4 million people live in Italy, whose capital city is Rome, and the country is the 4th most populous country in Europe with this population. In the country where the population growth rate is -0.15%, the elderly population is the majority. Italy's official language is Italian, and its entire population speaks Italian. The most spoken languages after Italian are Spanish, French and English. Italy is the 5th most visited country in the world rankings and is the 4th country that earns the most from tourism.
- A_2 Greece: Approximately 10.9 million people live in Greece, whose capital city is Athens. The official language of the country is Greek. However, Turkish, Macedonian, Albanian and Armenian are also spoken by minorities. The most widely used foreign language in the country is English. Greece is a democratic and developed country with a good economy, quality of life and standard of living.
- A_3 Germany: Approximately 83 million people live in Germany, whose capital city is Berlin, and 10.6 million of this population are foreigners. In addition, the number of young people in the country is in a minority. The official language of the country is German. Almost all of the young population in Germany speaks English as well as their mother tongue. In addition, Spanish and French are used as foreign languages in the country. Germany is known all over the world for its giant industry and it is one of the most important economic powers in the world. It is among the countries that should be seen with different historical buildings in terms of touristic.
- A_4 Czech Republic: Approximately 10.5 million people live in the Czech Republic, whose capital is Prague. The official language of the country is Czech, and the use of English and German is very common in the tourist areas of the country. In addition, the majority of the young population living in Prague can speak English. The Czech Republic has a diversified economy. 60% of the economy in the country is services, 37.5% is industry and 2.5% is agriculture. World-renowned products of the country are crystal, glasswork and garnet stone.
- A_5 Sweden: Approximately 9.8 million people live in Sweden, whose capital is Stockholm. Swedish, which is spoken by the majority of the population, was accepted as the official language of the country in 2009. However, apart from Swedish, the country has 5 different minority languages. These languages are Finnish, Meänkieli, Sami, Romani and Yiddish. Sweden is a welfare state, financed by relatively high income taxes, ensuring the distribution of income throughout the society. Timber, hydroelectricity and iron ore constitute the resource base of the country's economy for foreign trade.
- A_6 Portugal: Approximately 10.3 million people live in Portugal, whose capital is Lisbon. The official language of Portugal is Portuguese. Due to its similarities with Spanish, some of the people can understand or speak Spanish. English is widely known. While the economic income of Portugal is mostly provided by tourism and porto wine, oil refineries, cement, paper

and automotive production also have an importance in the country. Depending on agriculture and industry, Portugal is among the top 10 in the world in terms of welfare level.

3.4 Problem Assumptions and Limitations

In the framework of the research, it is assumed that no matter which alternative is chosen, a field hospital of the same size will be built and this establishment will be realized with European Union funding. In addition, it is assumed that the technology and drug supply of this field hospital, which is established, will be met by the European Union. Finally, for this field hospital, it is assumed that the legal responsibilities are met and the required permits are taken in alternative countries. Also, it is assumed that all decision makers who make evaluations within the scope of the study have equal importance in terms of the opinions they provide.

The most important limitation of this research is that instead of 27 countries in the European Union, 6 of them were evaluated. In addition, a more in-depth research area could be created with more main and sub criteria that could be added to the research model. Also, the research can be expanded by solving the same research model with different MCDM methods and the results can be compared.

Despite these limitations, this study was carried out in order to provide countries with a rapid perspective in the fight against the COVID-19 pandemic, which is still active all over the world, and to show the way.

3.5 Problem Solving Techniques

The research model was solved with the SWARA and EDAS methods used consecutively. In the first stage of the solution methodology, 20 decision criteria were weighted with the SWARA method, and in the second stage of the solution, 6 alternative countries were ranked with the EDAS method and the most suitable location was found for a field hospital that can be established in Europe.

The SWARA and EDAS methods used in the proposed methodology were preferred due to their suitability to work with experts, their easy application, and the small number of studies in which these two techniques were used together in the literature.

Both time and cost savings were achieved with these two methods, which provide convenience to decision-makers especially in problem types that decision-makers cannot agree on when choosing alternatives and/or have incomplete information for evaluating alternatives.

The proposed solution methodology with SWARA/EDAS methods for the research is shown in Fig. 3.

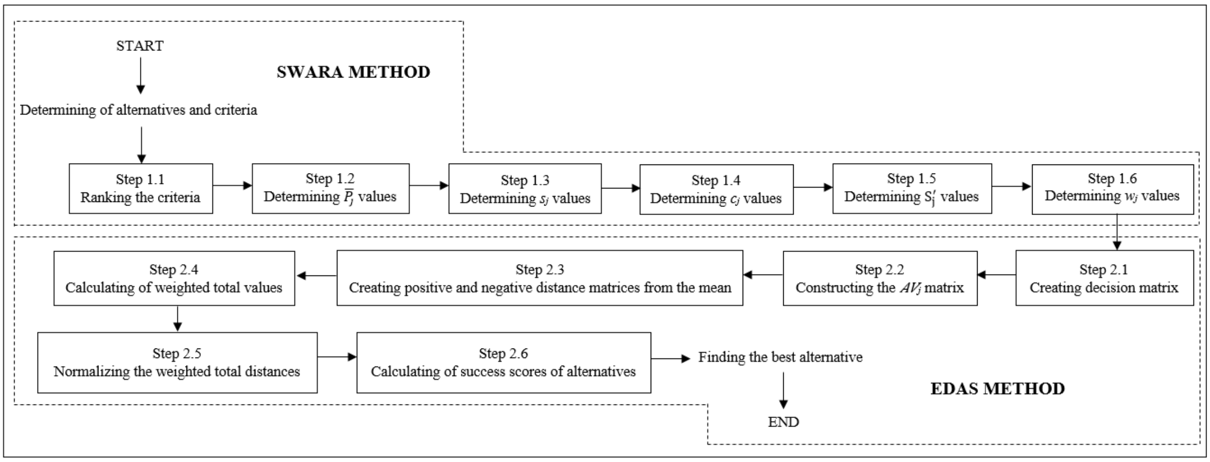


Figure 3. Solution methodology with SWARA/EDAS

3.5.1 Implementation Steps of SWARA Method

In the process of determining the criterion importance weights, the SWARA method, which is based on the possibility of estimating the opinions of decision makers or field experts regarding the importance of the criteria, was proposed by Keršuliene, Zavadskas and Turskis [28].

It is possible to summarize the steps of the SWARA as follows [28, 29, 30]:

Here, decision makers are k ($k = 1, ..., l$), alternatives are a_i ($i = 1, ..., m$) and criteria are c_j ($j = 1, ..., n$).

Step 1 *Ranking the criteria:* In the first step, the criteria are ranked by the experts in order of decreasing importance, with the most important criterion first and the least important one at the last.

Step 2 *Determining $\overline{P_j}$ values:* The experts reorder the decision criteria. In this ordering, the most important criterion's value (p_j) is equal to *1.00*, while the other criteria's values are between *0.00* and *1.00* (P_j^k; $0 \leq P_j^k \leq 1$). If criteria are to be evaluated by more than one expert, relative importance levels for each criterion is obtained by taking the geometric or arithmetic mean ($\overline{P_j}$) of the criteria rankings determined by the experts.

Step 3 *Determining s_j values:* Decision makers determine the relative importance levels for each criterion, starting with the second important criterion. For this, criterion j is compared with the previous criterion $j-1$.

Step 4 *Determining c_j values:* The c_j value of the first criterion is always equal to *1.00* and the c_j values of the other criteria are obtained by using Eq. (1).

$$c_j = s_j + 1 \qquad j > 1 \tag{1}$$

Step 5 *Determining S_j' values:* The significance vector S_j' is calculated with the help of Eq. (2).

$$S_j' = \frac{S_{j-1}'}{c_j} \; j > 1 \tag{2}$$

Step 6 *Determining w_j values:* The final importance weights of the evaluation criteria are calculated with the help of Eq. (3).

$$w_j = \frac{S_j'}{\sum_{j=1}^{n} S_j'} \tag{3}$$

3.5.2 Implementation Steps of EDAS Method

EDAS method is one of the MCDM methods and was developed by Ghorabaee, Zavadskas, Olfat and Turskis [31]. EDAS method uses the evaluations based on the average solution distance in determining the most optimal among the alternatives in the decision-making stages and the application steps of the method are as follows [31, 32, 33]:

Step 1 *Creating decision matrix:* The decision matrix is constructed with n decision criteria and m alternatives, as shown in Eq. (6).

$$X = \left[X_{ij}\right]_{n \times m} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \tag{6}$$

Step 2 *Constructing the AV_j matrix:* The mean values matrix is calculated by using Eq. (7) and Eq. (8). Thus, average solution matrices related to the determined evaluation criteria are created.

$$AV = \left[AV_j\right]_{1 \times m} \tag{7}$$

$$AV_j = \frac{\sum_{i=1}^{n} X_{ij}}{n} \quad (8)$$

Step 3 *Creating positive and negative distance matrices from the mean:* For each criterion, the positive distance matrix from the mean (*PDA*) shown in Eq. (9) and the negative distance matrix from the mean (*NDA*) shown by Eq. (10) are created. If the criteria are benefit-based (should be maximized), *PDA* and *NDA* matrices are obtained with Eq. (11) and Eq. (12). If the criteria are cost-based (should be minimized), then *PDA* and *NDA* matrices are obtained by Eq. (13) and Eq. (14).

$$PDA = \left[PDA_{ij}\right]_{m\times n} \quad (9)$$

$$NDA = \left[NDA_{ij}\right]_{m\times n} \quad (10)$$

$$PDA_{ij} = \frac{\max(0,(X_{ij}-AV_j))}{AV_j} \quad (11)$$

$$NDA_{ij} = \frac{\max(0,(AV_j-X_{ij}))}{AV_j} \quad (12)$$

$$PDA_{ij} = \frac{\max(0,(AV_j-X_{ij}))}{AV_j} \quad (13)$$

$$NDA_{ij} = \frac{\max(0,(X_{ij}-AV_j))}{AV_j} \quad (14)$$

Step 4 *Calculating of weighted total values:* Weighted total positive distances (SP_i) and weighted total negative distances (SN_i) are calculated with the help of Eq. (15) and Eq. (16). In these equations, w_j expresses the importance weight of each decision criterion.

$$SP_i = \sum_{i=1}^{n} w_j PDA_{ij} \quad (15)$$

$$SN_i = \sum_{i=1}^{n} w_j NDA_{ij} \quad (16)$$

Step 5 *Normalizing the weighted total distances:* The weighted and normalized NSP_i and NSN_i values of all alternatives are calculated by using Eq. (17) and Eq. (18).

$$NSP_i = \frac{SP_i}{mak(SP_i)} \quad (17)$$

$$NSN_i = 1 - \frac{SN_i}{mak(SN_i)} \quad (18)$$

Step 6 *Calculating of success scores of alternatives:* Averaging the sum of NSP_i and NSN_i values, success scores (AS_i) for each alternative are calculated by using Eq. (19). The success scores calculated for each alternative take values between *0.00* and *1.00*. As a result of the calculations, the alternative with the highest score is determined as the best alternative.

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad (19)$$

3.7 Problem Solution

Within the scope of the study, multi-criteria model and alternative countries were determined based on literature research and expert opinions.

Following the proposal of the MDCM model in Figure 1, the problem was started to be solved with the integrated SWARA / EDAS method according to the proposed solution methodology given in Figure 3. The solution steps of the problem were carried out in the following order. First, the importance weights of 20 decision criteria were found with the SWARA method:

Step 1.1-1.2: Criteria were ranked by the 5 decision makers from most important to least important, and average importance values ($\overline{P_j}$) were calculated for each criterion. This ranking performed by decision makers is shown in Table 1.

The 5 experts whose opinions were taken during the evaluation phase of the study consist of health professionals, administrators and international health investors working in the health sector. The industry experience of the experts ranges from 10 to 28 years.

Table 1. Ranking of problem criteria

Criteria	Decision Makers										$\overline{P}_j$
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	
1	15	8	17	6	14	0.40	0.70	0.38	0.75	0.30	0.506
2	3	2	10	5	7	0.94	0.95	0.64	0.80	0.75	0.816
3	7	4	7	1	6	0.78	0.85	0.77	1.00	0.80	0.840
4	8	11	3	9	9	0.75	0.58	0.93	0.60	0.55	0.682
5	9	13	19	2	1	0.70	0.48	0.30	0.95	1.00	0.686
6	1	3	2	3	5	1.00	0.90	0.96	0.90	0.85	0.922
7	20	20	18	18	20	0.20	0.25	0.35	0.15	0.07	0.204
8	5	5	1	13	8	0.84	0.80	1.00	0.40	0.60	0.728
9	2	1	4	4	2	0.98	1.00	0.90	0.85	0.95	0.936
10	4	7	16	8	3	0.90	0.75	0.40	0.65	0.93	0.726
11	6	6	5	12	4	0.81	0.77	0.87	0.45	0.90	0.760
12	16	9	11	14	12	0.35	0.66	0.57	0.35	0.35	0.456
13	19	12	15	19	16	0.28	0.52	0.44	0.10	0.23	0.314
14	17	17	14	15	17	0.33	0.35	0.47	0.30	0.20	0.330
15	18	18	13	20	19	0.30	0.31	0.50	0.05	0.10	0.252
16	11	10	6	17	11	0.65	0.60	0.81	0.20	0.50	0.552
17	12	14	8	16	15	0.60	0.45	0.72	0.25	0.27	0.458
18	10	16	12	7	10	0.68	0.40	0.55	0.70	0.53	0.572
19	14	19	20	10	18	0.48	0.28	0.25	0.55	0.15	0.342
20	13	15	9	11	13	0.52	0.42	0.67	0.50	0.33	0.488

Step 1.3: s_j values were obtained.

Step 1.4: c_j values were obtained with Eq. (1).

Step 1.5: S_j' values were obtained with Eq. (2).

Step 1.6: w_j values were obtained with Eq. (3).

All calculated s_j, c_j, S_j' and w_j values for all problem criteria are shown in Table 2.

Table 2. s_j, c_j, S_j' and w_j values for all problem criteria

C	$\overline{P}_l$	s_j	c_j	S_i'	w_j	C	$\overline{P}_l$	s_j	c_j	S_i'	w_j
9	0.936	-	1.000	1.000	0.0692	*16*	0.552	0.020	1.020	0.689	0.0477
6	0.922	0.014	1.014	0.986	0.0682	*1*	0.506	0.046	1.046	0.659	0.0456
3	0.840	0.082	1.082	0.911	0.0630	*20*	0.488	0.018	1.018	0.648	0.0448
2	0.816	0.024	1.024	0.890	0.0616	*17*	0.458	0.030	1.030	0.629	0.0435
11	0.760	0.056	1.056	0.843	0.0583	*12*	0.456	0.002	1.002	0.627	0.0434
8	0.728	0.032	1.032	0.817	0.0565	*19*	0.342	0.114	1.114	0.563	0.0390
10	0.726	0.002	1.002	0.815	0.0564	*14*	0.330	0.012	1.012	0.557	0.0385
5	0.686	0.040	1.040	0.784	0.0542	*13*	0.314	0.016	1.016	0.548	0.0379
4	0.682	0.004	1.004	0.781	0.0540	*15*	0.252	0.062	1.062	0.516	0.0357
18	0.572	0.110	1.110	0.703	0.0486	*7*	0.204	0.048	1.048	0.492	0.0340

The solution phase continued with the steps of EDAS method after the steps of applied SWARA method and 6 alternative countries were evaluated according to this method:

Step 2.1: Decision matrix was created and showed in Table 3.

Step 2.2: AV_j values was calculated with Eq. (8).

The decision matrix and AV_j values of alternatives are shown in Table 3. In this matrix the objective evaluations of the alternatives were made with lots of different resources. For only two criteria such as C_6 and C_{14} subjective assessments were made by experts.

Table 3. Decision matrix and AV_j values

Criteria		w_j	Alternatives						AV_j
			1	*2*	*3*	*4*	*5*	*6*	
1	*min*	0.0456	20.67	23.39	28.34	29.55	27.50	17.20	24.453
2	*min*	0.0616	87.9	80.2	120.8	80.5	120.6	80.5	95.083
3	*min*	0.0630	28.8	16.4	35.6	13.5	36.3	14.6	24.200
4	*max*	0.0540	11.9	2.2	16.6	2.1	1.8	2.1	6.117
5	*max*	0.0542	22.8	22.0	21.5	19.6	19.9	21.8	21.267
6	*min*	0.0682	1	3	1	2	4	4	2.500
7	*min*	0.0340	407.81	545.87	324.29	585.26	64.64	203.88	355.292
8	*max*	0.0565	3.85	3.17	4.37	3.46	4.24	3.25	3.725
9	*min*	0.0692	1189.0	2089.4	481.7	502.9	1591.1	2278.0	1355.350
10	*max*	0.0564	0.035	0.032	0.019	0.006	0.030	0.022	0.024
11	*max*	0.0583	0.162	0.089	0.180	0.166	0.129	0.091	0.136
12	*min*	0.0434	4.42	6.70	2.95	3.37	2.12	3.45	3.835
13	*min*	0.0379	3.043	4.182	3.965	0.315	2.892	0.001	2.400
14	*min*	0.0385	3	3	2	2	1	2	2.167
15	*max*	0.0357	4.4	2.2	7.8	6.8	8.9	2.4	5.417
16	*min*	0.0477	73.11	60.96	70.62	49.18	79.17	52.88	64.320
17	*max*	0.0435	0.46	0.29	0.58	0.95	1.05	1.13	0.743
18	*max*	0.0486	58	53	69	52	72	84	64.667
19	*max*	0.0390	687	615	785	731	800	754	728.667
20	*max*	0.0448	9.97	17.33	3.15	2.20	6.77	6.55	7.662

Step 2.3: Positive and negative distance matrices from the mean were created. In this step problem criteria were separated to be benefit-based or cost-based and suitable equations were used for calculations.

Step 2.4: SP_i and SN_i values were calculated by using Eq. (15) and Eq. (16). In these calculations used w_j values were obtained by SWARA.

Step 2.5: NSP_i and NSN_i values were calculated by using Eq. (17) and Eq. (18).

Step 2.6: AS_i values were calculated by using Eq. (19).

Calculated SP_i, SN_i, NSP_i, NSN_i, AS_i values for all problem alternatives and the ranking of alternatives are shown in Table 4.

Table 4. SP_i, SN_i, NSP_i, NSN_i, AS_i values for all alternatives and the ranking

	Alternatives	SP_i	SN_i	NSP_i	NSN_i	AS_i	*Ranking*
1	Italy	0.1675	0.0856	0.6827	0.6835	0.6831	2
2	Greece	0.1114	0.2705	0.4541	0.0000	0.2270	6
3	**Germany**	**0.2454**	**0.1298**	**1.0000**	**0.5202**	**0.7601**	**1**
4	Czech Republic	0.1809	0.1581	0.7371	0.4155	0.5763	3
5	Sweden	0.1398	0.1754	0.5695	0.3517	0.4606	5
6	Portugal	0.1559	0.1814	0.6353	0.3294	0.4823	4

3.8 Problem Findings

In the first step of the proposed solution methodology, the importance weights of the decision criteria were found by using SWARA method. According to the values given in Table 3, the most important four criteria in the proposed model are proximity to central of EU (C_9), proximity to old population (C_6), operational cost (C_3) and investment cost (C_2). According to the conclusion to be drawn here, proximity to the market and costs are very influential on the location selection decision of the field hospital. On the other hand, the decision criteria that have the least impact on this decision are the possibility of terror attack to country (C_{13}), well-being index (C_{15}) and pollution (C_7) according to the values in Table 3.

In the second stage of the proposed solution methodology, with using the EDAS method, alternative locations were ranked and the most suitable alternative country was selected. The final results in Table 5 were obtained by carrying out the steps of this method, which evaluates the alternatives according to the negative and positive distance matrices from the mean. According to this table, in the lead of the proposed model, Germany was the most suitable country for such a field hospital among 6 alternative European Union member countries with a success score of 0.7601. Germany was followed by Italy with 0.6831 success score and Czech Republic with 0.5763 success score. This result is consistent due to the fact that Germany is at the mid-point of the EU and its elderly population is high. Ease of transportation and other features of the country make Germany stand out for a possible field hospital.

Finally, in the sensitivity analysis section of the study, when the criteria weights found by the SWARA method were changed partially, it was checked whether the first alternative ranking result obtained by the EDAS method changed. The weights of the 5 main criteria in the proposed MCDM model were increased by 10%, respectively, and the result values and rankings are shown in Table 5. In the calculations, it was observed that there was no change in the ranking of the alternatives.

Table 5. Sensitivity analysis by changing criterion weights

	Results by increasing the Cost criteria by 10%		*Results by increasing the Location criteria by 10%*		*Results by increasing the Transportation criteria by 10%*		*Results by increasing the Risk criteria by 10%*		*Results by increasing the Country Feature criteria by 10%*	
Alternatives	*AS_i / Ranking*		*AS_i / Ranking*		*AS_i / Ranking*		*AS_i / Ranking*		*AS_i / Ranking*	
Italy	0.6833	2	0.6868	2	0.6876	2	0.6790	2	0.6787	2
Greece	0.2354	6	0.2113	6	0.2244	6	0.2255	6	0.2397	6
Germany	**0.7474**	**1**	**0.7683**	**1**	**0.7640**	**1**	**0.7627**	**1**	**0.7577**	**1**
Czech Republic	0.5838	3	0.5483	3	0.5769	3	0.5946	3	0.5794	3
Sweden	0.4479	5	0.4412	5	0.4601	5	0.4785	5	0.4760	5
Portugal	0.4948	4	0.4559	4	0.4646	4	0.5035	4	0.4945	4

4. Conclusion

The spread and effects of the COVID-19 pandemic, which surrounded the whole world and killed nearly three million people, still continue today. Although rapid vaccine and drug researches are trying to contain the pandemic, the number of countries that have been successful in this regard is very few yet.

This study is about the determination of the selection of location for a field hospital that is likely to be established in European countries especially which has the elderly population and severely injured in COVID-19 pandemic. Within the scope of the study, 6 alternative countries were evaluated according to 20 criteria, and countries were guided in this regard to combat both COVID-19 and other possible pandemics.

Although it is very difficult to give predictions for the ending day of the COVID-19 pandemic that affects the whole world today, and also to predict what the consequences will be if the pandemic is over is very difficult, too. In fact, the important thing against the COVID-19 pandemic or against other pandemics that may occur in the future is that the world public can act with a common mind and responsibility in the treatment of all diseases, wherever they are in the world. Also to intervening in these pandemics without further spreading is the important subject for all over the world.

With this study, it is aimed to provide a quick perspective and guide the countries in the fight against the COVID-19 pandemic, which affects the whole world and is still active in some countries. With the results found, a preliminary study has been prepared on the rapid response to the COVID-19 pandemic or possible epidemic diseases that may affect the European region.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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