



## Research Article

# Analysis of criteria acting on coronavirus

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## ABSTRACT

Viruses are obligate intracellular parasites that can infect animals, plants, bacteria and many more microorganisms. Viruses are spread by aphids and insects in plants, and by bloodsucking insects in animals. In humans, they can cause flu by spreading through respiratory, human-to-human contact, water and food. Some viruses, however rare, infect humans from animals. Coronavirus is one of the viruses transmitted from animals to humans. The new type of coronavirus (Covid-19), which is on the world agenda, is similar to seasonal flu, previously unidentified and contagious virus in humans. In this study, new types of coronavirus and its effects were investigated and studies related to coronavirus conducted worldwide were analyzed. As the treatment process in the world continues, every country has started to take its measures. The measures taken by countries, especially Turkey, have been identified. It is aimed to calculate the importance and priority values of the measures with the Analytic Network Process and Fuzzy Analytic Hierarchy Process methods, which is one of the multi-criteria decision-making methods. As a result of the values obtained, it is planned to prioritize the measures taken while struggling coronavirus and contribute to the struggle against coronavirus by giving emphasis to the priority measures.

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## INTRODUCTION

Throughout history, people have struggled with various epidemics. The spread of epidemics has also occurred due to wars and interactions with trade routes. Many people lost their lives due to epidemics, while survivors continued to live with the disease's trauma and fear. Some of the epidemics that cause period-by-period loss of life have become pandemics and spread worldwide [1]. While these spreading virus-borne epidemics may cause deaths, ways to

fight them have also been found over time. In the context of this struggle, public awareness was raised, the number of medical personnel such as doctors and pharmacists was increased, quarantine was applied when necessary, schools were vacated, students were examined, vaccines were sent to the public, free medicines were distributed, food and beverage items were protected and food aids were made. Just as the pandemic negatively affected economies all over the world, it also changed social life and made it mandatory to restrict face-to-face relationships [2].

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Today, the coronavirus is being battled. Coronavirus is an animal-borne (Zoonotic) virus that causes the most common colds in humans. Coronavirus is a virus that affects the upper respiratory tract in humans. It causes negligible upper respiratory infections and serious lower respiratory infections such as pneumonia and lung infection. Studies have shown that a new type of coronavirus (Covid-19) originated from bats. New type coronavirus is a mutated coronavirus as it passes from one host organism to another. These mutations can also occur when passing from person to person. Therefore, close monitoring of the virus genome during the outbreak is crucial in terms of measures to be taken and treatment to be applied. Given many countries with mounting epidemics now potentially face the first phase of the lockdown, safe ways out of this situation must be identified [3].

The most basic symptoms of coronavirus are high fever, cough and respiratory distress. Because the symptoms are quite similar to flu and pneumonia, tracking the disease is quite essential. The duration of beginning of symptoms of COVID-19 infection varies depending on demographic characteristics. Clinical signs ranging from mild respiratory failure to severe respiratory failure can be seen [4]. The flu is a slow course with weakness and sore throat, while coronavirus shows rapid progress. If flu symptoms are aggravated, shortness of breath and kidney failure are added among the symptoms, there is an increase in coronavirus suspicions. Although the virus's incubation period is not clear, it is thought to be between 2-14 days.

It is recommended to follow the prevention measures of respiratory infections to prevent transmission. The main route of transmission of the disease is through droplet infection spread through the respiratory tract during cough-sneeze. The first condition of this is to avoid contact with people. Close contact is meant to stay away from sick individuals and droplets spread around by the respiratory tract of sick individuals.

14 rules have been put in place by the Ministry of Health to protect against new type of coronavirus:

1. Hands should be washed frequently by rubbing with water and soap for at least 20 seconds.
2. People with common cold symptoms should be put at least 3-4 steps away from each other.
3. While coughing or sneezing, the mouth and nose should be hidden with disposable wipes. If there is no handkerchief, the inside of the elbow should be used.
4. Close contacts such as handshakes and hugs should be avoided.
5. Eyes, mouth and nose should not be touched.
6. Their travel abroad must be cancelled or postponed.
7. The first 14 days must be spent at home on return from abroad.
8. The current environments should be ventilated frequently.
9. Clothes should be washed with regular detergent between 60°C. and 90°C.

10. Frequently used surfaces such as door handles, fixtures, sinks should be cleaned daily with water and detergent.
11. People with common cold symptoms should not come into contact with the elderly and those with chronic disease, should not go out without wearing a mask.
12. Personal items such as towels should not be used in common.
13. Plenty of liquid should be consumed, balanced diet, sleep patterns should be considered.
14. People with non-falling fever, cough, and shortness of breath should contact a health care provider wearing a mask [5].

On the one hand, efforts are underway to treat existing patients and prevent the spread of the virus, on the other hand, new information is obtained, scientific studies are carried out, approaches are frequently updated [6].

It is reported that the spread of disease can be slowed by practices such as social distance and hand washing, and that deaths can be reduced by half by quarantining positive cases [7].

In addition to prevention works, the life cycle of coronavirus was studied to recognize the virus. Thus, studies are conducted on RNA to produce the drug to be used in the treatment of the virus [8]. The remarkable contributions to stop and treat viruses and involved diseases fall within multiple academic disciplines and professions. Most important, medical scientists, biologists, and public health researchers are the key contributors to a pandemic of this nature and scale. They implement laboratory research to learn the attributes of the virus and the characteristics of the family of viruses. They experiment, develop, test, and advance vaccines for bulk use, and eventually identify effective treatments [9]. The infection caused by the virus and the treatment methods are being investigated for this infection. The use of a drug called lopinavir-ritonavir for the treatment of AIDS and malaria is being tested for the treatment of coronavirus [10]. In order to investigate the therapeutic methods and increase the effects of the treatments, blood and stool samples of the patients were examined by selecting the hospital [11]. University Hospitals have also enabled the evaluation of hospital data for the purpose of determining the etiological and epidemiological profile of prevalent respiratory viruses in adults with acute respiratory infection [12]. For the same purpose, symptoms of the virus, transmission of the virus, risk factors related to the virus continued to be investigated and the measures taken were evaluated from a medical standpoint [13]. In addition to the treatments and research carried out, the implementation of technological support, which is important to optimize the clinical management of coronavirus pandemic, is also very important. With the aim of implementing technological support, challenges and prevention efforts of cases are investigated [14]. One of the studies measured the number of COVID-19, SARS or MERS cases, how many people were infected, how quickly the virus spread, how many people died, and the costs of quarantine. Results show that

quarantine was most effective, and cost less, when it started earlier. Combining quarantine with other prevention and control measures may have a more significant effect than quarantine [15].

In this study, the measures taken against coronavirus worldwide were compiled and evaluated using Analytic Network Process (ANP) and Fuzzy Analytic Hierarchy Process (FAHP) methods from Multi-Criteria Decision Making (MCDM) methods. This assessment aims to determine the most important and influential measures, together with determining the priority values of the measures taken against coronavirus. In this way, measures against coronavirus can be applied in accordance with their priority values, rather than randomly applied.

This study differs from other studies in the literature in terms of quantitative assessment of factors affecting coronavirus. The contribution of this study to studies in the literature is that it is a study investigating the effects of measures that can be taken within the scope of combating coronavirus on coronavirus, and that these measures benefit the fight against the virus by prioritizing them.

## MATERIALS AND METHODS

Decisions about situations or problems encountered in daily life often have multiple and often contradictory criteria. In MCDM, methods can be defined as the choice the decision-maker makes using at least two criteria in a set of many options. Many methods have been developed in MCDM. These methods have some advantages and differences over each other. Therefore, the structure and options of the problem should be considered when determining the most appropriate solution method [16].

MCDM is the process of evaluating a finite number of options using multiple criteria, usually weighted for selection, ranking, classification, prioritization or elimination, that are contradictory and do not use the same unit of measure, and some even take qualitative values [17].

MCDM methods are used in decision-making on issues such as solving optimization problems, statistical analyses, performance analyses, occupational health and safety analyses, and project management [18]. Many research and study methods are mainly Analytic Network Process, Analytic Hierarchy Process, VIKOR, TOPSIS, PROMETHEE and ELECTRE methods [19].

In this study, ANP and Fuzzy AHP from MCDM methods was used. ANP method developed by Thomas L. Saaty, the problem is modelled by a network structure and the relationships between the factors at the modelling stage are taken into account. ANP method allows for a more realistic and practical solution to decision-making problems resulting from this structure [20].

Although the AHP method addresses the knowledge of experts, it cannot reflect the human way of thinking. Fuzzy logic is a fuzzy logic system. Unlike AHP, where Net values

are used, benchmark rates in FAHP are given in a value range [21].

Chang (1992) [22] introduced a new approach to the handling of FAHP using the triangular fuzzy numbers for the binary comparison scale of FAHP and the order analysis method for artificial order values of binary comparisons [23].

## ANALYTIC NETWORK PROCESS

Many of the decision-making problems cannot be hierarchically structured due to dependencies between factors and interactions within themselves [24]. ANP method considers the relationships between criteria in the decision-making process, eliminating the need to model the problem by adhering to one direction, and taking into account more complex relationships between decision levels and characteristics [25]. First, It was laid out by Thomas L. Saaty and continues to be developed.

ANP method consists of identifying problems, the direction of the components and the relations between them, and showing these problems in a network. The feedback and interactions between the primary and intermediate structures that are not directly associated with the introductory and intermediate systems can be calculated thanks to this structure. More mixed relationships between decision levels and features are found by the ANP method [26].

ANP method is used quite frequently in decision-making processes and has several examples in the literature. ANP method; supplier selection, estimate the market-share, personnel selection, facility site selection, hotel selection, program selection, and evaluation studies are used in various decision making problems, such as strategy selection. In this article, an exemplary study of evaluation studies was carried out and criteria weights were evaluated. In evaluating the transition process to Industry 4.0 to help enterprises gain more knowledge and accelerate the integration process [27], in the selection of the most appropriate supplier for the raw material requirement of a company manufacturing spare parts [28], among the academic journals scanned in the Science Citation Index (SCI), in the choice of the journal best for the author [29], prevalence of substance use in young people, in identifying factors and risk areas affecting substance use [30] and in the combi boiler selection problem in the province of Denizli, which has just met with natural gas [31] used ANP method.

In the ANP method, problems are expressed by defining the relationships between criteria and aspects of these relationships with a network structure suitable for the purpose. Feedback and dependencies are taken into account in the method [32].

ANP method was used in this study, as it provides a more effective and realistic solution of decision-making problems.

1. Purpose is determined and model is established.

Criteria and alternatives are determined. The criteria associated with each other are created so that they are in the same set. Then the network structure is created by establishing a link between the criteria.

2. The binary comparison matrix is created and the eigenvector is calculated.

Criteria and alternatives, binary comparisons are made with interactive criteria and alternatives. These comparisons are performed on a 1-9 scale.

3. Weighted supermatrix are calculated.

A new matrix is created by multiplying the values in the nonweighted supermatrix by the weights of the set to which they belong. The created supermatrix are normalized.

4. The alternatives are sorted and the best alternative is chosen.

Final priorities of alternatives and criteria are calculated [26].

## FUZZY ANALYTIC HIERARCHY PROCESS

AHP, a multi-criteria decision method, is based on binary comparisons. Depending on the definition of the criteria, comparisons can be made subjectively or objectively. Comparison weights should be made objectively, considering how much more important one alternative is than the other [33].

FAHP was first laid out by Laarhoven and Pedrycz. In the study, judgments and weights were expressed in triangular fuzzy numbers [34].

Fuzzy AHP has been used in various studies in the literature, such as location selection, Personnel Selection, performance measurement, supplier selection, factor evaluations. Studies on project selection for urban transportation [35], personnel selection for the retail sector [36], cargo company selection for a business [37], computer selection for a business [38], location selection for a hospital in Ankara [34] and evaluation of factors affecting operating room performance [39] are examples for the fuzzy AHP method.

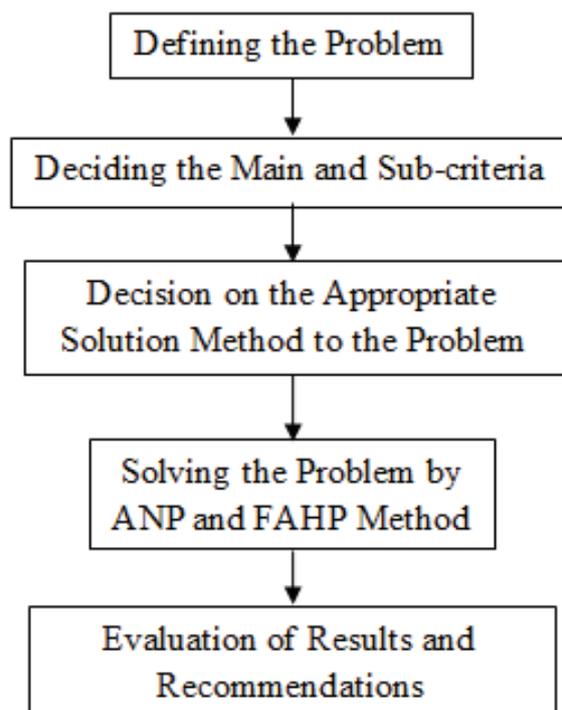
1. Fuzzy artificial magnitude value is defined according to objects. An extended analysis value is obtained by finding a matrix with the help of fuzzy addition.
2. Chang's proposed method is based on comparing the obtained synthesis values and obtaining weight values from these comparison values. Binary comparisons with fuzzy numbers are performed between criteria.
3. At the end of the comparisons, the geometric mean of the values is calculated.
4. Normalized weight vector is obtained by normalization. The normalization process is performed by summing all the elements of the vector, dividing each element by this summing. In this way, the normalized weight vector is calculated [40].

**Table 1.** Scale Used in FAHP According to Chang Method [23]

Verbal Significance	Fuzzy Scale
Equally Important	(1, 1, 1)
Weakly Important	(1, 3, 5)
Fairly Important	(3, 5, 7)
Strongly Important	(5, 7, 9)
Absolutely Important	(7, 9, 9)

## ANALYSIS OF CRITERIA

As part of the struggle the new type of coronavirus, each country has taken its own measures and aimed to protect the world's health, especially its citizens. In this study, the measures taken against the coronavirus in the world were determined. Figure 1 obtains flow chart of the study. The problem is solved by ANP and FAHP method.



**Figure 1.** Flow chart of study.

## ANP METHOD

In this ANP method, the criteria associated with each other are grouped in the same set. A network structure is established by the relationships between criteria. Network structure a binary comparison matrix was created between established criteria and comparisons were scored using a 1-9 scale. Figure 2 shows measures and the network structure established in the study.

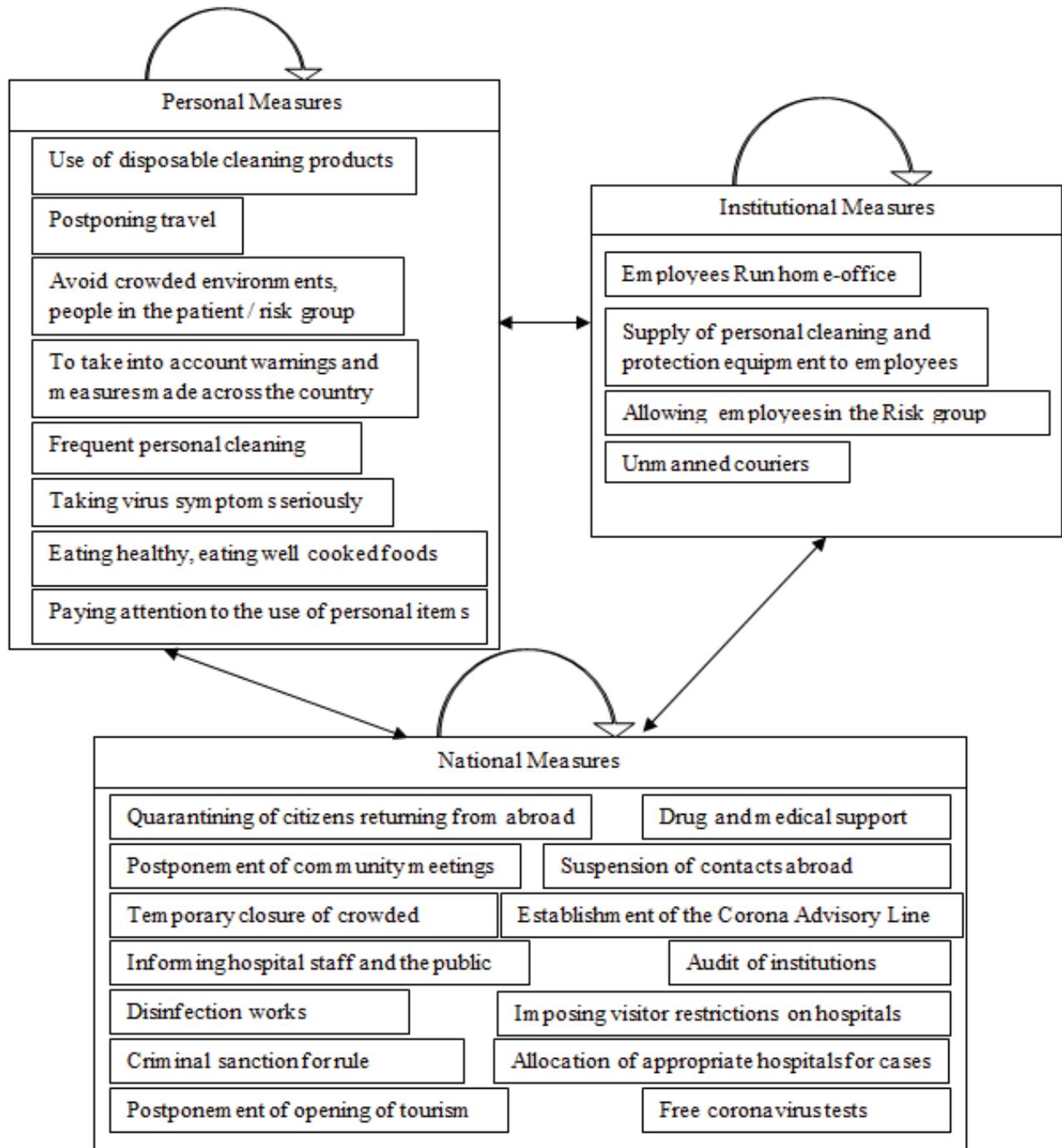


Figure 2. Network structure established by ANP method.

The measures to be taken with the established network structure are grouped and categorized. In this way, the most important criteria are found separately within each category. Table 2 includes comparisons between criteria.

As a result of evaluating the problem with the ANP method, priority values found in Table 3 were obtained.

As a result of evaluating the problem using the AAS method, the priority values found in Table 3 were obtained.

According to the results obtained, among all the measures, the most important are free corona virus tests, the establishment of a Corona Advisory line, the provision of medicines and medical support, and the quarantine of citizens from abroad. Free coronavirus tests would be a good step to dispel people’s reservations and fears. When people suspect their health status, they will easily undergo coronavirus testing, and the number of unconscious individuals

**Table 2.** Comparisons for the Corona Advisory line establishment sub-criteria and national measures main criteria

Informing the hospital staff and the public	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Drug and medical support
Informing the hospital staff and the public	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Criminal sanction for rule violations
Informing the hospital staff and the public	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Audit of institutions
Informing the hospital staff and the public	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Free coronavirus tests
Drug and medical support	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Criminal sanction for rule violations
Drug and medical support	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Audit of institutions
Drug and medical support	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Free coronavirus tests
Criminal sanction for rule violations	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Audit of institutions
Criminal sanction for rule violations	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Free coronavirus tests
Audit of institutions	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	Free coronavirus tests

carrying the virus will decrease. In this way, there will also be reductions in the transmission of the virus. Thanks to the Corona Advisory line, everyone will be able to learn about the virus, ask their questions and share their problems without hesitation with people. Looking at this result, it is clear that the most important main criterion is national measures. National measures and related rules will cause people to become aware of the virus. The most important sub-criteria of the main criteria for personal measures are to take the symptoms of the virus seriously and to take into account warnings and precautions made throughout the country [41]. If individuals do not take symptoms seriously and follow quarantine rules, the virus will spread further. The most important sub-criterion of the main criteria of corporate measures is that employees in the risk group are allowed. It can cause coronavirus to spread further without taking symptoms seriously because employees are worried about losing their jobs. If national and institutional measures are not taken, people some personal measures will be ineffective. Therefore, the most essential main criteria are institutional and national measures.

### FUZZY AHP METHOD

In real decision-making problems, it is not always possible to get accurate data. The decision maker fails to make

numerical estimates, but is more effective in qualitative estimates than in numerical estimates [42].

Because the basis of priorities in AHP is the decision-maker's perception-based judgments (which are certainly true, especially for non-physical, imprecise situations), fuzzy AHP produces more successful results [43]. For this reason, many researchers have been interested in the fuzzy extension of the AHP theory developed by Saaty, expressed as fuzzy AHP, which provides more precise definitions in the decision-making process compared to traditional AHP techniques [44].

The values in Table 4 were obtained from the solution of the problem with FAHP. According to these values, it was concluded that the most important criteria are to take virus symptoms seriously, to quarantine citizens returning from abroad, to inform hospital staff and the public, to suspend their contacts abroad and to postpone community meetings such as meetings and conferences.

According to these results, it seems that most of the most important criteria are sub-criteria of the main criterion of national measures. The most important criterion, the sub-criterion of taking virus symptoms seriously, is among the personal measures. In this case, the criteria that should be given priority in taking measures should be the criteria under the heading of national measures.

**Table 3.** Priority values calculated for criteria

Main Criteria	Sub-Criteria	Weights
Personal Measures	Use of disposable cleaning products	0.12928
	Frequent personal cleaning	0.05060
	Avoid crowded environments, people in the patient / risk group	0.06123
	Eating healthy, eating well cooked foods	0.00159
	To take into account warnings and measures made across the country	0.28076
	Postponing travel	0.12309
	Taking virus symptoms seriously	0.32797
	Paying attention to the use of personal items	0.02548
National Measures	Quarantining of citizens returning from abroad	0.10910
	Suspension of contacts abroad	0.09027
	Postponement of community meetings, such as meetings, conferences	0.02096
	Drug and medical support	0.16330
	Establishment of the Corona Advisory line	0.17030
	Temporary closure of crowded places	0.01807
	Disinfection works	0.04647
	Allocation of appropriate hospitals for cases	0.03698
	Informing hospital staff and the public	0.03982
	Imposing visitor restrictions on hospitals	0.01061
	Audit of institutions	0.01629
	Postponement of opening of tourism sector	0.01618
	Free coronavirus tests	0.20493
Criminal sanction for rule violations	0.05672	
Institutional Measures	Employees run home-office	0.17964
	Supply of personal cleaning and protection equipment to employees	0.40560
	Allowing employees in the Risk group	0.41149
	Unmanned couriers	0.00328

## RESULTS AND DISCUSSION

In this study, the measures taken by countries against the disease caused by the new type coronavirus were discussed. If these measures are not taken, the coronavirus will continue to affect the entire world, causing daily loss of life. In the past, it can be said that the mental health of healthy people will also be adversely affected due to this pandemic.

The aim of the study is to determine the importance and priority levels of the measures taken while the treatment process and the fight against new types of coronavirus is ongoing. According to the priority levels determined, the order in which the measures taken should be implemented will be revealed.

## CONCLUSION

When the results of the solution are examined, it is seen that the most important main criterion is national measures. The same result was obtained in both method solutions. The conclusion is that the biggest business belongs to

decision makers across the country. Free coronavirus tests will show how far the disease has spread, and citizens who consider themselves at risk will have the test done regardless of financial concern. Therefore, continuing to be in the community without testing will be prevented. Thanks to the coronavirus Advisory line to be established, people will not rely on hearsay information they obtain from social media. They will be able to get the right information from the right source and get rid of all the question marks in their heads about the coronavirus. With the provision of medication and medical support, people in the risk group or sick will not have to worry about medical issues as well as illness concerns. In this way, the course of the disease can be changed in cold blood. The quarantine of citizens returning from abroad is a very important measure. Even if the returning people isolate themselves from society, the spread of the disease can become unstoppable due to the people who can visit them. For this reason, they must be observed under quarantine and pass the coronavirus test. If the Test result is not positive, it will protect its health and the health of its environment outside of quarantine by following the

**Table 4.** Weights of criteria for fuzzy AHP

Sub-criteria	Weights
Use of disposable cleaning products	0.019
Frequent personal cleaning	0.0435
Avoid crowded environments, people in the patient / risk group	0.0273
Eating healthy, eating well cooked foods	0.0215
To take into account warnings and measures made across the country	0.0489
Postponing travel	0.0507
Taking virus symptoms seriously	0.0967
Paying attention to the use of personal items	0.0349
Quarantining of citizens returning from abroad	0.0812
Suspension of contacts abroad	0.0663
Postponement of community meetings, such as meetings, conferences	0.0614
Drug and medical support	0.0217
Establishment of the Corona Advisory Line	0.0267
Temporary closure of crowded places	0.0518
Disinfection works	0.0265
Allocation of appropriate hospitals for cases	0.032
Informing hospital staff and the public	0.0674
Imposing visitor restrictions on hospitals	0.0234
Audit of institutions	0.016
Postponement of opening of tourism sector	0.0419
Free coronavirus tests	0.0256
Criminal sanction for rule violations	0.0335
Employees run home-office	0.0119
Supply of personal cleaning and protection equipment to employees	0.0211
Allowing employees in the risk group	0.0415
Unmanned couriers	0.0076
<b>TOTAL</b>	<b>1</b>

rules that other people follow. Taking personal measures is also of great importance at this point. Taking the symptoms of the virus seriously and taking into account the warnings and precautions made throughout the country protects the health of people as well as the health of the community. In this case, the most important of the personal measures, citizens to protect their own health in order to take care of personal cleaning and personal goods use, social isolation by paying attention to society and crowded environments is to avoid. As the number of people who take their own health seriously increases, Community Health will also be protected. Institutional measures are supportive of other measures. Allowing employees in the Risk group causes people to take their own health seriously as well as encourages them to take personal precautions.

## AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

## DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

## CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## ETHICS

There are no ethical issues with the publication of this manuscript.

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