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Milli Savunma Üniversitesi
Barbaros Deniz Bilimleri ve Mühendisliği Enstitüsü
Deniz Harp Okulu Yerleşkesi
Tuzla/İstanbul/Türkiye

Phone/Telefon : +90 216 395 26 30/2100 - 2104
Fax/Belgegeçer : +90 216 395 26 58
E-mail/E-posta : *jnse@dho.edu.tr*
Web : https://dergipark.org.tr/tr/pub/jnse

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MİLLİ SAVUNMA ÜNİVERSİTESİ
BARBAROS DENİZ BİLİMLERİ VE MÜHENDİSLİĞİ ENSTİTÜSÜ
DENİZ BİLİMLERİ VE MÜHENDİSLİĞİ DERGİSİ

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Assoc.Prof.Dr. (Doç.Dr.) Ertan YAKICI

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**An ethical committee approval and/or legal/special permission has not been required within the scope of this study.*

AN ENERGY SYSTEM SIMULATION OF TURKEY WITH A 50% RENEWABLE ENERGY SCENARIO*

Emre LEBLEBİCİOĞLU[1]
Egemen SULUKAN[2]
Tanay Sıdkı UYAR[3]

[1]*Marmara University, Department of Mechanical Engineering, Istanbul, Turkey,*
leblebicioglu.emre@gmail.com; ORCID: 0000-0001-9974-3645

[2]*National Defence University, Turkish Naval Academy, Department of Mechanical Engineering, Istanbul, Turkey,*
esulukan@dho.edu.tr; ORCID: 0000-0003-1138-2465

[3]*Beykent University, Department of Mechanical Engineering, Istanbul, Turkey,*
tanayuyar@beykent.edu.tr; ORCID: 0000-0002-0960-1203

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ABSTRACT

Decreasing the usage of fossil fuels in the electricity production is a tough challenge for countries. The world is still depended on fossil fuels to generate electricity. Increasing the share of renewable energy systems in electricity production is significant in many aspects such as lower CO2 emissions, grid flexibility, decentralizing, etc. Nowadays, many countries shape their energy policies and strategies to use more renewable and indigenous resources. Turkey is one of these countries and has ambitions goals to use more domestic sources to produce electricity. Turkey generally aims to reduce the usage of imported energy sources in electricity generation. Thus this paper investigates the share of 50% renewable energy system (RES) simulation in the electricity production via the EnergyPLAN model. An energy system analysis was conducted in a 50% renewable scenario in 2023. The main target of this scenario is to perform a 50% renewable energy system in electricity production. A reference year is 2018 and the results of the 50% RES scenario were compared with a reference scenario. A main focus of this study is to investigate aspects of carbon emissions, RES share, and costs between the scenarios for the years 2018 and 2023.

Keywords: *Energy System Simulation, EnergyPLAN, Renewable Energy.*

An Energy System Simulation of Turkey with a 50% Renewable Energy Scenario

% 50 YENİLENEBİLİR ENERJİ SENARYOSU İLE TÜRKİYE'NİN ENERJİ SİSTEM SİMÜLASYONU

ÖZ

Elektrik üretiminde fosil yakıt kullanımının düşürülmesi zor bir süreçtir. Tüm dünya hala elektrik üretiminde fosil yakıtlara bağlı durumdadır. Güç üretiminde yenilenebilir enerji payının arttırılması, CO_2 emisyonunun düşürülmesi, şebeke esnekliğinin sağlanması ve merkezi olmayan elektrik üretimi gibi birçok yönden avantaj sağlamaktadır. Günümüzde birçok ülke enerji stratejilerini ve politikalarını daha fazla yerli ve yenilenebilir kaynakların kullanımı şekillendirmektedir. Türkiye de bu ülkelerden birisidir ve elektrik üretiminde daha fazla yerli kaynak kullanımı için etkili politikalara sahiptir. Türkiye genel olarak elektrik üretiminde ithal enerji kaynaklarının kullanımını düşürmeyi hedeflemektedir. Bu makalede EnergyPLAN modeli ile 2023 için %50 yenilenebilir enerji sistemi simülasyonu incelenmiştir. Enerji sistem analizi, 2023 için %50 yenilenebilir enerji sistem senaryosu üzerine kurulmuştur. Bu senaryodaki temel hedef, elektrik üretiminde %50 yenilenebilir enerji kullanımını gerçekleştirmektir. Bu çalışmada referans yıl ise 2018 olarak seçilmiştir ve 2023 senaryosunun sonuçları ile kıyaslanmıştır. Bu çalışmanın odağı 2018 ve 2023 senaryolarının yenilenebilir enerji payı, CO_2 emisyonu ve maliyetler yönünden incelenmesidir.

Anahtar Kelimeler: *Enerji Sistem Simülasyonu, EnergyPLAN, Yenilenebilir Enerji.*

1. INTRODUCTION

Renewable energy sources are significant to reduce the usage of fossil fuels in the electricity production. Raising the share of renewables provides energy independence and lower CO_2 emissions. The world is still depended on fossil fuels in the electricity production. Even though Turkey has a huge renewable potential, it still has a high share of fossil fuels in the power generation. Using the high share of fossil fuels for the power generation also causes economic and environmental problems for Turkey. Turkey imports a significant amount of natural gas and coal to produce electricity. Importing energy sources increases an energy dependency and cause economic consequences. In 2018, the share of fossil fuels in the electricity production was more or less 70% (Republic of Turkey Ministry of Energy and Natural Resources, 2018). Even though increasing the share of renewables seems the best solution to decrease the usage of fossil fuels, it is not enough to supply all energy demand for the countries, which have high energy consumption, such as Turkey in the short term. That is why nuclear energy is another option to be considered.

In this article, the 50% renewable energy scenario for the year 2023 is the main target. The 50% RES scenario also contains nuclear and indigenous coal usage. The usage of natural gas was not ignored completely but was reduced. The year 2023 was chosen for this study since the Turkish government has ambitious goals for this year. The government aims to reduce the usage of non-domestic energy sources and to use more domestic and renewable sources. It is foreseen that Turkey will reach 38,8% RES share and decrease the natural gas share to 20,7% in the electricity production until 2023 (Presidency of the Republic of Turkey, 2019). This paper investigates the 2023 scenario by considering these goals. The year 2018 was also chosen as a reference year and a reference scenario was built for this year. This paper shows a pathway to increase the RES share from 2018 to 2023. Moreover installed capacity expansions, CO_2 emissions and economic analyses are fundamental topics of this paper.

Energy system simulations and analyses were performed by using EnergyPLAN, which is hourly energy system simulation software. A fundamental purpose of EnergyPLAN is to assist in designs of national or regional energy system planning and policy strategies. This software uses

hourly energy system simulations in a year and is based on technical and economic analyses. An energy system simulation of Turkey for 2018 and 2023 was implemented by using the EnergyPLAN model and results were discussed in this paper.

For Macedonia, Denmark, Ireland and Portuguese, country models were made by EnergyPLAN in the different studies.

The study titled "A 100% renewable energy system in the year 2050: The case of Macedonia" (2012) is a country model which was made by EnergyPLAN. This paper investigates the 100% renewable energy system implementation in Macedonia by using the EnergyPLAN model. The energy systems simulation and analyses were carried out for two renewable scenarios, designed for the years 2030 and 2050. The first scenario of this study is the 50% renewable energy system for the year 2030. The second scenario is the 100% renewable energy system for the year 2050 (Ćosić, Krajačić & Duić, 2012).

In the research of (2009) H. Lund and B. V. Mathiesen, an energy system analysis of 100% renewable energy systems for Denmark in the years 2030 and 2050 was implemented by EnergyPLAN. The method of energy systems analysis contains hour by hour computer simulations, leading to the design of flexible energy systems. The results were detailed energy system designs and balances for two target years: the year 2030 with 50% renewable energy and the year 2050 with 100% renewable energy from biomass and a combination of solar power, wind, and wave (Lund & Mathiesen, 2009).

The paper titled "The first step towards a 100% renewable energy system for Ireland" (2010) presents a 100% renewable energy system pathway for Ireland. EnergyPLAN was used as an energy system analysis tool in this study. First of all, a reference scenario of the existing Irish energy system was created, and three different 100% renewable energy systems were created with each focusing on various resources such as biomass, hydrogen, and electricity. Then the 100% renewable energy system model was established for Ireland (Connolly, Lund, Mathiesen & Leahy, 2011).

A study whose title is "Renewable energy scenarios in the Portuguese electricity system" addresses the topic of renewable energy scenarios for the

electricity sector, analysing different possible future strategies for the Portuguese system. Each one of these strategies was characterized according to the expected electricity consumption and renewable share, with the final aim of analysing a possible 100% RES scenario. EnergyPLAN was used to simulate each scenario for a year. The 100% RES scenario was found to be theoretically possible but a significant increase in the total capacity of the system would be necessary to ensure no shortfall during the summer season (Fernandes & Ferreira, 2014).

By considering the national studies which are emphasized above, this study was shaped for Turkey. The technical and economic results of this study may provide a different perspective to the decision-makers in Turkey.

2. BACKGROUND

2.1. Energy Overview of Turkey

Turkey supplies its energy demand by different sources such as lignite, hard coal, imported coal, natural gas, petroleum, and renewable resources. The energy production of Turkey is based on fossil fuels, mainly coal and natural gas. Moreover, Turkey's energy demand is growing day by day and this brings some concerns such as the rising fuel dependence. Thus, Turkey set ambitious energy policies, which will provide energy independence for the country.

2.1.1. Electricity Consumption of Turkey

Turkey is a growing country and its energy consumption rises every year due to the industrialization and the growth of population. The primary electricity consumption of Turkey increased by 2,2% to 304 TWh in 2018 and its electricity generation went up by 2,5% to 304.8 TWh (Republic of Turkey Ministry of Energy and Natural Resources, 2018). Furthermore, the electricity consumption is expected to increase by 4,3% annually and to reach 375,8 TWh in 2023 according to the base scenario (Presidency of the Republic of Turkey, 2019).

2.1.2. Electricity Production of Turkey

Turkey generates electricity by various energy sources such as fossil fuels and renewable sources to meet its total electricity consumption. At the end of 2018, Turkey supplied its energy demand by 37,8 % coal, 30,3% natural gas, 19,7% hydropower, 6,5% wind, 2,6% solar, 2,4% geothermal and 1,3% from other sources. The installed power capacity of Turkey reached 88.551 MW by the end of 2018. This capacity consisted of 31% hydropower, 29,5% natural gas, 22,2% coal, 7,9% wind, 1,4% geothermal, 5,7% solar and 1,4% other sources (Republic of Turkey Ministry of Energy and Natural Resources, 2018).

2.2. Estimated Energy Overview in 2023

The year 2023 is the 100th year of the Turkish Republic. Thus, Turkey has many goals to achieve until 2023. In this study, 2023 energy goals were taken as a reference to achieve the 50% RES scenario. Main energy goals for 2023 are shown in Table 1 below.

Table 1. 2023 Energy and mining goals of Turkey (Presidency of the Republic of Turkey, 2019).

2023 Energy and Mining Goals of Turkey	
Primary Energy Demand (BTEP)	174279
Electricity Demand (TWh)	375,8
Rate of Natural Gas in the Electricity Production (%)	20,7
RES Share of Electricity Production (%)	38,8
Power Production by Indigenous Sources (TWh)	219,5
Total Installed Power Capacity (MW)	109474

Turkey's energy goals and investments were analyzed to build the most realistic energy system scenario for the year 2023. The power capacity expansions were determined according to estimated energy capacities and the economic growth of Turkey. Furthermore, the year 2018 was chosen as a reference year. That is why scenarios should have been shaped in 5 years period. So time limitations were also considered to create scenarios.

3. METHODOLOGY

The EnergyPLAN model was used to analyze and simulate Turkey's energy systems in this study. EnergyPLAN is an input/output hourly simulation tool that is used for energy system analysis at the national or regional level. The EnergyPLAN computer model was developed by Aalborg University, Denmark. This model is based on hourly values during a year. It also carries out technical simulations and market-economic simulations. A fundamental purpose of this model is to assist the design of regional and national energy system strategies and policies (Lund & Thellufsen, 2019).

The model has inputs and outputs. Inputs are renewable energy sources, demands, costs, installed power plant capacities. Outputs are energy balances, fuel consumption, total costs, import/exports, and annual productions.

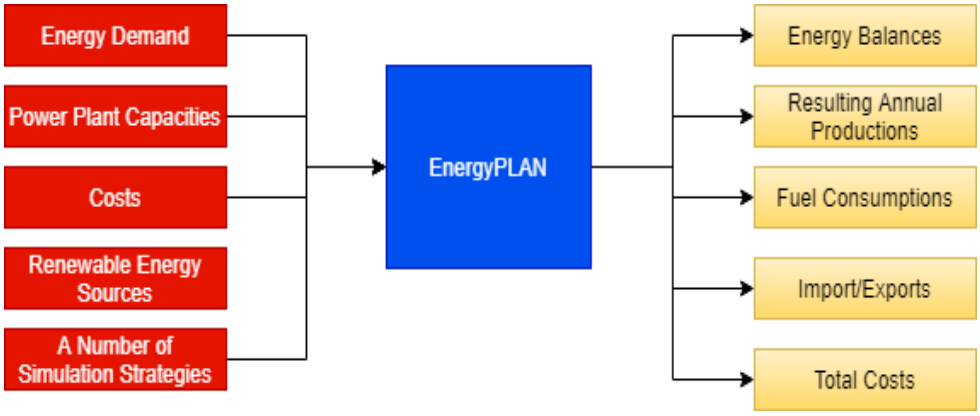

Figure 1. EnergyPLAN model input/output parameters.

Figure 1 shows those fundamental input/output parameters of the EnergyPLAN model. In this study, data of energy demand, power plant capacities, costs, and renewable energy sources were entered in the software for the reference and 50% RES scenarios. Moreover, output parameters such as total costs, annual productions were analyzed and compared.

4. ENERGY SCENARIOS OF TURKEY FOR 2018 AND 2023

A long term energy strategy of Turkey is to reach its energy independence. Turkey also wants to decrease its carbon emissions by shifting electricity production from fossil fuels to clean energy sources. Yet, Turkey cannot give up the coal in the short term because of the large amount of coal reserves which are existed in the Turkish territory. Turkey is going to decrease coal and natural gas imports for electricity production by using more domestic coal and renewable.

Nuclear energy is a part of Turkey's energy strategy for 2023. Akkuyu Nuclear Power Plant in Mersin is being commissioned nowadays and it is going to be operational with full capacity of 4800 MW until the end of 2023. Akkuyu nuclear power plant is going to produce annually 35 TWh electricity, which is almost 9% of total electricity demand in 2023 (Republic of Turkey Ministry of Energy and Natural Resources, 2020). Akkuyu nuclear power plant is also a vital part of this study. The fundamental aim of the energy scenario for 2023 is to model the country's energy system with lower carbon emissions, using more indigenous and renewable resources.

4.1. A Reference Energy Scenario and Model Validation

First of all, a reference energy scenario for a specific year was implemented to analyze and to compare energy scenarios. In this study, the year 2018 was chosen as a reference year due to the availability of real proven data. Moreover, the reference scenario was built for this year.

4.1.1. 2018 Reference Energy Model

The reference energy model is an existing energy system in 2018. The main purpose of this model is to compare results with the 50% renewable scenario for 2023. All approved energy system data in 2018 were obtained and inserted into EnergyPLAN software. Furthermore, the total electricity demand in 2018 is 304,2 TWh/year. The installed power capacity of Turkey by sources is shown below.

Table 2. Installed electricity capacity by sources in 2018 (EPIAS, 2018).

Resources	**2018 (MW)**
Hard Coal + Lignite	10213
Imported Coal	8939
Asphaltite	405
Fuel Oil	739
Natural Gas	25647
River Hydro	7749
Hydropower	20505
Geothermal	1260
Biomass + Waste	946
Wind Energy	6950

Along with the installed power capacities that are shown in Table 2, hourly electricity production data by sources in 2018 were taken from the EPIAS Transparency Platform. Hourly power generation data was loaded into EnergyPLAN software as text files for each source separately. The text files were created with vertically 8784 rows and this number represents the number of hours in a year.

EnergyPLAN analyses the installed power capacities and the hourly electricity generation and gives the most realistic output. The result of the reference model was compared with the real data and validated.

4.1.2. Model Validation

This scenario was created by real energy demand and supply data. All data were taken from energy balance tables (Republic of Turkey Ministry of Energy and Natural Resources, 2018) and EPIAS-Transparency Platform. After establishing the reference EnergyPLAN model, the output of this model was compared with EPIAS electricity generation and production data as shown in Table 3 below.

Table 3. Model validation between EPIAS data and EnergyPLAN model output.

Demand and Supply	**EPIAS Data (TWh/year)**	**EnergyPLAN Model Output (TWh/year)**	**Difference (%)**
Demand	304,2	304,2	0,01
Wind	19,85	19,9	0,25
Solar	5,76	5,84	1,37
Hydro-Dams	41,01	41,06	0,12
Geothermal	6,92	6,92	0,02
Hydro-Rivers	18,88	19,86	0,1
Thermal Power	203,7	205,53	0,89

As can be seen in the Table 3, differences between EnergyPLAN output and EPIAS data are in the acceptable range, which means all technical data such as the annual hourly supply and the demand data, were identified to the software correctly. Then, renewable energy and indigenous scenarios can be built on this reference scenario.

The result of the reference energy scenario shows that the RES share is 31,6% and the amount of yearly electricity production by renewables is 96,20 TWh/year.

4.1.3. Cost of Reference Energy Model

Costs of energy systems are another important parameter that needs to be analyzed. The estimated costs of the existing energy system capacity in Turkey were calculated and identified in the software. The annual fixed operation-maintenance and installed costs of power plants in 2018 were calculated, using the average of costs between 2010 and 2018. (IRENA, 2020)

Table 4. Costs of power plants (IRENA, 2020).

Type	Installed Cost (USD/kW)	Fixed O&M Cost (USD/kW)	Fixed O&M Cost (%)
Onshore Wind	1740	26,22	2
Solar	2366	15,19	1,15
Hydropower	3045	41,63	1,5
Geothermal	5268	113,29	4,22
Biomass	5800	125,19	3
Coal	3661	40,41	1,1
Natural Gas	954	12,15	1,27

The unit costs of power plants are shown in Table 4. These values were entered in EnergyPLAN software and calculated the total cost of all power plants in 2018, as 221770 MUSD.

Table 5. Costs of the reference energy scenario.

Costs	Amount (MUSD)
Variable Cost	997
Fixed Operation Cost	4059
Investment Cost	216713
Total Cost	221770

The given costs in Table 5 were calculated using the unit costs and installed power plants by sources. Total cost represents the cost of the existing Turkish energy system in 2018. By 2023, power capacity expansion will be carried out in 5 years period since 2018. Using the estimated capacity expansions from 2018 to 2023, the total installation cost to perform the 50% RES scenario is calculated.

4.2. The 50% Renewable Energy Scenario

After validating the reference energy scenario for the year 2018, the 50% renewable energy scenario for 2023, can be implemented by expanding the 2018 scenario.

The scenario is based on the high share of renewable in electricity production. As it is mentioned before, energy independence and high renewable energy penetration shape Turkey's energy strategy and policies. This scenario is a re-arranged version of Turkey's 2023 Energy Plan. The renewable energy capacity was expanded and energy dependency was reduced by ignoring petrol and imported coal and reducing the usage of natural gas in electricity production.

4.2.1 Power Capacity for the 50% RES Scenario

The installed capacity of the renewable energy system was increased by considering the renewable energy potentials of Turkey, time and policy limitations. 2019-2023 National Energy Strategic Plan of Turkey is also considered as a reference for determining installed power capacity by sources in 2023. According to this plan, estimated installed renewable and indigenous power capacities in 2023 are in Table 6 below.

Table 6. Installed power capacity goals for 2023 (Republic of Turkey Ministry of Energy and Natural Resources, 2020).

Sources	**Estimated Installed Power Capacities in 2023 (MWe)**
Solar PV	10000
Wind	11883
Geothermal	2884
Hydropower	32037
Indigenous Coal	14664

For the 50% renewable scenario in 2023, installed power capacities were expanded as shown below:

- **Coal:** 14664 MW
- **Natural Gas:** 19736 MW
- **Biomass:** 3400 MW
- **Nuclear:** 4800 MW
- **Solar:** 13950 MW
- **On-Shore Wind:** 15350 MW
- **Dammed-Hydro:** 24737 MW
- **River-Hydro:** 9650 MW
- **Geothermal:** 2450 MW

The electricity demand of Turkey is estimated to reach 375,8 TWh/year, according to the 2023 Energy and Mining Goals of Turkey which are shown in Table 6.

For expanding power capacity, the feasible energy potential of Turkey was used by taking Melikoglu's study (Melikoglu, 2016) as a reference. This study mainly discusses the role of renewable and nuclear energy for Turkey's 2023 vision by emphasizing theoretical and economical energy potentials by sources.

Table 7. Difference between installed power capacity goals for 2023 and the 50% renewable energy scenario.

Sources	Installed Capacity Goals in 2023 (MWe)	The 50% Renewable Energy Scenario for 2023 (MWe)	Difference (%)
Solar PV	10000	13950	39,5
Wind	11883	15350	29,18
Geothermal	1550	2450	58,06
Hydropower	32037	34387	7,33
Indigenous Coal	14664	14664	0
Natural Gas	19736	19736	0
Biomass	1334	3400	154,87
Nuclear	4800	4800	0

Table 7 shows the power capacity changes by sources between the installed capacity goals in 2023 and the %50 renewable scenarios for 2023. As can be seen in Table 7, there is a significant amount of power capacity growth in biomass, geothermal, solar PV and wind. On the other hand, the power capacity of natural gas and indigenous coal power plants remained stable. Since there is just one nuclear power plant, under construction in Turkey nowadays, the nuclear capacity was remained the same to provide a more realistic scenario. Power capacity growths were calculated carefully to obtain the most realistic scenario and results. Time, economic and political limitations were combined with the capacity potentials by sources in Turkey and the best and most realistic scenario was created.

EnergyPLAN is based on hourly simulation. That is why hourly electricity production files were also created for 2023 by the increasing hourly electricity production in 2018. According to installed power capacities, the

annual estimated electricity generation by sources is shown in Table 8 below.

Table 8. Annual electricity production and consumption for the 50% RES scenario.

Sources and Demand	Electricity Demand and Supply (TWh/year)
Electricity Demand	375,8
Wind	51,86
Solar PV	23,06
River Hydro	35,8
Dammed Hydro	53,37
Biomass	16
Natural Gas	77,8
Indigenous Coal	74,27
Nuclear	35
Geothermal	14,63
Import Electricity	0

Table 8 shows the annual estimated electricity production by sources and consumption for the 50% RES scenario. All power plants supply electricity demand since there is no import electricity.

Figure 4 shows the shares in electricity production by sources. As it can be seen in the figure that RES share makes up 50% of the total electricity generation as it is aimed. On the other hand, the share of natural gas is 20% as the energy goals of Turkey for 2023. Furthermore, the rate of indigenous and renewable is 70%. This rate is also significant to decrease the country's energy dependence.

4.2.2 Cost Analysis of the 50% RES Scenario

Increasing the installed power capacity causes investment costs. Along with investment costs variable and operational costs also grow. EnergyPLAN also calculates costs, when unit costs by sources are entered into the

software. The growth of power capacity was multiplied by the unit installed costs which are shown in Table 9. Then the total investment cost for 50% was obtained.

Table 9. Unit costs of power plants.

Type	Installed Cost (USD/kW)	Fixed O&M Cost (USD/kW)	Fixed O&M Cost (%)
On Shore Wind	1319	26,22	2
Solar	1331	15,19	1,15
Offshore Wind	4356	109,59	2,5
Hydropower	2752	41,63	1,5
Geothermal	2680	113,29	4,22
Biomass	4080	125,19	3
Coal	3661	40,41	1,1
Nuclear	6016	121	2
Natural Gas	954	12,15	1,27

In Table 9, unit costs of each power plant are shown by using data from U.S. Energy Information Administration, 2020. The cost analysis of this scenario was implemented using 2020 data.

Calculated total costs in 2018 and 2023 are the costs of the installed power capacity. Hence, the total costs for the 2023 50% RES scenario can be calculated by installed capacity expansions from 2018 to 2023. The amount of power plants' expansions is multiplied by the unit installed costs which are shown in Table 9. Then the total investment cost for 50% is obtained.

5. RESULTS AND DISCUSSION

Analyses in the EnergyPLAN software were implemented only for the electricity. Heating, cooling and transportation were not considered in this study. The reference energy scenario and the 50% renewable energy scenario were carried out in the software. Moreover, results were compared with each other. The main comparison parameters are RES electricity

production and annual CO_2 emission. These parameters show the benefits of renewable energy penetration in electricity production.

Table 10 describes the differences between the reference scenario and the 50% renewable scenario. The reference energy scenario represents the existing energy system of Turkey in 2018. On the other hand, the 50% renewable energy scenario is a target for this study. The main difference between these two scenarios is the renewable energy penetration in electricity production.

Table 10. Comparison between the reference energy scenario and the 50% renewable energy scenario.

Sources	**Reference Year 2018**	**The 50% Renewable Energy Scenario for 2023**	**Difference (%)**
Solar PV	5064	13950	175,47
Wind	6950	15350	120,86
Geothermal	1260	2450	94,44
Hydropower	27455	34387	25,25
Biomass	946	3400	259,41
Indigenous Coal	10213	14664	43,58
Natural Gas	25647	19736	-23,04
Nuclear	0	4800	

In Table 10, there is a significant growth in biomass, geothermal, wind, solar PV and indigenous coal power plants. Due to the government's energy policy, indigenous coal power plants have a high share of the installed power capacity. The target is based on the usage of indigenous and renewable sources. The annual renewable electricity production was estimated as 188,72 TWh/year for the 50% renewable scenario for 2023, while it is 96,2 TWh/year in the reference scenario for 2018.

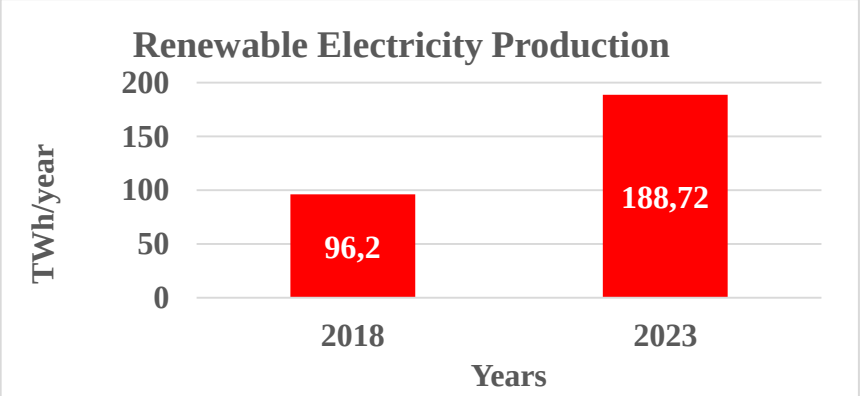

Figure 2. Renewable electricity production.

RES share in the power generation is the main target of this scenario, as can be seen in Figure 3 below. 188,72 TWh/year corresponds to 50,2% of total electricity production in the 50% RES scenario, while 96,2 TWh/year accounts for 31,6% of total power generation in the reference energy scenario.

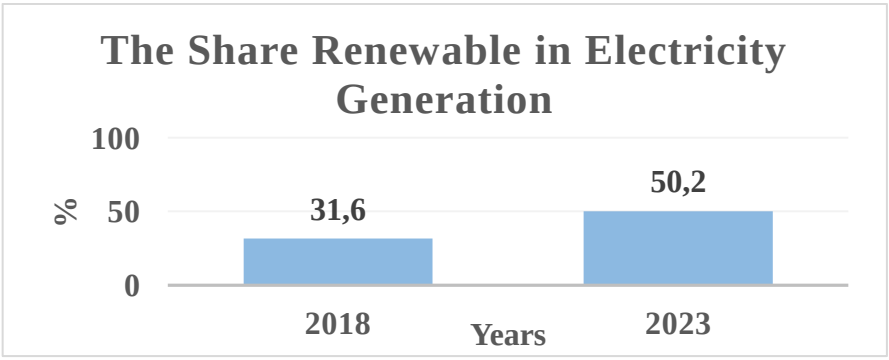

Figure 3. The share of renewable in electricity production.

CO_2 emission mitigation is one of the main goals of the Paris Agreement and global clean energy targets. To decrease the adverse effect of global warming, CO_2 emissions in the power generation should be reduced. That is why this parameter is a significant result of this study. Annual CO_2 emission

in 2018 and 2023 can be seen in Figure 4 below as a result of EnergyPLAN analyses of two scenarios.

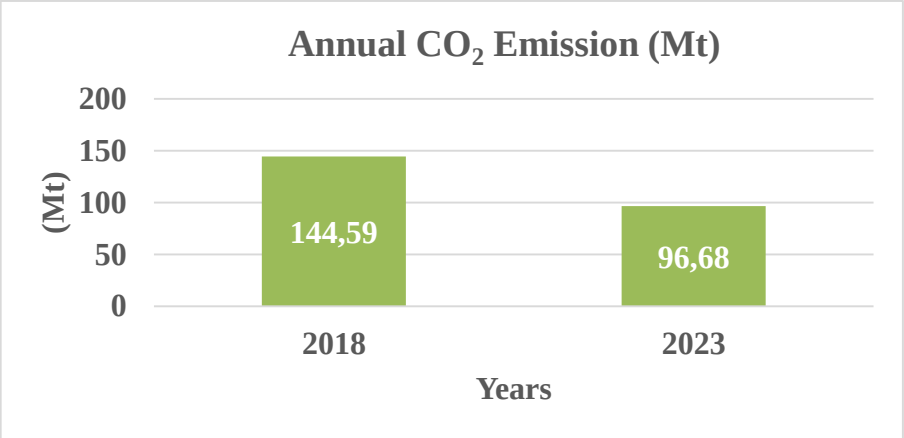

Figure 4. Annual CO_2 emissions.

As can be seen in Figure 4, CO_2 emission was decreased from 144,587 Mt to 96,683 Mt between 2018 and 2023 as a result of scenario analyses of EnergyPLAN.

5.1. Economic Analyses of Scenarios

Power plants have some expanses from the installation to the variable and fixed O&M costs. In this study, the scenarios have costs to perform and to maintain. High renewable energy penetration requires considerable investments. Higher RES share and more capacity expansions mean higher investment costs. This section shows the required investment costs to achieve the 50% RES scenario. The total investment cost of capacity expansions is the cost to achieve the 50% RES scenario.

The investment costs by type of power plants can be seen in Table 11. The total investment cost for the 50% RES scenario is 100357 M USD. Furthermore, there is 5 years time range between the two scenarios in 2018 and 2023. Then the total investment cost is divided by 5 and the annual total cost is obtained. In this calculation, the total annual cost is 20071,4 M USD.

This means, yearly 20071,4 million USD should be invested to perform the 50% RES scenario until the year 2023.

Table 11. Costs comparison between the reference energy scenario and the 50% renewable energy scenario.

Sources	**Capacity Expansions for 2023**	**Unit Costs (MUSD/MW)**	**Total Investment Cost (MUSD)**
Solar PV	8886	1,33	11827
Wind	8400	1,32	11080
Geothermal	1190	2,68	3189
Hydropower	6932	2,75	19077
Biomass	2454	4,08	10012
Indigenous Coal	4451	3,66	16295
Natural Gas	0	0,95	0
Nuclear	4800	6,02	28877
		Total	100357

CO_2 taxes and electricity transmission costs were not considered in this study. Costs of power plants were used to carry out the economic analysis of the scenarios.

The total investment cost is determined 100357 MUSD for achieving the 50% RES scenario. Nevertheless, Akkuyu nuclear power plant makes up more than a quarter of this amount by 28877 MUSD. When the nuclear power plant is ignored in the calculation, the cost of indigenous and renewable power plants is 71480 MUSD.

6. CONCLUSION

In this study, the 50% renewable energy system of Turkey for the year 2023 was performed. The results show that due to the time limitation, to achieve this scenario in 2023 is not a dream but challenging. A significant amount of investment is needed to implement this scenario. Akkuyu Nuclear Power Plant should be 100% operational till 2023 to assist in corresponding the energy demand. Furthermore, the installed capacity of renewable power plants should be increased more than the energy targets.

While the share of fossil fuels in the reference energy scenario was 68,4% in the electricity production, this share was decreased to approximately 40% in the 50% RES scenario. For this reason, the CO_2 emission was reduced from 144,587 Mt to 96,683 Mt. This fall is significant in the aspects of health, environmental and economic. Furthermore, this study shows that reducing a huge amount of CO_2 emission is possible by decreasing the share of fossil fuels in electricity production.

In the 50% scenario, the imported coal was ignored in the electricity share and the share of natural gas was decreased from 30,3% to 20%. This means, the energy dependency of Turkey was also reduced and a considerable amount of money was saved. The cost of lower CO_2 emission and 50% renewable share was obtained as 100357 MUSD. This value can be directly considered as the total cost of the 50% RES scenario.

Due to the time limitation and political targets, energy storage systems were not integrated into the 50% RES scenario. Because the storage integration to the power plants needs a considerable amount of money and time. However, the energy storage systems are needed for scenarios with a higher RES share.

To sum up, although performing a high rate of RES at the national level provides many benefits, it also causes a high amount of costs. However, this should be considered in many aspects such as health expenses,

environmental problems, which are caused by CO_2 emissions. Then the real cost of clean energy transition can be determined.

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RESEARCH ARTICLE

**An ethical committee approval and/or legal/special permission has not been required within the scope of this study.*

A NOVEL TENSOR RPCA METHOD FOR CLUTTER SUPPRESSION IN GPR IMAGES*

Deniz KUMLU[1]
Batuhan GÜNDOĞDU[2]

[1]*Navy Research Center, Turkish Naval Forces, Istanbul, Turkey, dkumlu@gmail.com; ORCID: 0000-0002-7192-7466*

[2]*National Defence University, Turkish Naval Academy, Department of Electrical and Electronics Engineering, Istanbul, Turkey, mbgundogdu@dho.edu.tr; ORCID: 0000-0002-9395-7519*

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ABSTRACT

The clutter problem in ground penetrating radar (GPR) images highly effects the peformance of target detection ratio. Various methods have been proposed for clutter suppression purposes in the GPR literature. They can be mainly grouped as low rank, low rank and sparse and tensor-based decomposition methods. Principal component analysis (PCA) and robust principal component analysis (RPCA) are classicle approaches and could be classified as low rank and low rank/sparse decomposition methods, respectively. Recently proposed tensor-based methods provide an alternative perspective of solving the low rank and sparse decomposition to handle challenging situations such as shallowly buried objects or rough surface situations. Motivated by the performance of Tensor-based methods, we propose a new pre-transformation step for tensor robust principal component analysis (TRPCA) and compare it with the PCA and RPCA methods over a simulated GPR dataset. Our proposed method outperforms the classical PCA and recent RPCA methods both visually and quantitatively in terms of clutter removal.

Keywords: *Ground Penetrating Radar (GPR), Principal Component Analysis (PCA), Robust PCA (RPCA), Tensor RPCA (TRPCA), gprMax.*

YNR GÖRÜNTÜLERİNDE KARGAŞANIN BASTIRILMASI İÇİN ÖZGÜN TENSÖR GTBA METODU

ÖZ

Yere nüfuz eden radar (YNR) görüntülerinde kargaşanın varlığı hedef tespit oranını büyük ölçüde etkilemektedir ve kargaşanın bastırılması için birçok yöntem önerilmiştir. Bu yöntemler temel olarak alçak sıra, alçak sıra ve seyrek ve tensör ayrıştırma yöntemleri olarak gruplanabilir. Temel bileşen analizi (TBA) kargaşa bastırma yöntemler arasında ilk akla gelen yöntemdir ve alçak sıra ailesinde yer alır. Daha sonra, bu yöntem alçak sıra ve seyrek ayrıştırma yöntemi olarak gürbüz temel bileşen analizi (GTBA) adıyla geliştirilmiş ve yüzeye yakın gömülen hedefler ve pürüzlü yüzeyler gibi zorlu durumlarla başa çıkabilir hale gelmiştir. Son zamanlarda önerilen tensör tabanlı yöntemler alçak sıra ve seyrek ayrıştırma problemine alternatif çözümler sağlamaktadır. Bu yöntemlerin sonuçlarından motive olarak, yeni bir ön-dönüşüm adımı ile tensör gürbüz temel bileşen analizi (TGTBA) yöntemi önerilmiştir ve önerilen yöntem TBA ve GTBA yöntemleri ile benzetim veri seti üzerinden karşılaştırılmıştır. Önerdiğimiz yöntem klasik TBA ve yeni önerilen GTBA yöntemlerine karşı hem görsel hem de sayısal olarak üstünlük sağlamıştır.

Anahtar Kelimeler: *Yere Nüfuz Eden Radar (YNR), Temel Bileşen Analizi (TBA), Gürbüz TBA (GTBA), Tensör GTBA (TGTBA), gprMax.*

1. INTRODUCTION

Ground-penetrating radar (GPR) is an effective and nondestructive geophysical tool for near surface applications and it is widely used for buried object detection. GPR sends radar pulses and uses the electromagnetic properties of the penetrated materials (dielectric permittivity, electrical conductivity and magnetic permeability) to image the subsurface. The received signal in one iteration constitutes the A-scan which is a 1D signal and concatenation of A-scans constitutes the B-scan or GPR image (Daniels, 2005).

The major problem in the obtained GPR image is that the target signature is obscured by the clutter. The clutter can be arisen from several reasons such as ground-bounce, direct-wave arrival, presence of other candidate objects and environmental factors. To increase the detection probability, the clutter effect has to be suppressed. For this purpose, various methods are proposed and we can divide them into 4 major groups as low rank decomposition based methods (Verma et al., 2009), multi-resolution based methods (Kumlu & Erer, 2018; Kumlu, Erer, & Kaplan, 2020b), low rank and sparse decomposition based methods (Tivive, Bouzerdoum, & Abeynayake, 2019; Kumlu & Erer, 2020a) and tensor decomposition based methods (Song et al., 2019). The first three groups are widely studied in the literature (Verma et al., 2009; Kumlu & Erer, 2018; Kumlu & Erer, 2020a) and many methods are proposed. The latest one (Song et al., 2019) is a new subject and it is now trending topic.

The most popular method for clutter removal is principal component analysis (PCA) which belongs to low rank based methods (Abujarad & Omar, 2006). It is used to decompose GPR image into many sub-images which equal to the number of A-scans. The sub-image belongs to the most significant eigenvector corresponds to the clutter component and the sum of remaining sub-images constitute the target component. The main problem of PCA is that it cannot remove clutter well enough if the target is shallowly buried or the surface of the ground is rough.

The robust principal component analysis (RPCA) is a low rank and sparse decomposition based method (Song et al., 2017). It exploits the low rank property of clutter and sparse property of target. After the decomposition by RPCA, the obtained low rank part corresponds to clutter component and the sparse part corresponds to target component. It shows superior performance compared to the classical PCA method however it still have some trouble during shallowly buried objects and rough surfaces.

The tensor robust principal component analysis (TRPCA) is recently proposed in GPR image decomposition (Song et al., 2019) and it exploits the advantage of multidimensional tensor and provides an alternative perspective of solving the low rank and sparse decomposition problem. In (Song et al., 2019), they are using low and high frequency filtering results of the GPR image to create an image tensor. The aim is to contain the spatial characteristics and spectral information during the GPR image decomposition. In our proposed method, we divide the GPR image into patches thus image-patch tensor is constructed. Each patch corresponds to the related A-scan and it keeps the structural information as patch-image. This procedure is a pre-transformation step. Then, TRPCA method is used and it effectively decomposes to GPR image into its clutter and target component.

The rest of the paper is organized as follows. Section 2 introduces a methodology for GPR clutter suppression method. Results for simulated datasets as well as comparisons with PCA and RPCA are presented in section 3. Concluding remarks are given in section 4.

2. METHODOLOGY

PCA is the traditional matrix decomposition method and it is extensively used for clutter suppression in GPR. The GPR image is a two dimensional matrix denoted by $X \in R^{M \times N}$ where M and N represent the time and distance index, respectively. PCA decomposes X into sum of low rank component L and noise component N, i.e., $X = L + N$. The PCA method searches for the best rank-k estimate of X by minimizing the following cost function (Wold, Esbensen & Geladi, 1987).

$$\min_L \|X - N\|_F^2 \quad \text{s.t.} \quad \text{rank}(L) \leq k \tag{1}$$

Here *F* refers to Frobenius norm. For the decomposition subspace, the most dominant component (the highest eigenvalue) equals to the clutter image and sum of the rest equals to target image in practical.

However, the well-known PCA method cannot efficiently decompose the GPR image if there is severe clutter present which generally corresponds to the field data. To overcome this drawback, the robust version of PCA is proposed which is called as RPCA.

The aim of the RPCA method is to find a low rank approximation as well a sparse approximation (Candès et. al, 2011) of the GPR image X where the low rank component denotes *L*, and the sparse component denotes *S*. Thus, the cost function of RPCA is

$$min_{L,S} \|L\|_* + \lambda \|S\|_1 \quad \text{s.t.} \quad X = L + S \tag{2}$$

Where $\|L\|_*$, $\|S\|_1$, and λ denote the matrix nuclear norm of *L*, L1-norm of *S* and the regularization term, respectively. The main motivation of the cost function in (2) is the nuclear norm and L1-norm provides the tightest convex relaxation for the rank of input matrix and L0-norm.

RPCA method shows superior performance compared to the classical PCA method, however, it still has some trouble for the severe clutter case. In the literature, the tensor based methods are proposed to provide an alternative solution for the low rank and sparse decomposition for multi-dimensional data and it exploits the information where contained in different dimensions. Tensor RPCA or known as TRPCA which is effectively applied to video processing, seismic denoising, and target detection problems (Lu et al., 2019).

To apply TRPCA, the pre-transformation step is necessary for GPR image which is the novelty of our work. In order to construct the multi-dimensional data, we divide the GPR image into $r \times r$ patches. As a result, the GPR image $X \epsilon R^{M \times N}$ is converted into $D \in R^{r \times r \times N}$ to construct the

image-patch tensor. In our problem, the parameter r is selected as $\sqrt{M}$ since the length of the A-scans are equaled to M. Thus, the relation between each A-scans are modeled as image-patch tensor and A-scans are converted to 2D form by reshaping column vector with length M into $\sqrt{M} \times \sqrt{M}$ image.

The cost function for TRPCA is

$$min_{L,S}\|L\|_* + \lambda\|S\|_1 \quad \text{s.t.} \quad X = L + S \tag{3}$$

Where $\|L\|_*$ denotes the tensor nuclear norm of 3D tensors, $\|S\|_1$ is the sum of absolute values of all the entries in S and λ is the regularization parameter (Lu et. al, 2019). They show that (3) can recover low rank and sparse components under certain conditions (when L_0 is not too large and $\mathcal{E}_0$ is reasonably sparse).

For the GPR image case, after the decomposition of X, the low rank component L corresponds to clutter part and sparse component $\mathcal{E}$ corresponds to target part.

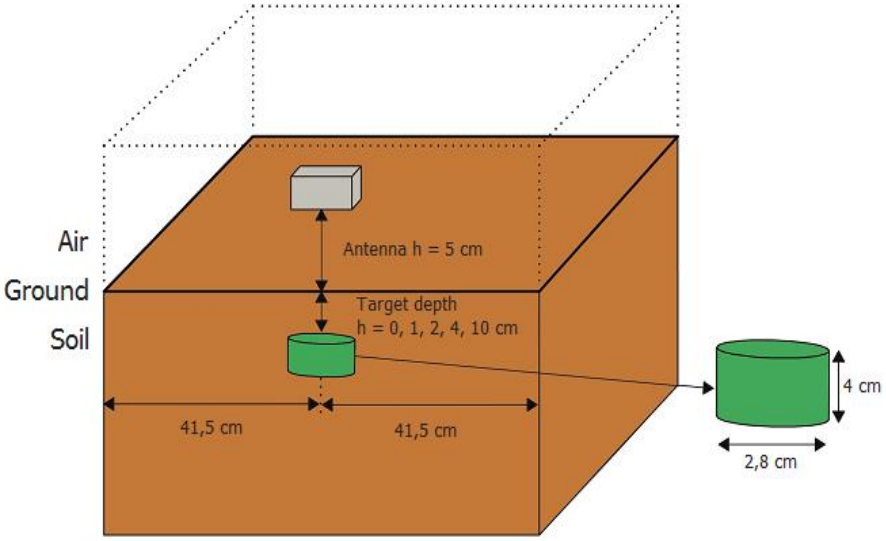

Figure 1. The experimental design of the simulated dataset.

3. EXPERIMENTAL RESULTS

The proposed TRPCA method is compared with the classical PCA (Abujarad & Omar, 2006) and recent RPCA method (Song et al., 2017). The obtained results show the superiority of our proposed method. The methods are evaluated both visually and quantitatively over the simulated dataset which is generated by the gprMax electromagnetic simulation software (Warren, Giannopoulos, & Giannakis, 2016). The experimental setup of the simulated dataset is shown in Figure 1. Our dataset contains, 2 different materials, 5 different burial depths and 6 different soil types. Since, they are constructed by simulation software, we have the reference images. These images give us ability to evaluate the performance of methods quantitatively which may not possible for the real datasets. The peak signal-to-noise ratio (PSNR) is used for the quantitative evaluation and the formulation is

$$\mathrm{PSNR(dB)} = 10\log\left(\frac{1}{\mathrm{MSE}}\right) \quad \textbf{(4)}$$

$$\mathrm{MSE} = \frac{1}{M\times N}\sum_{i=1}^{M}\sum_{j=1}^{N}(\mathrm{X_T}(i,j) - \mathrm{X_R}(i,j))^2 \quad \textbf{(5)}$$

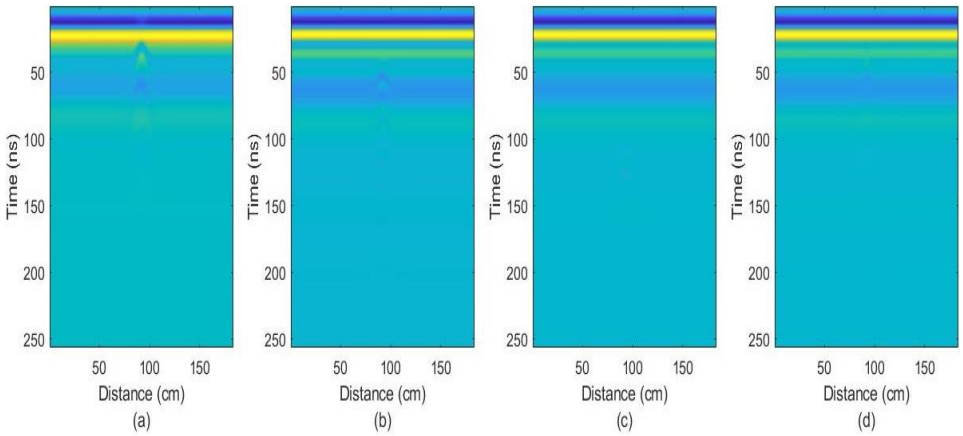

Figure 2. Raw data used for visual results: a) aluminum target, 1 cm burial depth and dry sand soil, b) aluminum target, 2 cm burial depth and wet sand soil, c) plastic target, 10 cm burial depth and dry clay soil, d) plastic target, 2 cm burial depth, dry loam soil.

MSE denotes the mean square error, X_T and X_R denote the obtained target component and reference GPR image, *i* and *j* are the pixel locations.

During the implementation of the methods, the following parameters are used:

- There is no parameter for the PCA,
- Penalization parameter $\lambda = 1.9e^{-2}$ is selected for RPCA and other parameters are default.
- Penalization parameter $\lambda = 6e^{-3}$ is selected for TRPCA, the patch size is selected as $r = 16$ and other parameters are default.

For the visual and quantitative performance evaluation part, four different scenarios are used and the experimental setup is presented in Figure 1. The sample GRP images from each case are shown in Figure 2. As seen in the Figure 2(a), the buried object is very closer to the surface and it is overlapped with clutter which is one of the challenging situations. In Figure 2(b), the buried target is aluminum and the soil is wet sand thus, its target signature is much weaker than the dry sand case in Figure 2(a). Figure 2(c) and (d) are plastic buried target and they are barely seen visually.

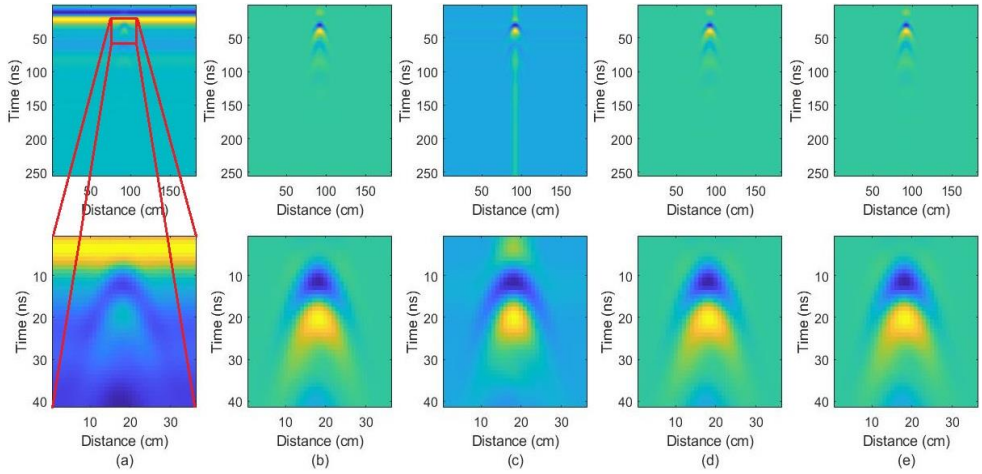

Figure 3. First Row: Original Results, Second Row: Zoomed Version: a) raw data, b) reference data clutter suppression results for, c) PCA, d) RPCA, e) TRPCA.

The visual results of the raw data in Figure 2(a) are presented in Figure 3(c)-(e) and the second row is the zoomed area for the target signature. As seen in the visual results, PCA cannot suppress the clutter since the target burial depth is 1 cm which is very shallow for PCA. The visual results of RPCA and TRPCA is similar however there is slight distortion around target signature in RPCA. The visual result of TRPCA looks identical to reference image and show better performance compared to the PCA and RPCA. The quantitative results support our visual results. As seen in the Table 1:

Table 1. PSNR (dB) results for aluminum target with different burial depths.

Aluminum Target	PCA	RPCA	TRPCA
0 cm	51.98	79.38	**80.26**
1 cm	36.22	130.35	**147.00**
2 cm	90.53	137.62	**144.28**
4 cm	97.27	146.78	**156.76**
10 cm	84.44	140.43	**145.78**

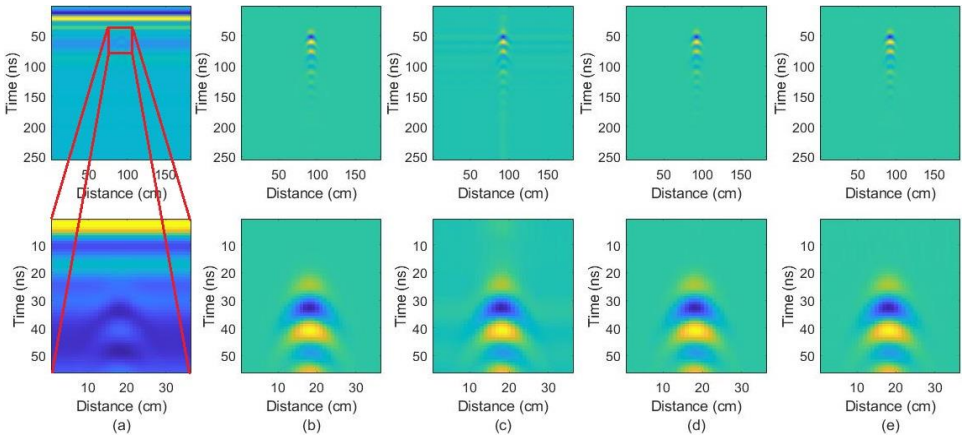

Figure 4. First Row: Original Results, Second Row: Zoomed Version: a) raw data, b) reference data clutter suppression results for, c) PCA, d) RPCA, e) TRPCA.

For all the burial depth TRPCA outperforms PCA and RPCA for aluminum target. Especially for the shallowly buried target (1 cm), TRPCA performance is approximately %13 better than the RPCA.

The visual results of the raw data in Figure 2(b) are presented in Figure 4(c)-(e) and the second row is the zoomed area for the target signature. As seen in the visual results, PCA obtains target signature however the residual of clutter is still available in the form of horizontal lines. The visual results of RPCA and TRPCA look similar however there is slight distortion around target signature in RPCA.

The visual result of TRPCA looks identical to reference image and show better performance compared to the PCA and RPCA.

The quantitative results support our visual results. As seen in the Table 2, for all the soil types TRPCA outperforms PCA and RPCA for aluminum target. Especially for the wet sand oil, TRPCA performance is approximately %10 better than the RPCA.

Table 2. PSNR (dB) results for aluminum target with different soil types.

Aluminum Target	**PCA**	**RPCA**	**TRPCA**
Dry sand soil	90.53	137.62	**144.28**
Damp sand soil	103.53	132.68	**137.03**
Wet sand soil	73.32	132.83	**145.82**
Dry clay soil	101.55	129.30	**135.48**
Wet clay soil	90.62	135.69	**141.32**
Dry loam soil	100.89	128.08	**135.69**

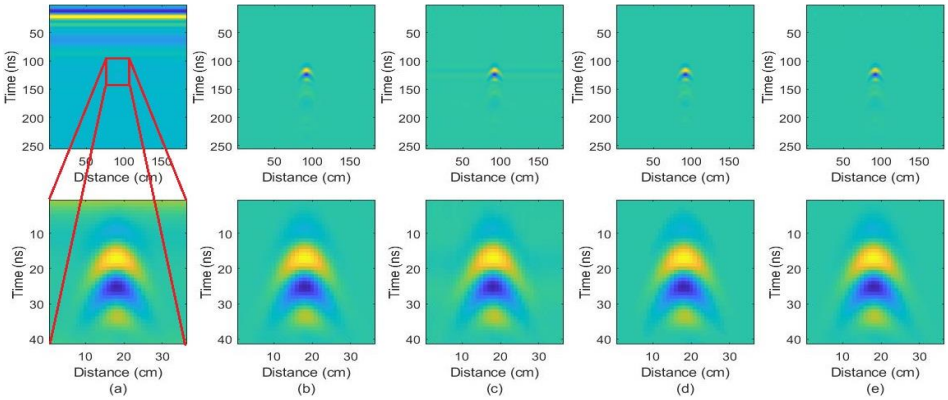

Figure 5. First Row: Original Results, Second Row: Zoomed Version: a) raw data, b) reference data clutter suppression results for, c) PCA, d) RPCA, e) TRPCA.

The visual results of the raw data in Figure 2(c) are presented in Figure 5(c)-(e) and the second row is the zoomed area for the target signature. As seen in the visual results, PCA obtains target signature however the residual of clutter is still available in the form of horizontal lines. The visual results of RPCA and TRPCA look similar to each other.

The quantitative results in plastic target case are not obvious as in the aluminum target. However, TRPCA outperform RPCA for 3 out of 5 GPR images. There are not dramatic differences between TRPCA and PRCA in the sense of PSNR (dB) value. Both of them outperform the classical PCA method with huge differences in quantitative analysis.

Table 3. PSNR (dB) results for plastic target with different burial depths.

Plastic Target	PCA	RPCA	TRPCA
0 cm	53.91	**92.95**	80.26
1 cm	58.71	101.90	**104.59**
2 cm	99.82	126.04	**128.60**
4 cm	104.11	**132.06**	130.85
10 cm	96.55	115.36	**125.79**

The visual results of the raw data in Figure 2(d) are presented in Figure 6(c)-(e) and the second row is the zoomed area for the target signature. As seen in the visual results, PCA obtains target signature however the residual of clutter is still available in the form of horizontal lines. The visual results of RPCA and TRPCA look similar to each other. Both of them effectively suppressed the clutter and outperform the classical PCA method.

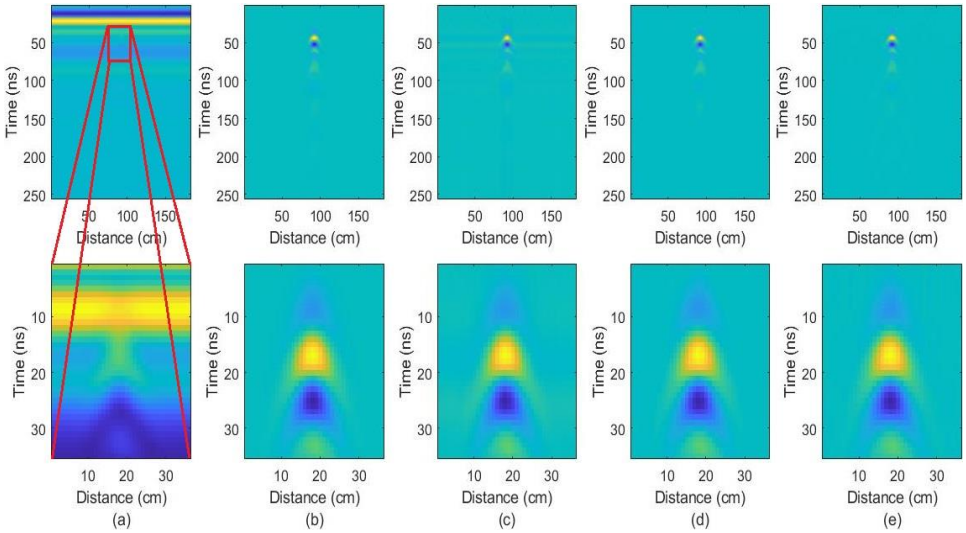

Figure 6. First Row: Original Results, Second Row: Zoomed Version: a) raw data, b) reference data clutter suppression results for, c) PCA, d) RPCA, e) TRPCA.

Again, the quantitative results in this case are not obvious as in the aluminum target. However, TRPCA outperform RPCA for 4 out of 6 GPR images. There are not dramatic differences between TRPCA and PRCA and both of them outperform the classical PCA method with huge differences.

Table 4. PSNR (dB) results for plastic target with different soil types.

Aluminum Target	PCA	RPCA	TRPCA
Dry sand soil	47.42	**72.46**	68.26
Damp sand soil	92.17	121.62	**126.99**
Wet sand soil	70.29	**135.67**	133.52
Dry clay soil	99.82	126.04	**128.60**
Wet clay soil	94.12	125.82	**131.11**
Dry loam soil	99.25	125.92	**128.87**

4. CONCLUSION

The proposed TRPCA based clutter suppression method applies a novel pre-transformation step during the construction of image-patch tensor in GPR. The 1D A-scans are converted to 2D images and they are concatenated to construct multi-dimensional image tensor. Since, 2D GPR images are formed by the concatenation of A-scans, the constructed new image tensor from A-scans are interrelated. Then, TRPCA method is used for the decomposition of the constructed GPR image tensor. The obtained results are compared with the classical PCA and recently proposed RPCA method over the simulation dataset both visually and quantitatively. The obtained results show that TRPCA method heavily outperforms classical PCA and recently proposed RPCA in the aluminum target case and it has better decomposition results in the plastic target case.

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**An ethical committee approval and/or legal/special permission has not been required within the scope of this study.*

BUSINESS IMPACT OF COVID-19 PANDEMIC ON GLOBAL MARITIME INDUSTRY*

Hülya CENGİZ[1]
Eda TURAN[2]

[1] *National Defence University, Turkish Naval Academy, Department of Social Sciences, Istanbul, Turkey,*
hcengiz@dho.edu.tr; ORCID: 0000-0002-2011-3948

[2] *Yildiz Technical University, Department of Naval Architecture and Marine Engineering, Istanbul, Turkey,*
edaturan@yildiz.edu.tr; ORCID: 0000-0002-8965-1744

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ABSTRACT

Coronavirus (COVID-19) pandemic has affected whole world in terms of health and global economics. As in all sectors, global maritime industry which comprises many work expertise and provides international work space for the employees, has also been stressed. For this importance, COVID-19 business impact survey on global maritime industry has been conducted during the first wave of the pandemic. Respondents of the research survey were working in a wide range of position and job alignments in the sector that are located in 21 countries all over the World. The purpose of this study is to determine the business effect of pandemic on global maritime industry. For this aim, a survey that consists of 36 questions has been conducted. These questions were initially related with descriptive ones that are firm characteristics and expertise. Then, ability of the companies while executing business operations under these situation has been investigated and the problems about financial structure as of liquidity, government & institutions assistance, transaction strategies, the actions of second wave, changes of employee, concern about future for company has been determined.

Keywords: *Coronavirus, Maritime, Pandemic, Business Impact.*

COVID-19'UN KÜRESEL DENİZCİLİK SEKTÖRÜNE TİCARİ ETKİSİNİN İNCELENMESİ

ÖZ

Koronavirüs (COVID-19) salgını, sağlık ve küresel ekonomi açısından tüm dünyayı etkisi altına almıştır. Tüm sektörlerde olduğu gibi, birçok iş uzmanlığını içeren ve uluslararası işgücü imkânı sağlayan küresel denizcilik sektörünü de sıkıntıya sokmuştur. Sektörün önemi göz önüne alınarak, COVID-19'un küresel denizcilik endüstrisi üzerindeki ticari etkisini belirlemek amacıyla salgının ilk dalgasında bir anket çalışması yapılmıştır. Araştırma anketine 21 ülkeden, sektörde çeşitli pozisyonlardaki ve farklı iş uzmanlığı bulunan sektör çalışanları katılmıştır. Bu çalışmanın amacı, pandeminin küresel denizcilik sektörü üzerindeki ticari etkisini belirlemektir. Bu amaçla 36 sorudan oluşan bir anket düzenlenmiştir. Anketin ilk bölümünde, firma özelliklerini ve uzmanlığını belirlemeye yönelik sorular yöneltilmiştir. Daha sonra şirketlerin pandemide faaliyetlerini devam ettirebilme becerileri araştırılmış; likidite, devlet ve kurum yardımları, işlem stratejileri, ikinci dalga için eylemler, istihdam, geleceğe yönelik beklentiler gibi finansal yapı ile ilgili sorunlar belirlenmiştir.

Anahtar Kelimeler: *Koranavirüs, Denizcilik, Salgın, Ticari Etki.*

1. INTRODUCTION

Coronavirus disease, which is also called as COVID-19, has firstly appeared in Wuhan, China and spread all over the world rapidly. By 28 December 2020, there have been 79.673.754 confirmed cases of COVID-19, including 1.761.381 deaths, reported to WHO (WHO, 2020).

COVID-19 has not only breached the circle of the worldwide economy but also stopped transportation throughout the world. International and local transportation has been reduced, which lessens oil consumption and energy utilization (Shehzad, Sarfraz, & Shah, 2020). As in all sectors, the transportation sector has suffered from the Covid-19 pandemic. Sea transport, which undertakes more than 80% of freight transport on an international scale, was also affected. The most striking change in terms of the decrease in the number of ships calling at the ports was observed in container ships at the beginning of the pandemic (Ozturk & Turan, 2020). Cruise shipping has also effected negatively from the results of coronavirus. Holidays in a cruise ship was an unforgettable experience before, however with the infection; it became a source of stress.

The COVID-19 has a far-reaching effect on the lives of people around the world. It showed a dramatic impression on international and local transportation. On the other hand, lock-down slowed the economic circle in the world, which results in shut down of production units and international trading. The pandemic has a significant influence in a worldwide basis (Shehzad, Sarfraz, & Shah, 2020).

Apart from this, pandemic has significantly influenced societies, global economic activities due to the transmission of the sickness. Countries adopted some solutions in order to cope with this unplanned situation in many ways. Some of them reorganized working hours while others were totally locked down and stopped activities excluding essential ones. Business transportation systems, especially airway transportation have been postponed, suspended or almost stopped. Tourism incomes of the countries have also declined dramatically. Moreover, commercial, educational, sportive and social facilities have also been cut down on. Decrease in

production level have also caused a threat for the economies of many countries and become a risk for high inflation rates and increase of unemployment numbers.

The paper is structured as follows: the literature review section summarizes the studies on epidemic outbreaks and highlights the effects of the pandemic on business. Then, the Methodology section describes the design of the survey and information about the respondents
The results and Discussions part of the paper presents the results of the research and evaluates the responses. As a consequence, conclusions and an outlook on future predictions are submitted.

2. LITERATURE REVIEW

In literature regarding coronavirus studies are mainly related with the effects of COVID-19 on the health and behavior of the people. Effects of the pandemic have mainly been considered to the environment and transportation systems especially for airway transport and public transport. To the best knowledge of the authors, studies on the effects of coronavirus on maritime cargo transport are not heavily investigated. The examinations on maritime transportation in the literature are mainly related with cruise shipping.

Ozturk and Turan (2020) investigated the effects of the pandemic on maritime cargo transportation summarized the exposure level of several ship types. It is observed that the most significant change was in container shipping and the number of ships calling at the ports decreased dramatically.

Ito et al. (2020) studied whether the movement of cruise ships effect the spread of coronavirus or not by tracking all ocean cruise ships around the World using automatic identification system data from January to March 2020 and declared that countries went on to accept cruise ships until March have faced with a higher COVID-19 infection rates compared to other countries. Moreover, they have analyzed the infection ratio subject to the ship size and operation schedules. They have pointed out that the risk of infection on board increases in large cruise ships and majority of these

cruise ships that have an infection, were sailing from the same home port to the same port of call in a week's time.

Loske (2020) showed a framework in order to reflect the impact of COVID-19 with a case study for German food logistics services and stated that purchasing style has been changed due to spending more time at home and stocking food in panic. He has evaluated transport volume growth rate with food demand, number of new infection cases and pointed out that the volume of the food logistics services increases with the new coronavirus cases. In addition to this study, Budd and Ison (2020) have also focused on individual behaviors in pandemic situations while taking into consideration community health and wellbeing. They mentioned the necessity of reorganization of the transport policy according to the mobility and economic situation during post-COVID-19.

European Maritime Safety Agency (EMSA) published a report on 27th November 2020 regarding the effects of coronavirus on shipping by examining several aspects such as ports, cruise shipping, port calls both in European Union (EU) and Far Eastern countries, vessel movements and also congestion at anchorage. According to the report, the shipping industry has been impacted both directly and indirectly from the outbreak of COVID-19. The maritime traffic was observed to decline especially between Europe and China and there is a severe decline in maritime passenger transportation.

Roy (2020) investigated the economic slowdown due to pandemic in main industries as aviation, oil, tourism, financial and healthcare sectors and indicated that the pandemic has spread rapidly all over the World and affected these industries negatively in terms of trade volume, interest rates, market volatility and demand and supply ratios. Ozili and Arun (2020) studied how a health crisis turned into a financial crisis and in this respect they collected marketing data for price and social data as lockdown days, restrictions from the continents of North America, Africa, Asia and Europe in one month period. They showed that these restrictions severely affect the global economy and decrease the level of economic activities.

Tanca et al. (2020) prepared a report regarding the political and economic impacts of coronavirus and measures taken in order to prevent sharp effects in Turkey. According to their report of EDAM (Dersu, Efe, Anna, & Öykü, 2020) Turkish economic institutions were forced to respond to an unprecedented and unpredictable transformation in its own fiscal status, as well as in global financial strategies and some financial adjustments have been implemented in Turkey.

Choquet and Sam-Lefebvre (2021) evaluated decisions of port authorities for cruise ships in the legal framework and presented that many ports have applied some precautions. Some of them refused access while others disembark or quarantine passengers onboard. It is understood that states have different applications in order to slow down the speed of the outbreak.

Chen and Pan (2020) mentioned the control strategy of China against the coronavirus epidemic in order to be a role model to other countries. They also compared the cases with other countries faced with this epidemic intensely. The most important factor for stopping the spread of the outbreak is seen as preventing flow of people. The other precautions were strict rules, following-up the cases efficiently, limiting the transportation movements.

Zhou et al. (2020) aimed to present the challenges and opportunities in travel health mainly concentrating on cruise ships since cruise ships have high risk in terms of pathogens and sickness. Therefore, they studied the situation of big cruise ships and reached that there were several cases in these ships and suggested that prevention of diseases is of great importance for global health in the cruise industry as economic growth and the ability for public health quick reactions in case of an epidemic should be enhanced.

3. METHODOLOGY

The analysis in this study is based on the data from an online research survey that was applied to the global maritime industry to measure the impact of COVID-19 in the World. Our questionnaire consists of 36 questions measuring the business impact of COVID-19 on the global maritime industry. The questionnaire has multiple choices, multiple choices

with multi select and open – ended questions. Firstly the respondents were asked descriptive questions regarding firm characteristics including country of company based in, work expertise in company, company business alignments, the departments in company, the positions in company, type of vessel(s) to company activities, and the number of employees in the company. Secondly, the respondents were asked how business operations of the companies , the ability to purchase inputs /sell outputs, challenges of company experience, demand of products/services, strategies have been affected by the coronavirus (COVID-19) pandemic. Finally, the respondents were asked to reveal problems about financial structure such as liquidity problems, support or benefits from the government, support of business or institutions, transaction strategies, the actions of the second wave, changes of employee, concern about the future for the company. Responses have been analyzed by IBM Statistic SPSS 22.

3.1. Survey Design and Details

A web-based survey has been designed in order to reach the employees in the global maritime industry during pandemic period. Built on our previous studies and experience in the industry, our mailing list delivers content tailored for its core audience of ship owners, managers, operators, charterers and others in the industry taking the decisions which drive global maritime industry. Questionnaires have been replied by 84 respondents in 21 countries all over the world.

58% of the respondents are located in Turkey, remaining are from USA, EU and Far Eastern countries. Opinion of the all partners of the global maritime industry is aimed to receive and therefore Q-questionnaires have been sent to ship owners, managers, operators, shipyards, charter firms, marine equipment and engine builders, ship brokers, ship chandlers, maritime lawyers, ship finance companies, maritime schools, maritime organization and classification societies, ship breakers, consultants and surveyors, port operators, port authorities and port agents. Half of the respondents are recorded as ship owner, manager, operator, shipbuilder or repairers as a work expertise and company business alignment. When the positions of the respondents were analyzed, it is seen that owners, managing directors or

boards who are decision makers in the companies, have participated in our questionnaire with a 27.5% ratio in all respondents. Other major departments are observed as business development, production, marketing and corporate communications that forms around 35% of the respondents. The rest of the respondents are working in other significant departments such as sales, purchasing, planning, design, research and development, human resources, class survey, education.

As a position basis, 21.4% of the respondents were seen as working as a managing director, board member or public administrator position in a company, 20.2% were division manager, factory operations/ branch manager or chief officer and 14.3% were self-employed business person, co-owner or freelancer. The rest of the respondents have been recorded as department supervisor, section leader, engineer, master and chief engineers onboard, academic personnel.

The concentration of the respondents or their companies on types of vessels and activities are given in Table 1. According to the Table 1, the professionality of the respondents is mainly on the operation of tanker, bulk carrier, general cargo and specialized vessels.

Table 1. Types of vessels and activities that respondents concentrate on.

Types of Vessels and Activities	**Percent (%)**
Tanker*	14.9
Bulk Carrier	12.8
General Cargo	10.7
Specialized Vessels***	10.1
Passenger Ships (Ferries, Cruise Ships)	8.3
Container	8.3
Offshore Vessels**	8
Roll-on Roll-Off Ship	7.4
Fishing Vessels	5.4
Naval Ships	4.8
Yachts	4.2
Reefer	3.9
Other****	1.2
Total	100%

*Oil Tankers, Liquefied Gas Carriers, Chemical and Product Carriers
**Supply Ship, Pipe Layers, Crane Barges or Floating Cranes, Semi-Submersible Drill Rigs Drill Ships, Accommodation Barges, Production Platforms, Floating Storage Unit (FSU), Floating Production and Storage Unit (FPSO), Anchor handling vessels, Diving vessels)
***Tugs, Tenders, Pilot Crafts, Dredgers, Cable Layers, Research Vessels, Salvage Vessels, Barges, Timber Carriers, Livestock Carriers, Ice breaker ships
****Floating Dry-docks, SAR Boats, Workboats, Research Vessels.

Ultimately, the number of full-time employees and percentage were 37companies (44%) with 250 and above employees, 18 companies (21%) having 10-49 employees, 16 companies (19%) having 50-249 employees and 13 companies (15%) having 0-9 employees.

4. RESULTS AND DISCUSSIONS

We have categorized our main results into three groups. Firstly, we have pointed out the effects of COVID-19 on business operations toward the beginning of the outbreak. Secondly support measures and strategies taken by the companies itself or governments against outbreak have been

investigated. Thirdly, we have focused on the expectations about the duration of the crisis and their own economic survival, in order to reflect the effects of future policies.

4.1. Effects of COVID-19 on Business Operations

The initial survey question asked owners was "*How have your business operations been affected by the coronavirus (COVID-19) pandemic*?" and three options have been allowed for them to answer. 29 companies (34.5%) stated that they were moderately affected, 26 companies (31%) were slightly affected, 20 companies (24%) were strongly affected and by contrast, 9 companies (11%) reported that they were not affected.

Respondents were also asked about how the coronavirus (COVID-19) pandemic affected their enterprise and their replies regarding the effects of the pandemic are listed in Table 2. This question has a multi-select option so respondents were allowed to answer more than one option. Other effects were difficulty in bringing onboard, reduced freight rates, lack of superintendents as well as service men due to the closure of the borders, modification of operating procedures, cancelled requests, dividing employees into groups for time and location separation, clients not paying their bills, reduction in the number of ship repair customers, more business, contract postponements/cancellations.

Table 2. Effects of the pandemic on maritime companies.

Effects	**Percent (%)**
Reduced logistics services	16.8
Reduced investment	16.8
Temporary shutdown	16.2
Clients not paying their bills	10.1
Reduced certification services	10.1
Employee absences due to sickness or childcare	8.9
None of the above	6.7
New problems with infrastructure, e.g. internet or roads	5
Other	5
Increased administrative bottlenecks	4.5
Total	100%

Top three effects of coronavirus on maritime companies were reported as reduced investment, reduces logistics services and temporary shutdown as presented in Table 2.

The effect of coronavirus pandemic to the ability to purchase inputs for enterprise and/or sell outputs was listed in Table 3. These results showed that difficulty in importing inputs from abroad highly affected the companies with a ratio of 30.6%. In the meantime, companies have mainly come across with difficulty in exporting their products and lower domestic sales to businesses accordingly.

Table 3. Ability to purchase inputs for the enterprise and/or sell outputs.

Ability to Purchase/Sell	**Percent (%)**
Difficulty in importing inputs from abroad	30.6
Don't know	21
Difficulty in exporting	16.9
Lower domestic sales to businesses	12.1
Lower domestic sales to consumers	8.1
Difficulty in accessing inputs domestically	7.3
Improved exporting	2.4
Increased domestic sales	1.6
Total	100%

Another question was about witnessing a change in demand of the products or services. Demand of products or services to be decreased was replied by the 54% of the respondents, 33% of them observed no change and 13% of them declared that there was an increase in demand.

4.2. Supportive Measures and Strategies Taken by the Companies itself or Governments against the Outbreak

In this part of the research, respondents were initially asked "*Which of the following challenges has your company experienced when trying to support employees?*" and responses were given in Table 4. The most challenging factor has been reported as difficulty in maintaining social distancing in the

workplace which is suggested between one and two meters by the experts. Employees not coming to work due to fear of getting sick and unable to test employees for virus/antibodies due to lack of test kits were seen as the significant challenges by the companies. 5.6% of the respondents selected others option and some of these challenges were submitted as difficulty in crew change, remote working conditions, employees not able to travel and most of the workers were being lockup in their dormitory by government agency, thus companies could not be able to have direct control to movement of the workers and in contrast some companies declared that they have tested all their employees regularly.

Table 4. Challenges companies experienced while trying to support employees.

Challenges Companies Experienced	**Percent (%)**
Difficulty in maintaining social distancing in the workplace	28.5
Unable to test employees for virus/antibodies due to lack of test kits	18.8
Employees not coming to work due to fear of getting sick	18.8
Unable to find masks to purchase	12.5
No challenges encountered to date	11.8
Other	5.6
Unable to find thermometers to use	2.1
Unable to test employees for virus/antibodies because employees do not want to be tested	2.1
Total	100%

In order to measure the strategies of the companies, respondents were asked whether they have adopted any strategies to cope with the crisis or not and their replies are given in Table 5. Development of prompt strategies during unexpected situations is fundamental to run a business in crisis and achieve the goals and to make stable the motivation of the personnel. This question has a multi-select option so respondents were allowed to answer more than one option. Teleworking (15.7%), temporarily reduced employment (12%)

and suspension of investments (10.6%) were mainly responded by the actors in the global maritime industry. Replies of respondents were also compared as Turkey and other countries. Strategies of the companies were mostly on adopting teleworking, temporarily reduced employment and suspension of investments in the Turkish companies and other foreign countries. Additionally, other countries were replied that they have increased marketing efforts.

Table 5. Strategies of the companies against pandemic.

Strategies	**Percent (%)**	**Turkey (%)**	**Other Countries (%)**
Teleworking	15.7	15.4	16.1
Temporarily reduced employment	12	12.2	11.8
Suspension of investments	10.6	10.6	10.8
Class extension	8.8	9.8	7.5
Increase marketing efforts	7.9	4.9	11.8
Reorganization	6.5	8.1	4.3
Postponement of planned dockings	5.1	4.9	5.4
Lay-up vessels	4.2	4.1	4.3
Customized/new products	4.2	3.3	5.4
Rescheduling of bank loans/refinance its existing loan with the bank	3.7	5.7	1.1
Laid off employees	3.2	3.3	3.2
Loaned employees to other enterprises	3.2	3.3	3.2

Continuation of the Table 5.

Online sales	3.2	4.1	2.2
Filed for bankruptcy	2.8	4.9	0.0
Other*	2.8	0.8	5.4
Postponement of BWTS retrofits	1.4	1.6	1.1
Started sourcing from new suppliers	1.4	0.0	3.2
Postponement of Scrubber retrofits	0.9	0.0	2.2
New Fleet or vessel purchase	0.9	0.8	1.1
Ownership and partnership change	0.9	1.6	0.0
Fleet or vessel sale	0.5	0.8	0.0
Total	100%	100%	100%

* Recruiting more workers with higher skill and focus for more high value jobs, increases in remote survey, increasing market offering with special price, recognizing seafarers as "key workers" and distance/online inspection on vessels, moving to online or digital platforms.

Measures provided by national/regional/local governments(s) for immediate liquidity problems, by segments have also been analyzed and measures provided by national/regional/local governments(s) for immediate liquidity problems have been reported as in place but not applicable for their company. On the other hand, measures provided by banks for immediate liquidity problems have mostly been indicated as no measures in place and measures not needed.

Support of the government to companies during the coronavirus pandemic have been examined and 47.6% of the respondents have declared that there was no support, 12.4% of them mentioned deferred tax payments, 11.4% healthcare resources. The other reports were unemployment resources (9.5%), finding low-interest loans (7.6%), public guarantee schemes (5.7%), more business loan opportunities (4.8%) and others such as special days off for parents (1%). Thereon, *government* measures that would be most helpful as the companies cope with the COVID crisis have also been inquired and expectations of the companies have been understood mainly for monetary issues such as employment programs (e.g. temporary unemployment programs or social security waivers) and financial programs (e.g. low

interest credit line or credit guarantees) which have the equal ratios as 25%. Moreover, tax waivers or temporary tax breaks (22.5%), reduction of tariffs on imported inputs (7%), cash transfers (7%), rent subsidies (2.5%) and no suitable reply (1%). This result also reflects that the economic impact of the pandemic is crucial for the companies and companies may need some financial support in the following months of the crisis in order to survive in the health crisis period that began to turn into an economic crisis.

In parallel to below evaluation, respondents were asked how easy it was to access information and benefits from government COVID related assistance programs and 48% of the respondents commented as standard, 20% of the respondents reported as difficult, 16% of the respondents replied as very easy, 11% of the respondents replied as easy and 5% of the respondents replied as very difficult.

When the respondents were asked "*What are the support measures urgently needed by the industry or your company itself*?" the replies have been listed in Table 6. Problems/delays on Crew sign on/off shore leave and Seafarer repatriation (18.4%), financial issues (14.3%) and challenges on ship attendance for certification and statutory purposes (11.1%) and around 32% due to the postponements or delays regarding regular operations. Also replies of respondents were compared as Turkey and other countries. The replies in the sector were observed as approximately similar in the industry regardless of countries.

Table 6. Support measures required by the companies and global maritime industry.

Support Measures	**Percent (%)**	**Turkey (%)**	**Other Countries (%)**
Problems/delays on crew sign on/off shore leave and seafarer repatriation	18.4	21.4	14.3
Financial issues	14.3	12.7	16.5
Challenges on ship attendance for certification and statutory purposes	11.1	11.9	9.9
Delays/difficulties on cargo operations	8.8	9.5	7.7
Restrictions on stores, supplies, spares	8.3	7.9	8.8
Delays/problems due to work restrictions (Repairs/Retrofits/ Recycling)	8.3	8.7	7.7
Validity of certificates	7.8	7.9	7.7
Postponement of deadline or extension for BWTS (Ballast Water Treatment System) and Scrubbers	6	5.6	6.6
Difficulties on medical handling of suspect cases on board	5.5	4.8	6.6
Support on employment	4.6	4.8	4.4
Bunkering/de bunkering	2.8	3.2	2.2
Questions/uncertainty on insurance covers and claims due to delay	1.8	0.8	3.3
Other*	1.4	0.0	3.3
Delays due to Pilot shortage/refusal to board	0.9	0.8	1.1
Total	100%		

* Low fuel costs start with the maintenance programs, extension of financial package for further period due to prolonged COVID-19 disruption.

The responses on the question of "*Which of the following business or institutions supported your company during coronavirus (COVID-19) pandemic*?" respondents' reply have been listed in Table 7. Half of the respondents declared that there were no supports from any business or institutions. Half of them stated that they had some supports from the

partners of the industry as classification societies, flag authorities, chambers of shipping, IMO (International Maritime Organization), BIMCO (Baltic and International Maritime Council), shipowners associations, INTERTANKO (International Association of Independent Tanker Owners), governments and chambers of commerce. When compared the replies of respondents as Turkey and other countries, the ratio of the support by Shipowners' Associations, BIMCO, government and Chamber of Commerce to other countries are seen more than in Turkey. In the meantime, Turkish companies had support mainly from Class Societies, Flag Authorities, Chamber of Shipping and IMO.

Table 7. Business and institutions supported maritime companies during coronavirus pandemic.

Types of Support	**Percent (%)**	**Turkey (%)**	**Other Countries (%)**
No support from any business or institutions	50.9	46.3	57.8
Class Societies	14.3	16.4	11.1
Flag Authorities	10.7	13.4	6.7
Chamber of Shipping	8.9	11.9	4.4
IMO	7.1	9.0	4.4
Shipowners' Associations	2.7	1.5	4.4
BIMCO	2.7	0.0	6.7
Other (Government, Chamber of Commerce)	1.8	0.0	4.4
INTERTANKO	0.9	1.5	0.0
Total	100%	100%	100%

How above mentioned business or institutions given in Table 7 could support the companies have also been enquired and deferred tax payments (13.1%), healthcare sources (13.1%), more business loan opportunities (9%) and unemployment resources (8.2%) were responded mostly.

When the respondents were asked "*How is COVID-19 affecting your transaction strategy (i.e., mergers, acquisitions, divestitures, joint ventures*

& partnerships) for the next 12 months?" replies have been listed in Table 8. Due to the unknown and unexpected era, most of the respondents has declared that they were not sure and just monitoring the situation nowadays. The ratio of the companies indicated that will not perform any strategy is 19% shows that it was not possible to change of transaction strategy depending on the sector structure.

Table 8. Transaction strategies due to the pandemic.

Transaction Strategies	**Percent (%)**
Not sure, monitoring the situation	28.6
No change to strategy	27.4
Not applicable, company does not have a transaction strategy, nor does it perform such types of transactions	19
Decreasing appetite for transactions	16.7
Increasing appetite for transactions	8.3
Total	100%

In line with the above question on the transaction strategies, the question of *"Which of the following transaction actions is your company considering as a result of COVID-19?"* has also been asked to the respondents and Table 9 was put forward. Majority of the respondents have answered as they did not consider any of the mentioned actions so far. 15.1% of the respondents have reported that they have evaluated new opportunities through joint ventures or partnerships to continue their activities.

Table 9. Transaction actions as a result of COVID-19.

Transaction Actions	**Percent (%)**
Not considering any of these actions at this time	42.5
Evaluating new opportunities through joint ventures or partnerships	15.1
Considering divesting some parts of our business	9.4
Pursuing opportunistic transactions focused on scope	9.4
Pursuing opportunistic transactions focused on scale	8.5
Accelerating delayed integration of acquired businesses to unlock synergies	7.5
Pursuing opportunistic transactions focused on talent	5.7
Defining turnaround strategies for distressed company business units	1.9
Total	100%

Opinion on the measures that the companies take to protect the health of their employees has also been received by the respondents and results have been detailed in Table 10. This question had also a multi-select option so respondents were allowed to answer more than one option.

Table 10. Measures taken by the companies for health of the employees.

Measures	**Percent (%)**
Providing facemasks	18.9
Enhanced cleaning and disinfection of the workplace	16.3
Providing personal protective equipment including gloves and gowns	11.9
Changing shifts and workgroups to improve social distancing	11.9
Implementing other measures to improve social distancing	11

Continuation of the Table 10.

Improving facility ventilation rates	8.1
Conducting employee COVID-19 screenings and assessments	7.8
Implementing physical or structural changes to the workplace (e.g., sneeze guards, barriers)	7.6
Working toward improving facility ventilation rates	4.7
None of the above	1.7
Total	100%

The risk of the businesses to be permanently shut down because of the crisis has also been searched and according to the respondents, 73% of them have given opinion that business closure is not envisaged. In the meantime, 80% of the respondents have indicated that they would not consider or implement workforce sharing (e.g., loaning employees to other companies in need of resources).

The results for the question of "*In which functions their company was anticipating a need to increase headcount in the next 12 months?*" have been listed in Table 11. This question had also multi-select option since respondents may have several anticipations. 18.7% of the respondents have reported that they did not anticipate requiring an increase headcount in the next 12 months while others have mainly indicated that engineering, environmental health and sustainability, human resources, digital and cyber security would be their priority for the headcount in line with the changes in the pandemic era.

Table 11. Expectations regarding headcount in the near future.

Expectations	**Percent (%)**
Not applicable, we do not anticipate needing to increase headcount in the next 12 months	18.7
Engineering	9.6
Environmental health and sustainability	7
Human resources	6.4
Cyber security	5.9
Digital	5.9
Manufacturing / production	5.3
Facilities and maintenance	4.3
Finance and accounting	4.3
Audit	3.7
Information technology	3.7
Marketing and communications	3.7
Sales	3.2
Administration	2.7
Research and development	2.7
Risk	2.7
Treasury and liquidity management	2.7
Legal	2.1
Supply chain, purchasing	2.1
Compliance	1.1
Product	1.1
Quality assurance	1.1
Total	100%

What extent the actions have been taken by the possible waves of the (COVID-19) pandemic issue has also been asked to the respondents and 45% of them have replied that all actions had been taken solely on the basis of government requirement while 31% of them indicated that no action had been taken and 24% of them have reported that all actions have been taken solely on the initiative.

4.3. Expectations on Post-crisis Period and Future Policies

The world after COVID-19 will not return to the World that was and many habits and trends are expected to be changed in the global business being accelerated by the impact of the pandemic. Rise of digital environment, behaviors in the new normal and other changes may affect companies in near future. This alteration is not only sourced by technological advances but also by the new thoughts regarding health issues, global economy, financial markets. In this context, respondents have been asked to analyze "*what skills they think that would be in the highest demand in a post-COVID-19 world* and reports of the respondents have been listed in Table 12. This question also had a multi-select option. When the replies of respondents were compared as Turkey and other countries expectations were close as ratio in the industry.

In our study, around half of the executives from maritime companies said that the pandemic is likely to accelerate the pace of their digital transformation and communication skills. The current crisis has forced organizations to adapt rapidly to new realities, opening everyone's eyes to new, faster ways of working with customers, suppliers, ship crew and colleagues such as digital marketing, communication skills and business intelligence.

Furthermore, cyber security (8.3%) is shifting priorities to support current needs: business continuity, remote work, and planning for transition to the next normal.

Table 12. Expected skills to be demanded in a post COVID-19 period.

Expected Skills	**Percent (%)**	**Turkey (%)**	**Other Countries (%)**
Communication	13.9	13.6	14.4
Business intelligence	9.1	8.9	9.6
Digital marketing	9.1	9.8	8
Cyber Security	8.3	7.9	8.8
Cloud computing	6.8	5.6	8.8
Collaboration	6.8	5.1	9.6
Data analysis or statistics	5.9	5.6	6.4
Emotional intelligence	5.9	7.0	4
Project management	5.9	5.1	7.2
Software engineering	5.9	7.5	3.2
Analytical reasoning	5.3	5.6	4.8
Machine learning	2.9	3.3	2.4
Not sure	2.9	1.9	4.8
Persuasion or influence	2.7	3.3	1.6
Solution architecture	2.7	3.7	0.8
Customer service	2.4	2.8	1.6
SEO (Search Engine Optimization) or growth hacking	1.2	1.9	0
DevOps (Developers and Operations)	0.9	0.5	1.6
UX (User Experience) design	0.9	0.5	1.6
Hardware design	0.6	0.5	0.8
Total	100%	100%	100%

The predictions of respondents regarding how their companies would change as a result of COVID-19 have been given in Table 13. This question was a multi-select option and it is seen that some of the respondents had several expectations. According to the results of the study, it was clearly seen that more remote working, more stocking in-house and utilization from the domestic suppliers would highly be preferred.

Table 13. The predictions on the change of the companies during post COVID-19 period.

Predictions	**Percent (%)**
We will offer more remote working in the future	33.3
It will not change	24.8
None of the above	14.3
We will hold more stock in-house rather than JIT (just-in-time)	11.4
We are now considering using more domestic suppliers	10.5
We are now considering using more offshore suppliers	4.8
Other*	1
Total	100%

* Some social distancing precautions such as barriers between seats on kitchen tables will stay.

The COVID-19 pandemic has reminded previous outbreaks and it is understood that future may bring new pandemics and the results of these unexpected periods had several impacts on the businesses due to the restrictions and postponements in the business cycles. Although the pandemic started as a health crisis, it has severe consequences in the World and it is impossible to say that any country would be unaffected and returning to the times before the pandemic will take some time. Thereafter, the respondents have been asked the question of "How soon do you expect your company will bounce back after movement restrictions are lifted?" and their replies have shown in Table 14. 25% of the respondents have reported that they were not experiencing a dip in sales/activity and 23.8% of them have expected within 0-3 months after the restrictions. Only 2.4% of the respondents have replied to this question as they did not expect any bounce back and they were in difficulty.

Table 14. Expectations of companies bounce back after restrictions.

Expectations	**Percent (%)**
0-3 Months	23.8
3-6 Months	14.3
6-12 Months	15.5
12-18 Months	14.3
18-24 Months	4.8
We are not experiencing a dip in sales/activity	25
Never	2.4
Total	100%

The respondents have also been asked whether there were changes in turnover after Coronavirus in the first half of 2020 compared to the first half of 2019" and their turnover expectations for the second half of 2020 compared to the second half of 2019. Responses have been illustrated in Fig.1 & 2. Many of the respondents have remarked that their current and expectations on turnovers were in a falling tendency.

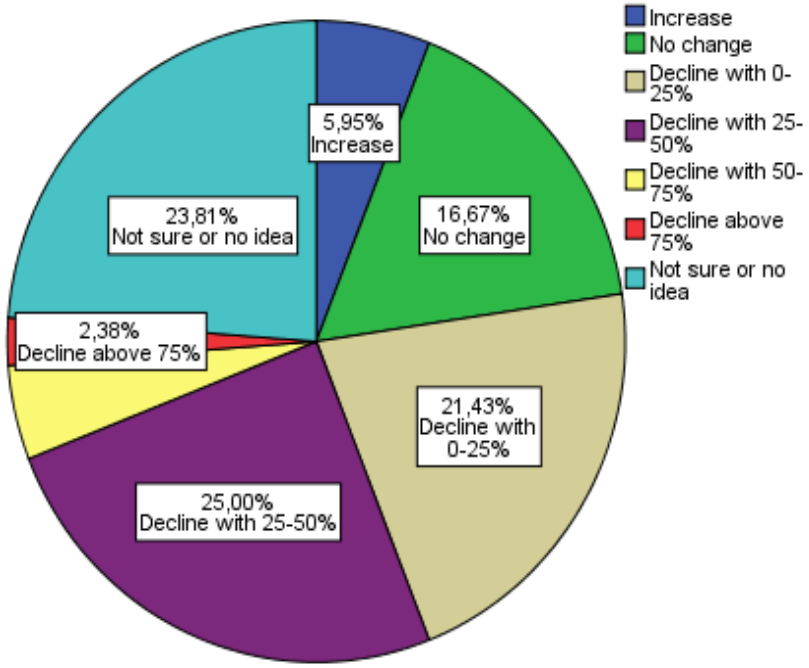

Figure 1. Change in turnover after coronavirus in the first half of 2020 compared to first half of 2019.

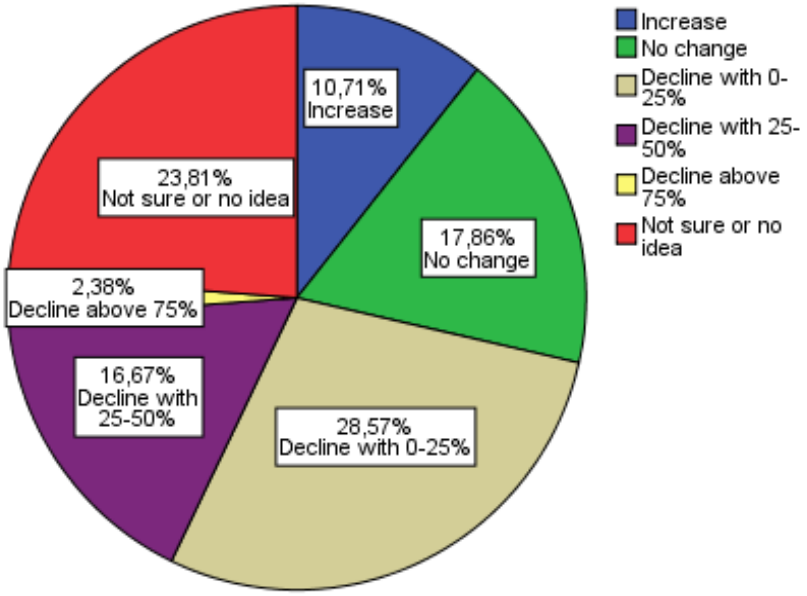

Figure 2. Turnover expectations for the second half of 2020 compared to the second half of 2019.

Acting on the above question, the expectations about the development of employment in 2020 compared to 2019 have also been examined for seafarers and office/yard/field personnel separately. The replies of the Respondents are listed in Table 15. Respondents working in both of these fields have declared that there would be no change on recruitment and remain stable as in 2019.

Table 15. Expectations on recruitment in 2020**.**

Expected development of the employment of seafarers for 2020, compared to 2019		**Expected development of the employment of office and yard/field personnel for 2020, compared to 2019**	
	Percent (%)		**Percent (%)**
Not relevant to our business	45.2		
Increase	8.3	Increase	10.7
No change	22.6	No change	54.8
Decline with 0-25%	15.5	Decline with 0-25%	22.6
Decline with 25-50%	6	Decline with 25-50%	6
Decline with 50-75%	0	Decline with 50-75%	3.6
Decline above 75%	2.4	Decline above 75%	2.4

In final, expectations of the respondents regarding returning to investments in fleet renewal as planned prior to COVID-19 have been listed in Table 16 and majority of the respondents relevant to their business have filled in that they have a lesser extent expectation as planned prior to COVID-19.

Table 16. Investments in fleet renewal.

Investments in fleet renewal	**Percent (%)**
Not relevant to our business	54.8
Lesser extent as planned prior to COVID-19	17.9
Same extent as planned prior to COVID-19	14.3
No return as planned prior to COVID-19	9.5
Greater extent as planned prior to COVID-19	3.6
Total	100

5. CONCLUSION

COVID-19 pandemic that has appeared suddenly in China in the end of 2019, overspread all around the world very fast, in a three months period. All sectors and countries have been affected more or less and it is obviously understood that companies must scale their initiatives in accordance with the requirements of the new normal and new future accordingly.

In our study, we have executed a survey in the global maritime industry in order to present the business challenges due to the coronavirus, precautions to keep the business running and protect the health of the employees from the illness and expected developments in the post-COVID period. This study contributes the literature since to the best knowledge of the authors, the studies on maritime proficiency were low and also it provides an insight to the employees about current situation of the maritime industry. Moreover, it is significant that the respondents are not located only in a single region and research has been applied to companies located in several geographical regions. Other crucial point of the study is that authors have reached especially the decision makers in the companies since the situation was uncommon and required urgent disaster and crisis management. The situation reflects that coronavirus pandemic will exist in our lives more months even though developments in the medical sector are extremely fast. The results and the developments on pandemic show that companies used to live with this situation and act quickly in accordance with the new normal conditions, will survive successfully and take advantages of this period.

Our study has some limitations. The main limitation of this research paper is the mutation of the coronavirus rapidly, adding or losing the restrictions by the countries subject to the advances in the health sector especially for vaccines. On the other hand, in addition to the evaluation of the companies in the global maritime industry, the policies of governments and regulatory bodies during coronavirus crisis may also be examined in the future studies.

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RESEARCH ARTICLE

**An ethical committee approval and/or legal/special permission has not been required within the scope of this study.*

MANAGING PUBLIC TRANSPORT DURING COVID-19: AN ANALYSIS OF THE IMPACT AND PREVENTIVE RESPONSE IN ISTANBUL*

Muhammet DEVECİ[1]
Nezir AYDIN[2]
Ali Osman KUŞAKCI[3]

[1]National Defence University, Turkish Naval Academy, Department of Industrial Engineering, Istanbul, Turkey,
muhammetdeveci@gmail.com; ORCID: 0000-0002-3712-976X

[2]Yildiz Technical University, Department of Industrial Engineering, Istanbul, Turkey,
nzraydin@yildiz.edu.tr; ORCID: 0000-0003-3621-0619

[3]Ibn Haldun University, School of Business, Department of Management, Istanbul, Turkey,
aliosman.kusakci@ihu.edu.tr; ORCID: 0000-0003-1411-0369

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ABSTRACT

The number of passengers in public transport has decreased significantly in major cities around the world due to COVID-19. As residents of many countries work from home, they have avoided public transport to minimize their exposure to the outbreak and have changed their way of traveling within their cities due to major changes in local public transport services. Istanbul is one of the cities most affected by the pandemic in terms of the daily number of passengers using public transportation. For the first time since the pandemic started in Istanbul, the use of urban public transportation has decreased by more than 90 percent. The aim of this study is to examine the measures taken in Istanbul public transport in order to prevent the spread of the coronavirus pandemic. In addition, the trends in public transport and inter-modes demands during COVID-19 are analyzed. The results showed that COVID-19 measures to protect the health of passengers in Istanbul public transport are in line with global practices during the initial stage of the pandemic.

Keywords: *Novel Coronavirus Disease (COVID-19), Public Transportation, Protective and Health Measures, Istanbul.*

Managing Public Transport During COVID-19: An Analysis of the Impact and Preventive Response in Istanbul

COVID-19 SÜRECİNDE TOPLU TAŞIMAYI YÖNETMEK: İSTANBUL'DAKİ ETKİSİNİN VE ÖNLEYİCİ MÜDAHALENİN ANALİZİ

ÖZ

Toplu taşıma araçlarındaki yolcu sayısı, COVID-19 nedeniyle dünyanın büyük şehirlerinde önemli ölçüde azalmıştır. Birçok ülkenin vatandaşları evden çalıştıkları için, salgının etkisini en aza indirmek için toplu taşımadan kaçınmış ve toplu taşıma hizmetlerindeki aksamalar ve riskler nedeniyle seyahat tercihlerini değiştirmişlerdir. İstanbul, günlük toplu taşıma kullanan yolcu sayısı açısından pandemiden en çok etkilenen şehirlerden biridir. İstanbul'da pandeminin başlamasından bu yana ilk kez şehir içi toplu taşıma kullanımı yüzde 90'ın üzerinde azalmıştır. Bu çalışmanın amacı, Koronavirüs ile ilişkili salgının yayılmasını önlemek için İstanbul toplu taşıma araçlarında alınan önlemleri incelemektir. Makale ayrıca COVID-19 sırasında toplu taşıma ulaşım modları arasındaki talebin nasıl değiştiğini ve mevcut eğilimleri analiz etmektedir. Sonuçlar, yolcuların sağlığını korumak için İstanbul'da toplu taşıma araçlarında alınan COVID-19 önlemlerinin salgının ilk aşamasında global uygulamalarla uyumlu olduğunu göstermiştir.

Anahtar Kelimeler: *Yeni Koronavirüs Hastalığı (COVID-19), Toplu Taşıma, Koruyucu ve Sağlık Önlemleri, İstanbul.*

1. INTRODUCTION

A novel coronavirus (nCoV) disease, which causes severe acute respiratory syndrome, first reported in Wuhan/China on December 2019 (Du et al., 2020). This new coronavirus, which is named "COVID-19" by the World Health Organization (WHO), spread around the world just in a few months. About one month after the first case occurred, the epidemic is declared as a global public health disaster (Chung et al., 2020; Du et al., 2020) and as a pandemic on 11 March 2020 (He et al., 2020) by WHO. In less than five months, it is reported in all continents and in 210 countries. Since the first day (31 December 2019) of the appearance of COVID-19 and as of 01 March 2021, 112.348.223 cases and 2.484.324 deaths have been reported by ECDC (2021), whereas, happily the number of recovered cases have also increased. The daily number of reported cases and deaths by continent are shown in Fig. 1 and Fig. 2, respectively (ECDC, 2021).

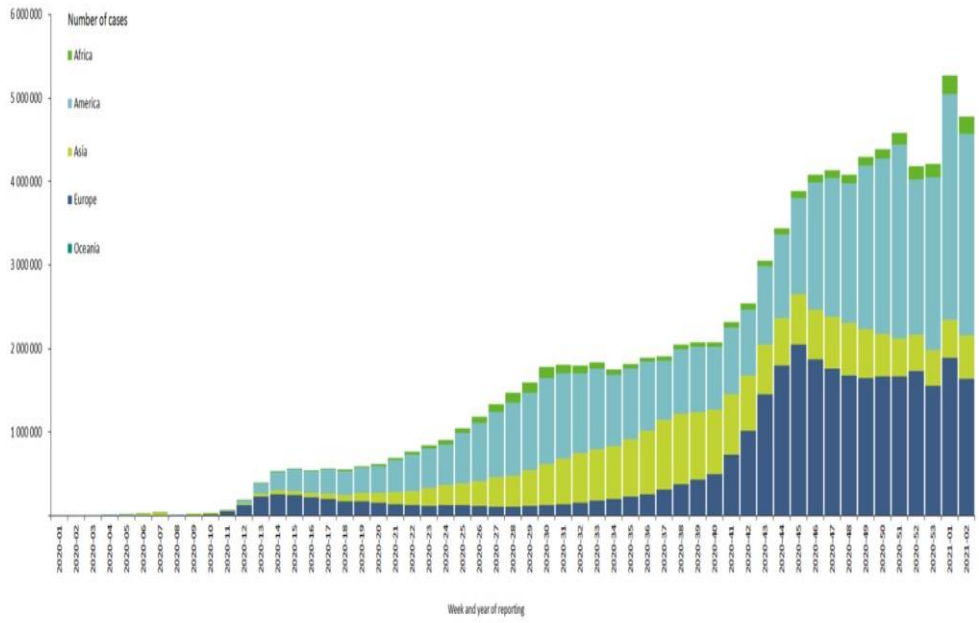


Figure 1. Number of the cases by continent, as of 23 January 2021 (European Centre for Disease Prevention and Control, 2021).

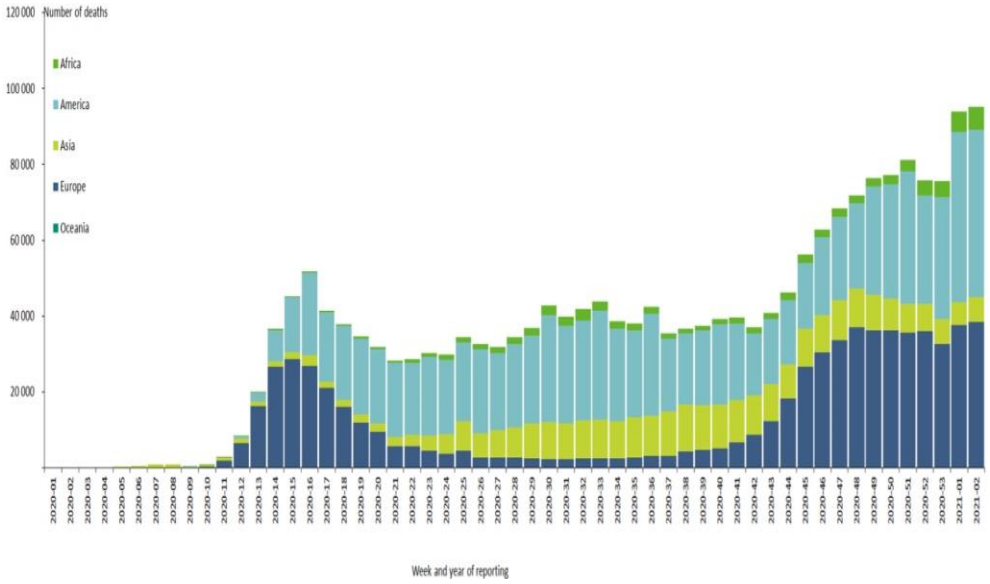


Figure 2. Number of deaths by continent, as of 23 January 2021 (European Centre for Disease Prevention and Control, 2021).

Several aspects of COVID-19 are studied from different points of views by researchers: Maleki et. (2020) forecasted the number of "confirmed" and "recovered" cases by using autoregressive time series models based on two-piece scale mixture normal distributions. Furthermore, Salgotra et al. (2020) developed genetic programming (GP) based models for the prediction of "confirmed" and "death" cases for the most affected states of India and for India as a whole. They concluded by mentioning the high reliability of the proposed models. Accordingly, Tuli et al. (2020) predicted the growth of the cases using machine learning (ML) techniques. They reported that a good prediction could be obtained by applying iterative weighting to Generalized Inverse Weibull distribution. Accurate forecasting models are highly important for managers to develop plans, such as resource utilization of health services, public transportation conditions etc., to fight against COVID-19. On the other hand, Qi et al., (2020) analyzed the spreading dynamics of the COVID-19 with daily average temperature and relative humidity in China. Jenelius and Cebecauer (2020) investigated the impacts of COVID-19 on public transport ridership in Sweden. Henser et al. (2021)

studied the impact of COVID-19 on cost outlays for car and public transport commuting for Sydney Metropolitan.

It is reported by Killerby et al., (2018) that the coronavirus shows a seasonal oscillation, which proves a robust linkage between meteorological factors and virus spread. Unfortunately, it seems that COVID-19 will continue for a while. Forecasting the growth of the pandemic is very important but taking precautions to stop its spreading is even more important to take it under control. Several precautions and quarantines have been applied for a long time by almost all countries, who are suffering from COVID-19. For instance, some of the precautions that are taken by Turkish government are reported in Kilic et al., (2020). Even these precautions helped a lot to prevent the spreading of the virus, later; governments are forced to stretch these precautions and quarantines because of economic and social issues. Once the governments let businesses start again, people had to use public transportation to go to work; even an important percent of people may start using their own private cars. It is a fact that crowded areas accelerate the spread of the virus, and public transportation is one of these crowded places especially in metropolitans such as Istanbul, Mexico City, Shanghai, New York, and Tokyo etc.

Considering the movement of millions of individuals via public transport in a day, the contacts of them seem inevitable, and these contacts will increase the spread of the pandemic if the same social life rules as before the pandemic of COVID-19 is followed. Therefore, countries, who fight against COVID-19, applied several precautions. For instance, Belgium, Portugal, Ireland and Italy rescheduled the public transport, and Slovenia and Slovakia banned or limited public transport services (Baka et al., 2020).

As a result, in order to take the pandemic under control, the management of public transport is vital for metropolitans, such as Istanbul. As being economic capital of Turkey, Istanbul is the most crowded city (TUIK, 2020) with more than 15 million residents. As shown in Fig. 3, the city is served with a wide variety of public transport modes including ferry, tram, metro, bus, and BRT. In Istanbul, approximately, 5.529.506.545 trips (more than 15 million trips in a day) take place by 12 railways/metros, 8 BRT-Bus Rapid Transit lines, more than 3000 buses, hundreds of ferries and jitneys, in a year (IETT, 2020). Therefore, this study analyzes the management of

COVID-19 in Istanbul's Public Transport and develops several precautions, designs, and suggestions. Regimented application of them led to a reasonably foreseeable trajectory of new infection and recovery cases in the city. Since the topic studied in this paper is the first research conducted on developing protective measures for public transport usage in the context of COVID-19, it is a novel study, whose contributions to the literature are very evident. Herewith, it provides a collection of examples of good-practices in public transport during the pandemic, which may inspire policy makers worldwide.

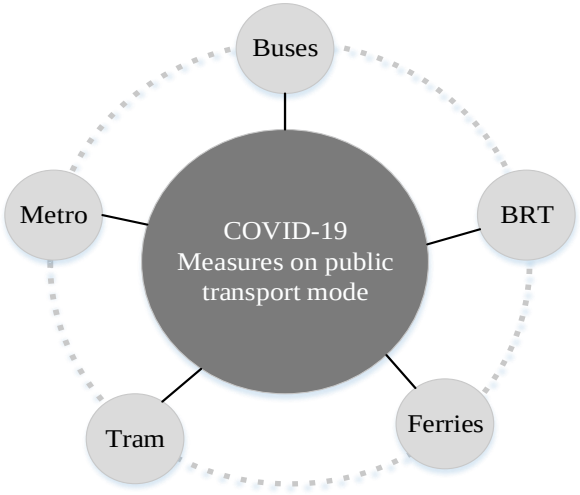


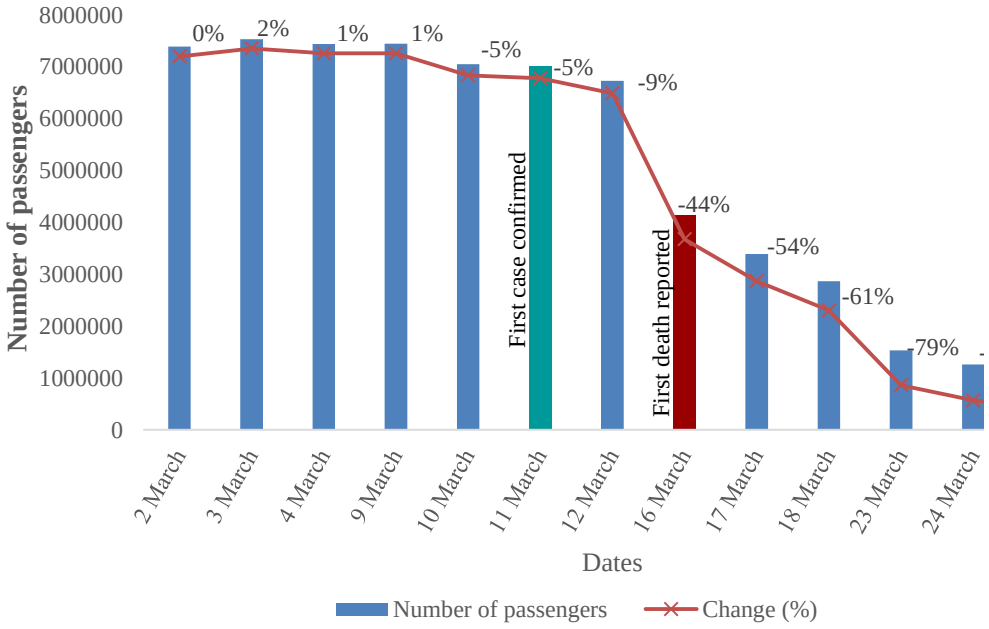
Figure 3. Istanbul public transport modes.

The rest of the paper is organized as follows: Section 2 presents the pre-COVID-19 situation of Istanbul`s public transport. The impacts of COVID-19 on Istanbul`s public transport are provided in Section 3. Section 4 delivers the protective measures on public transport in the context of COVID-19. Finally, the work and describes the future research opportunities are concluded.

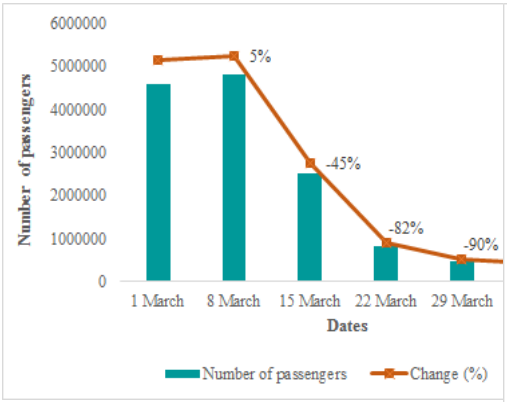
2. THE IMPACT OF COVID-19 ON THE ISTANBUL PUBLIC TRANSPORT

Being the most hit region in Turkey, self-isolation and imperative curfew practices imposed by the government, the impact of COVID-19 on the

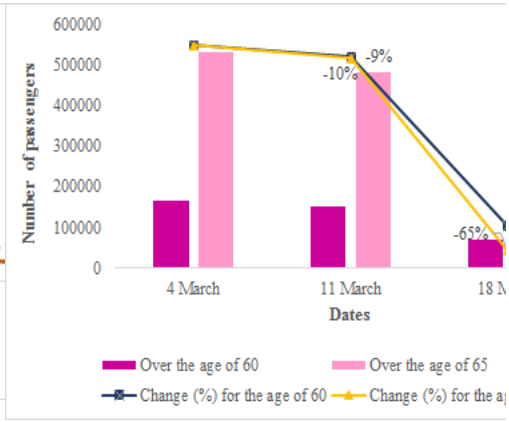
public transport in Istanbul in terms of ridership was ruinous. Fig 4 (a) shows that there is a significant decrease in demand after the first COVID-19 case on 11 March 2020. Demand for Istanbul public transport has dropped during the pandemic by as much as 85 percent. There is also a decrease again after the announcement of the first death on 16 March 2020. Fig. 4 (b) indicates the daily Sunday ridership trend. The number of passengers for those over the age of 60 and 65, who are categorized in the high risk segment, using public transport are shown in Fig. 4 (c). Older adults who have serious underlying medical conditions might be at higher risk of severe illness from COVID-19. So it is of vital importance for older adults to stay at home. Fig. 4 (d) indicates the daily Monday ridership trend. Daily demand trend between 9 and 12 March 2020 is shown in Fig. 4 (e) (IETT Statistics, 2020)



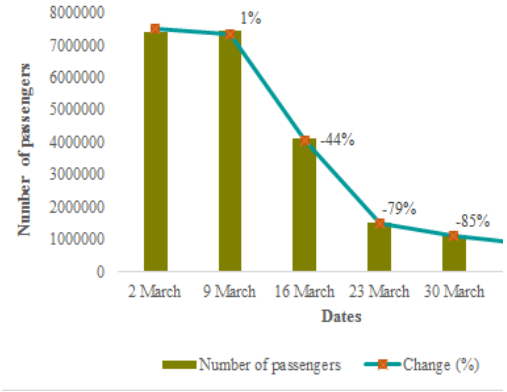
(a) Daily demand trend between 1 and 30 March 2020 (excluding weekends);



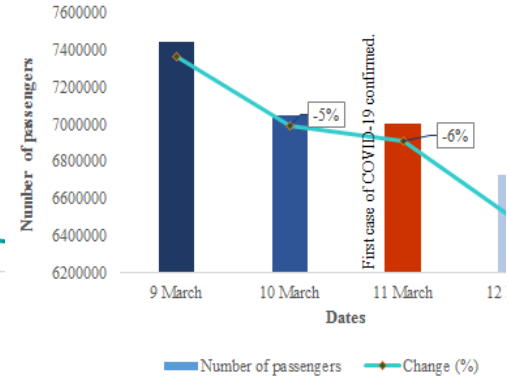
(b) Daily Sunday ridership trend;



(c) The demand trend for elderly travelers;



(d) Daily Monday ridership trend;



(e) Daily demand trend between 9 and 12 March 2020.

Figure 4. Ridership trends.

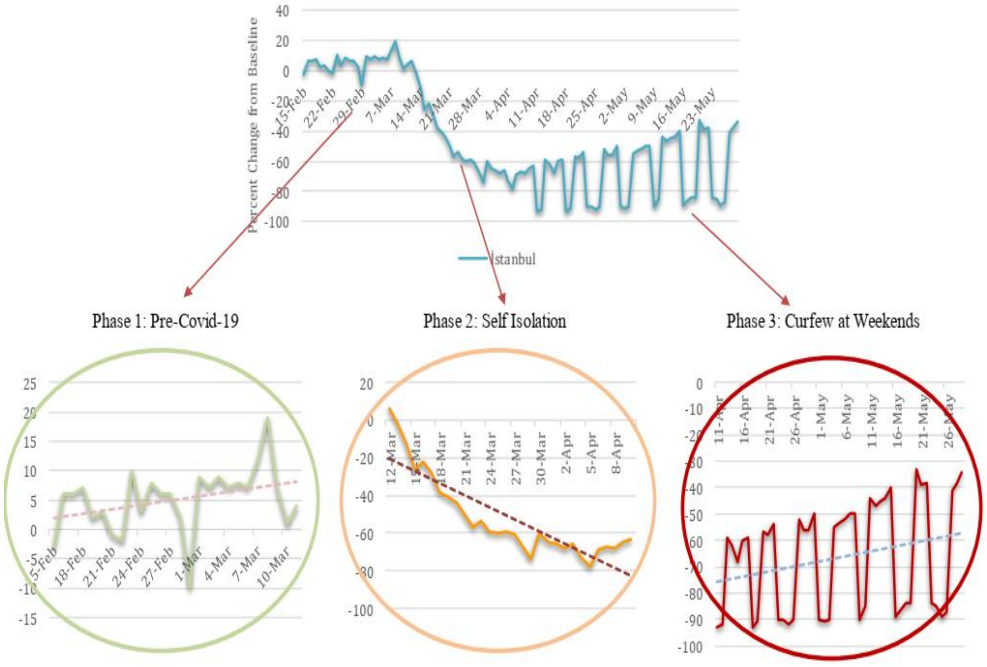


Figure 5. Percent change from baseline on transit stations in Istanbul (Google, 2020).

One of the interesting data source that needs special attention is the Google Mobility Reports (2020) which records anonymously percent changes in visits to public places compared to a baseline. The baseline for the percent change is defined as is the median value, for the corresponding day of the week, during Jan 3–Feb 6, 2020 at the respective location. One of the important dimensions of our interest in the given data is rendered from use of transit stations in the city such as subway, bus, and tram stations. Fig. 5 depicts daily percent changes on the use of public transportation during COVID-19. A closer look on the data reveals COVID-19 period, Feb. 15 to May 29, 2020 consists of three main phases, pre-COVID-19, self-isolation, and weekend curfews.

Some insights can be gained from Fig. 5 with regard to the measures taken by policy makers and their effects on Istanbul's public transportation network. At first stage, until the first case publicly denounced, there is no

indication of self-isolation and voluntary curfew as seen in pre-COVID-19 period. However, announcement of the first case, on March 12 (the end of 11 March), became a turning point where a strong negative trend in the use of public transport modes was observable. In addition, the curfew for elderly people and teenagers was strongly contributing to this negative trend. Additionally, it intensifies with voluntarily reduced activity and increased self-curfew practices during self-isolation phase. Lastly, at the third stage, law-enforced curfews at weekends successfully minimized the possible contact surfaces between people. However, a positive trend on the graph is detectable. This possibly indicates that some portion of the populations gradually softened self-imposed curfew as the spread of the virus and the number of newly infected people gradually decreases. The clear positive trend marks the weekdays where the percent change from baseline has declined from -60% to -35% in the last stage.

We also compared the mobility report data on transit stations of the most populated Turkish metropolitans, Istanbul, Ankara, and İzmir. Three cities provide an overall representative figure for the entire country with their cosmopolitan population. Despite the slight differences among the socio-economic structures and varying shares of public transportation on daily activities of mentioned cities, Fig. 6 shows that daily changes from the baseline on the use of transit stations follow almost a similar path with insignificant deviations. More precisely, all three stages, pre-COVID19, self-isolation, weekend curfews, have been experienced in a similar manner in three cities.

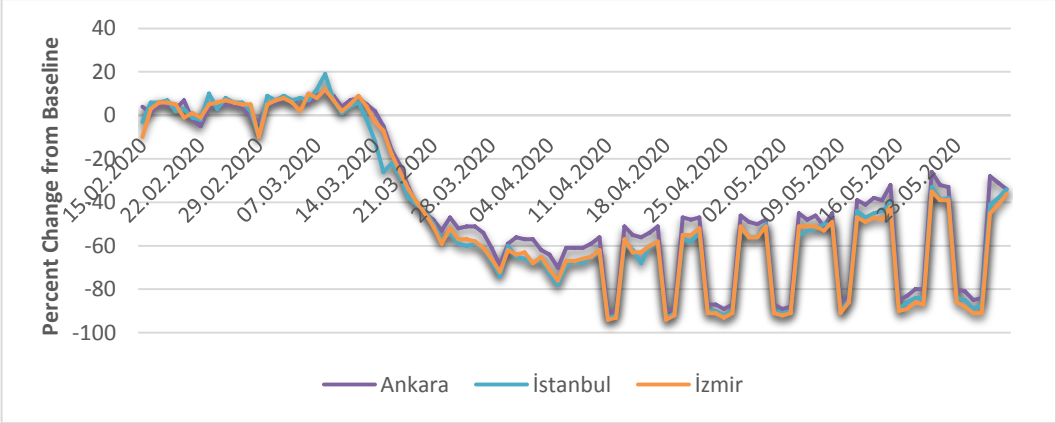


Figure 6. Comparison of three major metropolitans: İstanbul, Ankara, and İzmir (Google, 2020).

3. PROTECTIVE MEASURES IN PUBLIC TRANSPORT IN THE CONTEXT OF COVID-19

The following preventive and controlling measures in the context of COVID-19 have been taken in urban transport modes including road (buses, bus rapid transit-BRT), rail (metro, tramway, light rail, funicular) and maritime (ships, sea buses and motorboats) modes in Istanbul. Table 1 presents timetable of Istanbul's public transport measures during COVID-19 so far and how these measures have developed over time (IETT Istanbul).

Table 1. Timetable of Istanbul's public transport measures during COVID-19.

Date	Action
11 March 2020	All public transport vehicles started to be disinfected daily
18 March 2020	Free public transport for healthcare workers
19 March 2020	Temperature measurement of public transport drivers before the service
20 March 2020	Service changes due to decrease in demand
24 March 2020	Mandatory mask wearing and gloves for drivers
25 March 2020	Limited capacity usage (50%of the license capacity)
26 March 2020	Transparent protection cabinets for driver cabins in 3,000 buses Warning posters are posted to maintain social distancing on public transport
29 March 2020	Temporary bus closures due to closure of Istanbul International Sabiha Gökçen Airport. Seven bus lines (SG-1, SG-2, E-3, E-9, E-10, E-11 and MR60) have been temporarily suspended.
3 April 2020	Mandatory face masks for passengers on public transport.
4 April 2020	Temporary route closures for some of the routes due to closure of Istanbul Airport.
6 April 2020	Metro timetable is updated.
10 April 2020	Thermal camera inspection started at the BRT stations. BRT drivers started to work with protective gowns.
11-12 April 2020	Metro services has been temporarily suspended.
18-19 April 2020	Metro and tram timetables are updated due to curfew. (e.g. reduced frequency)
19 April 2020	Extra public transport services were introduced to the hospitals. 52 km route on the BRT line, all of the BRT stations and 228 BRT vehicles were cleaned/disinfected.
23-26 April 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency).
1-3 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency).
9-10 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency). Services are provided in 495 lines with a total of 8,609 trips, as well as 70 buses to hospitals.
16-19 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency). Services are provided in 494 lines with a total of 42,340 trips.
23-26 May 2020	Timetables of public transport are updated due to curfew. (e.g. reduced

	frequency). Services are provided in 498 lines with a total of 40,285 trips.
25 May 2020	The right of free public transport for all healthcare workers has been extended for another 3 months.
30-31 May 2020	Timetables of public transport are updated due to curfew. Services are provided in 498 lines with a total of 22,858 trips.
1 June 2020	Nostalgic tram services started again.
4 June 2020	Liquid hand sanitizer should be available in all vehicles. If the vehicle capacity is full, no passenger will be taken.

1. All passengers are required to wear face masks during their trips. Passengers without a face mask are not allowed in all public transport modes including bus, metro, BRT or city line ferries as illustrated in Fig. 7. In addition, drivers have to wear face masks during the pandemic.

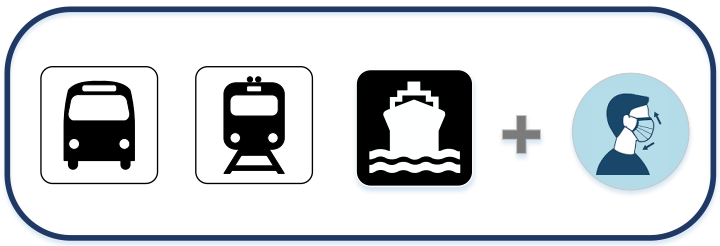


Figure 7. Obligatory face masks on Istanbul's public transport.

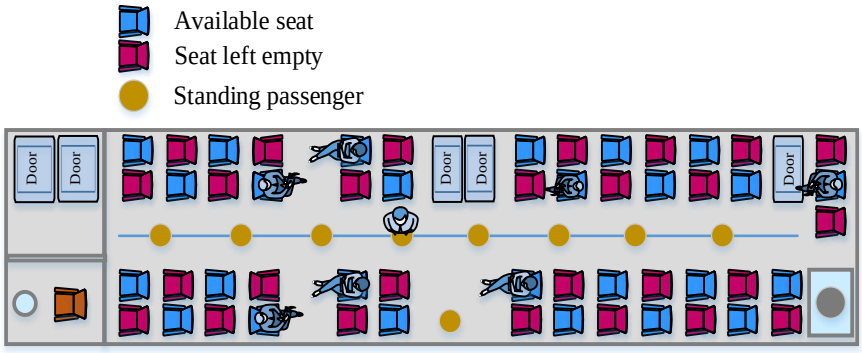
2. To protect drivers on public transport, protective equipment including masks, eye protection and gloves, must be provided to drivers. Drivers should be protected behind glass or plastic panels, as well as with protective barriers. Additionally, signs should be placed to prevent sitting near the driver.

3. The front door of the buses should be closed to protect drivers as illustrated in Fig. 8. Passengers are only allowed to get on and off using the middle and rear doors during the coronavirus pandemic.

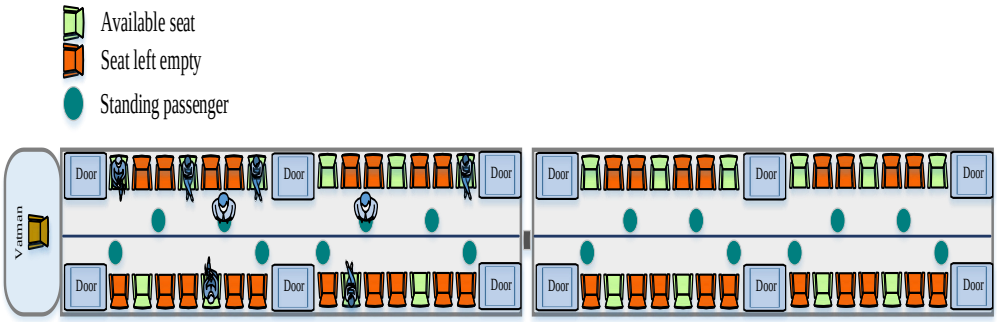
Figure 8. The front door out of use.

4. Passengers in public transport vehicles may not be able to effectively practice social distancing. Therefore, the interior of all public transport vehicles should be redesigned with caution/warning signs to ensure social distancing.

5. Social distance rules are applied in all public transport vehicles. For bus, BRT, metro and tram vehicles, the number of standing passengers should not exceed the number of seating passengers. However, the seats that are placed in a face-to-face arrangement should sit diagonally. In other words, passengers should be prevented from traveling face to face. In addition, at most one-third of the standing passenger capacity can be used in these vehicles. Labels are used to designate the points where passengers can stand as illustrated in Fig. 9.



(a) New bus design;



(b) New metro design.

Figure 9. New bus and metro design to prevent the spread of Covid-19.

6. Creation of isolated areas where suspected passengers are kept.

7. Implementing cleaning and disinfection to the interiors of vehicles, stations and equipment used by passengers. Public transport vehicles are disinfected daily before every trip and when necessary.

8. All passengers and drivers use hygienic hand sanitizers (see Fig. 10) during boarding and alighting.

Figure 10. Hand sanitizers available on stations.

9. Thermal cameras are installed at station entrances.

10. Social distancing posters should be placed at stations and bus stops. An example can be seen in Fig. 11.

Figure 11. Social distancing posters at stations and bus stops.

11. Fig. 12 shows the preference order for travels. If possible, people should continue staying at home unless they need an essential travel. If that is not possible, then people should prefer active transport modes such as walking, or cycling. If that is also not possible, then they should prefer public transport.

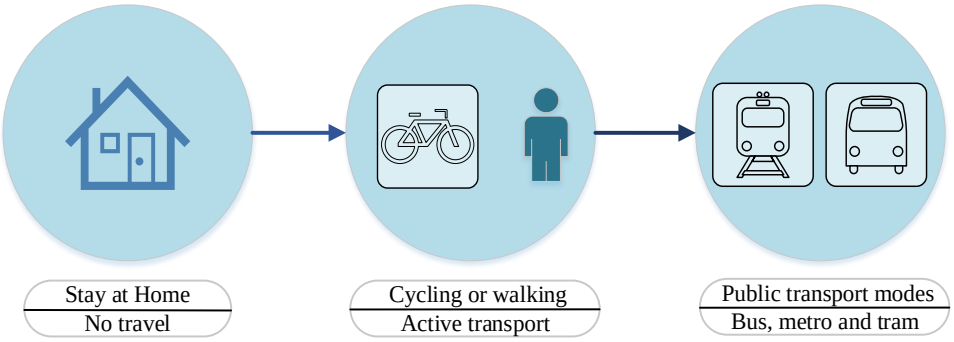


Figure 12. Preference order for travel.

12. Warning and informative videos and posters should be placed all over the stations and public transport vehicles to raise awareness about preventing the spread of coronavirus. Some examples can be seen in Fig. 13.

Figure 13. Preventive measures.

13. Updated timetables for all transport services due to significant drops in passenger demand. In addition to the measures taken by Istanbul's public transport authority, examples of measures from around the world for public transport are shown in Fig. 16.

14. Installation of cabinets that disinfect the whole body against COVID-19 at the main terminal stations as depicted in Fig. 14.

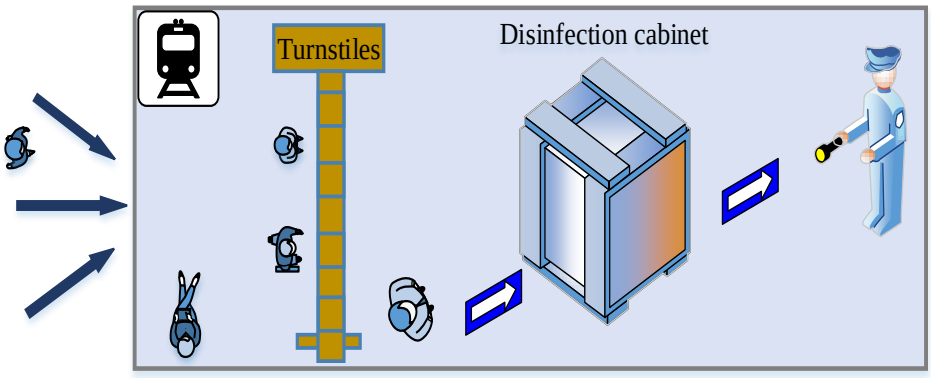


Figure 14. A disinfection cabin at station entrances.

15. In order to prevent transmission of COVID-19 through the surfaces touched often, cash payments are not allowed. Electronic cards, contactless cards, tickets or mobile tickets can be used as payment methods on public transport as shown in Fig. 15.

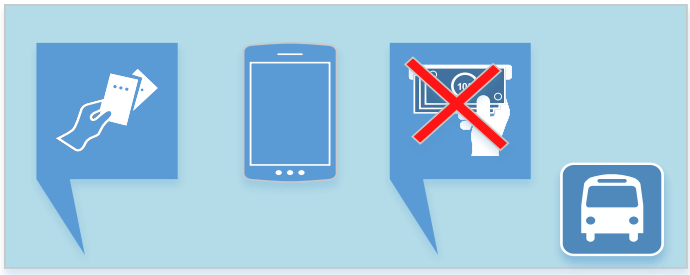


Figure 15. Non-cash payment methods.

Safety measures are implemented in Istanbul public transport against COVID-19. Fig. 16 shows a summary of actions on the Istanbul public transport has taken in response to COVID-19. These are as follows: cleaning and disinfection, social distancing measures, hygiene practices, protective gowns and thermal camera, respectively.

(a) Cleaning in BRT (Haber Turk Newspaper, 2020);

(b) Disinfection in buses (IETT Istanbul, 2020);

(c) Disinfection in buses (Sabah Newspaper, 2020);

(d) Cleaning in metro (CNN Turk, 2020);

(e) Disinfection in stations (NTV News, 2020);

(f) Disinfection in buses (Net Haber Agency, 2020);

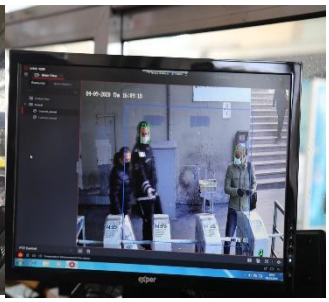
(g) Protective equipment (TRT News, 2020);

(h) Eye protection and gloves (Diken Newspaper, 2020);

(i) Social distance in metro (Diken Newspaper, 2020);

(j) Social distance in buses (HaberVer Services, 2020);

(k) Glass or plastic panels in BRT (Hurriyet Newspaper, 2020);



(l) Thermal camera in stations (Diken Newspaper, 2020).

Figure 16. Istanbul's public transport measures against COVID-19.

4. CONCLUSION

As a result of the COVID-19 outbreak, public transport providers have to make significant changes in the way they serve their customers in a rapidly developing and uncertain environment. In this context, considering the analyses conducted on the Istanbul`s public transportation as well as comparisons done, no specific difference caught between the most crowded cities in Turkey, i.e. Ankara, Izmir, in terms of public transport usage, and a strong negative trend in use of public transport modes are detected.

Furthermore, it is shown that the law-enforced curfew at weekends successfully minimizes the possible contact surfaces between passengers. However, a positive trend on line is observed. This trend, possibly, indicates that a specific percent of the people gradually softened self-imposed curfew as the spread of the virus and the number of newly infected people on daily

bases reduced. According to the analyses and researches, to take COVID-19 under control and prevent its spread several suggestions and policies are created; which are wearing face masks during the trips, redesigning interior of the vehicles as pointing out the sitting/standing areas to unsure social distancing, having drivers to wear equipment such as masks, eye protection and gloves, establishing protective barriers between drivers and passengers or stopping the usage of front doors, disinfecting interiors of the vehicles daily or even better trip basis, providing hand sanitizers on vehicles, installing thermal cameras to determine infected people, encouraging people to use their private cars or bicycles if possible instead of public transport modes, informing passengers via videos and posters on stations and vehicles, updating timetables considering the demand, establishing disinfecting cabinets on stations so that passengers can use before getting on vehicles, and encouraging passengers to use electronic cards/tickets instead of cash.

Taking into account all suggestions and policies, the Istanbul`s public transport company has successfully taken all precautions to prevent the spread of the virus of COVID-19 with no delay. It can be inferenced that taking precautions and safety measures help in stopping the spread of the COVID-19, which can be observed from the statistics on the number of cases in Istanbul. Moreover, the results show that people will increasingly use bicycles and scooters and that studies can be conducted on these issues in the future.

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RESEARCH ARTICLE

**An ethical committee approval and/or legal/special permission has not been required within the scope of this study.*

EVALUATION AND ANALYSIS OF MOBILE COMMERCE TECHNOLOGIES USING A CHOQUET INTEGRAL-BASED APPROACH*

Tufan DEMİREL[1]

[1]*Yıldız Technical University, Department of Industrial Engineering, Istanbul, Turkey,*
tdemirel@yildiz.edu.tr; ORCID: 0000-0003-3051-5067

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ABSTRACT

Mobile Commerce is any transaction that involves the transfer of ownership or rights to use goods and services, which is initiated and/or completed by using mobile access to computer-mediated networks via an electronic device. Selection among m-commerce technologies is a multi-criteria evaluation problem having many conflicting and interactive criteria. In this study, 4 main criteria, which are economic trends, social trends, technological possibilities and data security and IT security, and 14 sub-criteria are determined to evaluate m-commerce standards and technologies. Choquet integral is used to evaluate mobile commerce technologies with multiple criteria. The accuracy of the obtained results is examined through a sensitivity analysis.

Keywords: *Multi-Criteria Decision Making, M-Commerce, Choquet Integral, Sensitivity Analysis.*

Tufan DEMİREL

CHOQUET İNTEGRAL TABANLI BİR YAKLAŞIM KULLANILARAK MOBİL TİCARET TEKNOLOJİLERİNİN DEĞERLENDİRİLMESİ VE ANALİZİ

ÖZ

Mobil Ticaret, elektronik bir cihaz yardımıyla bilgisayar aracılı ağlara mobil erişim kullanılarak başlatılan ve/veya tamamlanan mal ve hizmetlerin mülkiyet veya kullanım haklarının devredilmesini içeren herhangi bir işlemdir. Mobil ticaret teknolojileri arasından seçim, birçok çelişkili ve etkileşimli kriteri olan çok kriterli bir değerlendirme problemidir. Bu çalışmada, m-ticaret standartlarını ve teknolojilerini değerlendirmek için ekonomik trendler, sosyal trendler, teknolojik olanaklar ve veri güvenliği ve BT güvenliği olmak üzere 4 ana kriter ve 14 alt kriter belirlendi. Mobil ticaret teknolojilerini çok kriterli olarak değerlendirmek için Choquet integrali kullanıldı. Elde edilen sonuçların sağlamlığı bir duyarlılık analizi ile incelendi.

Anahtar Kelimeler: *Çok Kriterli Karar Verme, M-Ticaret, Choquet İntegral, Duyarlılık Analizi.*

1. INTRODUCTION

Referring the practice of conducting financial and promotional activities, mobile commerce (m-commerce) is about the services accessible using a handheld device. Despite being based on electronic commerce (e-commerce), it is quite different than the traditional way. Involving new services, technologies and business models; it is more advanced in making interaction available in a more personalized way to a wider audience. Handheld devices have different structures than computers, providing new opportunities as well as new constraints. It also gives the ability to exchange information by connecting with objects in a more direct way which was not possible until now. Being an emerging market, m-commerce has significant opportunities and significant risks.

It is impossible to conduct m-commerce without certain technologies. The interaction between embedded technologies, such as communicating wireless information with other devices and the combination of camera and image recognition, is vital for achieving the full potential of the mobile phones. In order to satisfy user experience; high quality information display, state of art technologies and secure structure are essential. Mobile networks should be able to deal with large amounts of traffic provided by high-speed connections to improve user comfort and reactivity (GS1, 2008). Success of m-commerce is mainly based on, the availability of technologies. M-commerce is built on several key technologies. Among alternatives, we can count GSM, 3G and upper versions, Wireless Networks (Bluetooth/Wi-Fi), SMS, and MMS.

The selection among m-commerce technologies is a multiple criteria selection problem with many conflicting main and sub-criteria. Among the main criteria, we can count *Economic Trends* with its sub-criteria: prices for mobile devices, prices of the mobile services and demand factors; *Social Trends* with its sub-criteria: this the need for increased mobility, market liberalization, and increasing demand for comfort; *Technological Possibilities* with its sub-criteria: the technologies of mobile devices, interface software development, transmission rate, user-friendliness, and personalization; *Data Security and IT Security* with its sub-criteria: data protection, data security technologies and international laws and standards.

The objective of our paper is to apply Choquet integral to the multi-criteria selection among mobile commerce technologies and standards. To the best of our knowledge, this is the first paper, which applies Choquet integral to this problem. Firstly, the main and sub-criteria are decide by using the experiences of experts and academic studies in the literature and are obtained by means of a hierarchical model. Then, using the joint judgments of the experts who work in IT, E-Commerce and GSM Sector, we calculate the priorities of the main and sub-criteria of the hierarchical model with Choquet integral. After that, sensitivity analyses are conducted so as to observe the behavior of any alternative technology by changing the weights of the main criteria. Finally, the results obtained by applying the method were evaluated and interpreted.

Choquet integral, used to solve MCDM problems, is a way of measuring the expected utility of an uncertain event. Marichal et al. (2005) constructed a freeware from this method to analyze an ordinal sorting procedure to assign alternatives to graded classes. Meyer and Roubens (2006) present a multiple criteria decision support approach using a fuzzy extension of choquet integral to provide a ranking of alternatives. The Choquet integral is a flexible aggregation operator being introduced by Sugeno (1974) and it is the generalization of the max-min and ordered weighted average operators, and weighted average method (Grabisch et al., 2000). In 2012, Yang and Chen proposed new aggregation operators to reflect the correlations among the elements better (2012). Choquet integral are being used to different areas recently; such as to evaluate intensity of knowledge work in jobs (Dahooie and Arsalan, 2013), and to select supply chain partners and configuration (Ashayeri et al., 2012). Apart from Choquet Integral, various fuzzy integral approaches are being proposed (Afshari et al., 2013).

The remaining sections of this paper are organized in the following fashion: Section 2 presents general approaches about mobile commerce. The evaluation criteria of mobile commerce Technologies and Standard are defined in Section 3. Section 4 introduces some definitions and formulations related to Choquet integral. In addition, the steps of the methodology are defined in the same section. The application can be found in Section 5. The last section provides a summary of the findings, making suggestions for further research.

2. MOBILE COMMERCE: A LITERATURE REVIEW

It is clear that, the Internet and related technologies will affect peoples' lives in ways we cannot imagine (Barnes, 2002). Although the use of mobile technologies for business activities was a minor in the past, it is rapidly growing nowadays.

Having the highest accessibility rate of all IT devices, mobile phones make it possible to reach the customer anytime and anywhere (Pousttchi et al., 2002). They are already in the center of most people's lives in developed countries. Although mobile phones will continue to be used to communicate with others, as it becomes easier and cheaper to transfer larger amounts of data, they will become a device that enables users to connect, transact and innovate. Mobile phones are connective devices, enabling individuals to connect to a large variety of sources of data whenever they want, wherever they want. Mobile phones are also transactional devices that prove ideal for payments and transactions. Besides, mobile phones are intelligent devices, by means of which multiple applications can meet and fuse (GS1, 2008).

In the first decade of this millennium, mobile communications have changed from 2G/2.5G to 3G/3.5G. In consequence, according to an analysis from the University of St. Andrews, the data transfer speed has increased from 56 Kbps in 2.5G/GPRS to 384 Kbps in 3G/UMTS (2014). Today, the most widely used technology is 3.5G/HSDPA, and it has data transfer rate between 3.5 Mbps and 21 Mbps, which is similar to that of the wired Internet. Recent developments lead to an increase in the use of mobile devices, to conduct m-commerce on the mobile Web (Venkatesh et al., 2003; Ngai and Gunasekaran, 2007; Liu and Liou, 2011).

M-commerce is a subset of electronic commerce that is at least one side uses mobile communication techniques during the procurement of service (Pousttchi et al., 2002). Ngai and Gunasekaran (2007) categorize the literature on m-commerce research and present an extensive review of these studies. Earlier studies are focused on understanding m-commerce and adapting it to businesses. Mahatanankoon et al. (2005) aims to provide empirical data on consumer perception of mobile applications during the first years of m-commerce to provide useful information about the future of m-commerce to companies. Since m-commerce is all about mobility, it has a

linear relationship with the improvements in mobile phones. In 2009, Chang et al. has conducted a study about smartphone characteristics that are beneficial for m-commerce. In the recent years, with the increase of smartphone and tablet usage, m-commerce has become a priority. Therefore, studies about m-commerce have evaluated from introduction to improvement and broaden of m-commerce usage, such as analyzing the key factors for a successful adoption to different regions and different business sectors (Al Hosni et al., 2010; Christou and Kassianidis, 2010; Chong et al., 2012). Also there are studies using MCDM methods, especially fuzzy analytic approaches in customer oriented research (Buyukozkan, 2009; Kabir and Hasin, 2011). In 2015, Cai et al. proposed an entropy-robust optimization model for m-commerce systems.

O'Donnell et al. (2007) conducts a research on the challenges and issues, arisen mainly from regulations and legal issues, in wireless-based projects with multiple organizations. Liu and Liou (2011) explain a hybrid multiple channel method in addressing the knowledge scarcity about the new channel users' consumption behavior.

One of the main problems in mobile commerce is the user's trust to the service provided. Varnali and Toker stated that in adopting mobile services, trust issue is a major barrier which should be dealt with (2010). These issues have motivated researchers to focus on the trust factor in the mobile context. Trust's importance in m-commerce has been supported in the study of Karjaluoto et al., stating that it has positive influence on both the impulsion to receive messages and the opinion toward mobile advertising (2008). In addition, Zhang and Mao found that predicted by psychological disposition and perceived ease of use, trust increases behavioral tendency to accept advertisement both directly and indirectly through the usage of SMS advertising (2008). According to Wang et al. (2015), in order rates per year rise owing to mobile devices since more and more customers are adopting mobile shopping. Omar et al. (2021), state that global m-commerce sales were £1.76 trillion in 2019 and are estimated to reach £2.21 trillion in 2020 according to Statista (2020).

3. MOBILE COMMERCE TECHNOLOGIES AND EVALUATION CRITERIA

In the following, the alternative m-commerce technologies and the evaluation criteria are explained. These alternatives and criteria will be used in the application section.

3.1. Alternative Technologies

Several standards held communication of mobile devices with the supporting network. The most influential standards are (GS1, 2008; Barnes, 2002):

GSM (A_1): The most used standard for mobile phones in the world is Global System for Mobile communication, which is estimated that 82% of the global mobile market. General Packet Data Service (GPRS) is a GSM standard wireless protocol offering continuous access to data networks. The speed can rise to a maximum of 56 kbit/s (GS1, 2008). It allows end users to access mobile Internet services even in the lack of 3G networks. In the recent years, Enhanced GPRS (EGPRS) or Enhanced Data rates for Global Evolution (EDGE), which is a higher bandwidth version of GPRS and an evolution of GSM, are still being widely used in the regions where 3G is not operating efficiently. EDGE meets the requirements for a 3G network but is named as 2.75G due to its limited capacity.

3G and Upper Versions (A_2): 3G, the third generation of mobile phone standards and technology, offers users a wider range of services by providing greater and more efficient network capacity. The high speeds will provide multimedia applications with high bandwidth usage. Universal Mobile Telecommunications System (UMTS) is one of the third-generation (3G) mobile phone technologies. High-Speed Packet Access (HSPA) extends and improves the performance of existing UMTS protocols, with collecting various mobile protocols. Fourth generation (4G), which is already being used in some regions of the world, is planned to have higher transmission rates (at least 100 Mbits/sec).

Wireless Networks (Bluetooth/Wi-Fi) (A_3): Wireless networks, i.e. Bluetooth or Wi-Fi, are an alternative communication technology since mobile phones support several technologies at once.

SMS (A_4): Using standardized communication protocols, Short Message Service is a text messaging service which allows mobile phones to exchange short text messages.

MMS (A_5): Multimedia Messaging Service (MMS) is an extension of SMS, including multimedia content over a cellular network. It extends SMS capability, allowing text messages greater than 160 characters. MMS can also deliver a variety of media such as video, image, or audio.

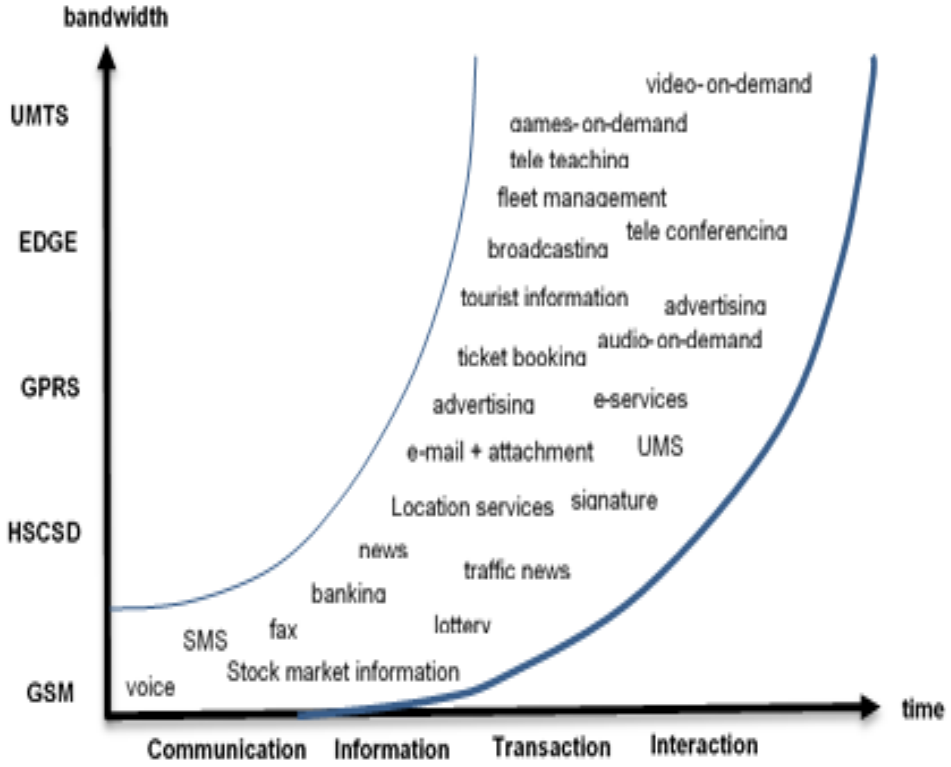

Figure 1. Diffusion of mobile services.

Figure 1 shows the relationships among network technologies and mobile applications, depending on time and bandwidth (Buellingen and Woerter, 2004).

3.2. Main and Sub-Criteria for the Evaluation of M-commerce Technologies

4 main criteria and 14 sub-criteria are used for evaluating m-commerce standards and Technologies in this paper. These criteria were selected from the studies of Buellingen and Woerter (2004), Anckar and D'Incau (2002), Abdelkarim and Nasereddin (2010), and Alturaigi and Altameem (2015). In addition, the opinions of experts in the e-commerce sector are also taken into account. The main and sub-criteria are explained below:

Economic Trends (ET): Under the economic trend criterion, four sub-criteria are defined: prices for mobile devices (ET_1), prices of the mobile services (ET_2) and demand factors (ET_3). Both prices of mobile devices and prices of mobile services are separate price-based criteria. The demand factor is a criterion that expresses the need for mobile commerce and mobile services.

Social Trends (ST): This main criterion defines the need for increased mobility (ST_1), market liberalization (ST_2) and increasing demand for comfort (SC_3). The demand for mobility is a leading force behind mobile banking, entertainment and marketing, and supported by the uniting world of computers and mobile devices. Comfort is the ability to access business activities anytime anywhere.

Technological Possibilities (TP): It is a main criterion defining the technologies of mobile devices (TP_1), interface software development (TP_2), transmission rate (TP_3), user-friendliness (TP_4) and personalization (TP_5). The first criterion refers to the compliance between the mobile device technologies and mobile commerce. Interface software development allows an interaction between users, and mobile commerce and device. The transmission rate is an important factor for mobile communication. User-friendliness explains the ability to access business activities and communication services with ease of use. Personalization provides time saving, comfort, and timeliness of information, flexibility and reduced search cost in the mobile commerce (Buellingen and Woerter 2004). It can be said that mobile devices could become the primary e-commerce tool for delivering personalized information, products, and services; even though

consumer personalization applications on mobile devices are still limited (Abdelkarim and Nasereddin, 2010).

Data Security and IT Security (ITS): It is a main criterion that defines data protection (ITS_1), data security technologies (ITS_2) and international laws and standards (ITS_3). Data protection is a vital condition in perfecting mobile business processes. Data security technologies contain data masking, backups, and hardware-based mechanisms for protecting data, disk encryption and data erasure.

A hierarchical structure for m-commerce technologies and standards is illustrated in Figure 2, employing the main and sub-criteria explained above.

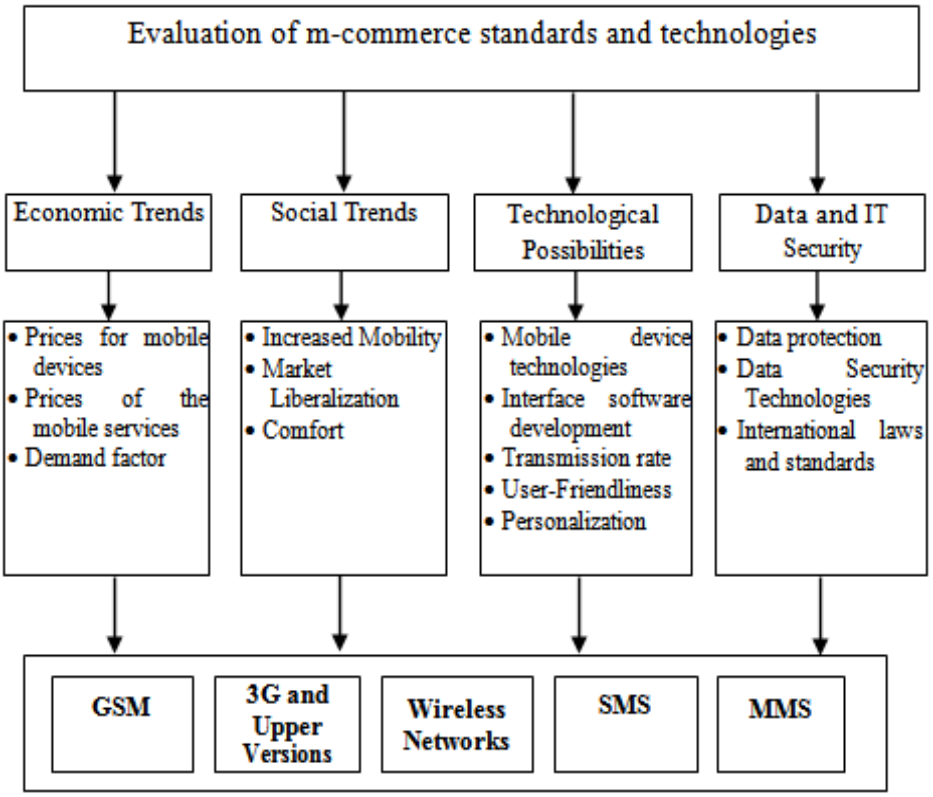

Figure 2. The hierarchy of the mobile commerce technologies and standards.

4. CHOQUET INTEGRAL METHOD

One of the methods used to solve MCDM problems is the Choquet integral. With this method, the expected benefit of an uncertain event can be measured. Academicians have developed many techniques for MCDM problems and solved problems in many different areas with these methods (Chang, 1996; Mikhailov, 2002; Kahraman et al., 2004; Gu and Zhu, 2006; Wang et al., 2008; Deveci et al., 2018; Khan et al., 2021). Our methodology follows Tsai and Lu's (2006) approach to Auephanwiriyakul et al. 2002).

The methodology is as follows (Tsai and Lu, 2006; Demirel et al., 2010; Çetin Demirel et al., 2017):

Step 1. Conducting a survey to obtain linguistic preferences. To quantify all linguistic terms for tolerance range, perceived performance levels of alternative m-commerce technologies and degree of importance; trapezoidal fuzzy numbers are used.

Linguistic terms given by respondent t for criteria i is identified as $\tilde{A}_i^t = (a_{i1}^t, a_{i2}^t, a_{i3}^t, a_{i4}^t)$, perceived performance levels by $\tilde{P}_i^t = (p_{i1}^t, p_{i2}^t, p_{i3}^t, p_{i4}^t)$, and the tolerance zone by $\tilde{e}_i^t = (e_{i1}^t, e_{i2}^t, e_{i3}^t, e_{i4}^t)$.

The average of the values obtained from more than one expert is calculated by Eq.(1).

$$\widetilde{A}_i = \frac{\sum_{t=1}^{k} \widetilde{A}_i^t}{k} = \left(\frac{\sum_{t=1}^{k} a_{i1}^t}{k}, \frac{\sum_{t=1}^{k} a_{i2}^t}{k}, \frac{\sum_{t=1}^{k} a_{i3}^t}{k}, \frac{\sum_{t=1}^{k} a_{i4}^t}{k} \right) \quad \textbf{(1)}$$

Step 2. Normalize the alternative technology value for each criterion using Eq. (2).

$$\widetilde{f}_i = \bigcup_{\alpha \in [0,1]} \bar{f}_i^{\alpha} = \bigcup_{\alpha \in [0,1]} [f_{i,\alpha}^{-}, f_{i,\alpha}^{+}] \quad \textbf{(2)}$$

Where $f_i \in F(s)$ is a fuzzy-valued function, $\tilde{F}(S)$ is the set of all fuzzy-valued functions and $f, f_i^{\alpha} = [f_{i,\alpha}^{-}, f_{i,\alpha}^{+}] = \frac{\bar{p}_i^{\alpha} - \bar{e}_i^{\propto} + [1,1]}{2}$, $\bar{p}_i^{\propto}, \bar{e}_i^{\propto}$ are α-level cuts of $\bar{p}_i^{\propto}$ and $\bar{e}_i^{\propto}$ for all $\propto = [0,1]$.

Step 3. Use Eq.(3) to calculate the alternative technology value of dimension *j*.

$$(C)\int \tilde{f} d\tilde{g} = \bigcup_{\alpha=[0,1]} \left[(C)\int f_{\alpha}^{-} dg_{\alpha}^{-}, (C)\int f_{\alpha}^{+} dg_{\alpha}^{+}, \right] \quad \textbf{(3)}$$

Where $\bar{g}_i : P(S) \to I(R^{+}), \bar{g}_i = [g_i^{-}, g_i^{+}], \quad \bar{g}_i^{\alpha} = [g_{i,\alpha}^{-}, g_{i,\alpha}^{+}]$,

$\bar{f}_i : S \to I(R^{+}),$ and $f_i = [f_i^{-}, f_i^{+}]$ for i=1, 2, 3, ..., n_j.

For this alternative technology value to be calculated, a λ value and the fuzzy measures *g(A(i)), i*=1,2,...,n, are needed. These can be obtained from the following Eqs. (4), (5), and (6) (Sugeno 1974; Ishii and Sugeno 1985):

$$g(A_{(n)}) = g(\{s_{(n)}\}) = g_n \quad \textbf{(4)}$$

$$g(A_{(i)}) = g_i + g(A_{(i+1)}) + \lambda g_i g(A_{(i+1)}), \qquad \text{where } 1 \le i < n \quad \textbf{(5)}$$

$$1 = g(S) = \begin{cases} 1/\lambda \left\{ \prod_{i=1}^{n} [1 + \lambda g(A_i)] - 1 \right\} & \text{if } \lambda \neq 0 \\ \sum_{i=1}^{n} g(A_i) & \text{if } \lambda = 0 \end{cases} \quad \textbf{(6)}$$

Where, $A_i \cap A_j = \emptyset$ for all *i, j* = 1,2,3,…,n and $i \neq j$, and $\lambda \epsilon (-1, \infty]$.
Let μ be a fuzzy measure on $(I, P(I))$ and an application $f: I \to \Re^{+}$.

The Choquet integral of f with regard to μ is defined by:

$$(C)\int_I f d\mu = \sum_{i=1}^{n}\left(f\left(\sigma(i)\right) - f\left(\sigma(i-1)\right)\right)\mu\left(A_{(i)}\right) \quad \textbf{(7)}$$

Where σ is a permutation of the indices in order to have $f\left(\sigma(1)\right) \leq \cdots \leq f\sigma(n)), A_{(i)} = \{\sigma(i), \ldots, \sigma(n)\}$ and $f\left(\sigma(0)\right) = 0$ by convention.

Step 4. Use a hierarchical process to aggregate all dimensional performance levels of the technology alternatives into overall performance levels, applying the two-stage aggregation process of the generalized Choquet integral. This is represented in Eq. (8). The overall performance levels yield a fuzzy number, $\widetilde{V}$.

$$\left.\begin{array}{lll} sub\ criteria: \begin{Bmatrix} ET1 \\ ET2 \\ ET3 \end{Bmatrix} \rightarrow & main\ criterion_1: & ET = (C)\int f_1 dg \\ \vdots & \vdots & \\ sub\ criteria: \begin{Bmatrix} ITS1 \\ ITS2 \\ ITS3 \end{Bmatrix} \rightarrow & main\ criterion_4: & ITS = (C)\int f_4 dg \end{array}\right\rangle Overall\ Value_1: A_1 = (C)\int f dg \quad \textbf{(8)}$$

Step 5. Assuming the membership of $\widetilde{V}$ is $\mu_{\tilde{v}}(x)$; the fuzzy number $\widetilde{V}$ is defuzzified into a crisp value *v* by using Eq. (9), and a comparison of the overall performance levels of alternative m-commerce technologies is made. Finally, weak and advantageous criteria among the technology alternatives are compared using Eq.(1).

$$F\left(\widetilde{A}\right) = \frac{a_1 + a_2 + a_3 + a_4}{4} \quad \textbf{(9)}$$

5. APPLICATION

This study aims to evaluate the alternatives of m-commerce technologies with regard to some conflicting criteria. The hierarchy in Section 3 was established by experts from IT (3 experts), E-Commerce (2 experts), and GSM (3 experts). These eight experts confirmed the criteria and sub-criteria and decided to use the evaluation scale in Table 1 (Delgado et al., 1998). Considering the experiences and positions of the field experts, it was accepted that all of them were of equal importance. Arithmetic mean was used in calculating the mean of the mathematical equivalents of the linguistic expressions obtained from the experts (Tsai and Lu, 2006).

Table 1. A nine-linguistic-term scale representing the relationship between trapezoidal fuzzy numbers and degrees of linguistic importance.

Low/High Levels		The degrees of importance		Trapezoidal
Label	Linguistic terms	Label	Linguistic terms	fuzzy numbers
EL	Extra Low	EU	Extra Unimportant	(0,0,0,0)
VL	Very Low	VU	Very Unimportant	(0,0.01,0.02,0.07)
L	Low	U	Unimportant	(0.04,0.1,0.18,0.23)
SL	Slightly Low	SU	Slightly Unimportant	(0.17,0.22,0.36,0.42)
M	Middle	M	Middle	(0.32,0.41,0.58,0.65)
SH	Slightly High	SI	Slightly Important	(0.58,0.63,0.8,0.86)
H	High	HI	High Important	(0.72,0.78,0.92,0.97)
VH	Very High	VI	Very Important	(0.93,0.98,0.98,1.0)
EH	Extra High	EI	Extra Important	(1,1,1,1)

The data are obtained that the individual importance of main and sub-criteria and their tolerance zones from the experts. While obtaining data from experts, experts make linguistic evaluations. Table 2 shows these data that were obtained from an expert.

Table 3 presents the average results that were evaluated by experts. Each expert's individual evaluations are combined by calculating the arithmetic mean of these numerical values by Eq.(1) in Step 1.

Table 2. Individual importance of criteria, tolerance zones, and an expert's linguistic evaluation of each m-commerce technology.

Main Criteria	Sub-Criteria	Individual importance of criteria	The Tolerance Zone	M-Commerce Technologies and Standards				
				GSM	3G and Upper Version	Wireless Networks	SMS	MMS
Economic Trends		H						
	Prices of mobile devices	H	[VL, H]	VL	M	M	VL	H
	Prices of the mobile services	VH	[M, SH]	H	H	SH	H	M
	Demand factors	M	[SL,VH]	M	VH	VH	SH	SL
Social Trends		M						
	Increased mobility	VH	[M,VH]	SH	VH	H	M	SH
	Market liberalization	SL	[M, EH]	H	EH	VH	M	M
	Comfort	M	[M, EH]	M	EH	L	M	SH
Technological Possibilities		VH						
	Technologies of mobile devices	EH	[M, EH]	M	EH	EH	M	SH
	Interface software development	VH	[M,VH]	SL	EH	VH	SL	M
	Transmission rate	M	[L, VH]	VL	EH	VH	L	VH
	User-friendliness	SH	[L,H]	M	H	SL	L	SL
	Personalization	H	[L, H]	L	H	L	H	H
Data and IT Security		EH						
	Data protection	H	[M, H]	M	SH	H	M	M
	Data security technologies	VH	[M, VH]	M	VH	H	H	H
	International laws and standards	VH	[M, H]	M	EH	H	M	M

The tolerance zones indicated in Table 3 have been obtained as follows: The first two numerical values of the lower linguistic value of a tolerance zone

in Table 3 are combined with the last two numerical values of the upper linguistic value of the same tolerance zone. If the tolerance zone is [(0.01,0.04,0.07,0.12), (0.59,0.66,0.81,0.86)], then the combined tolerance zone is (0.01, 0.04, 0.81, 0.86).

Table 3. The average results for Choquet Integral which are evaluated by eight experts.

Criteria	Individual importance	The Combined Tolerance Range	Perceived Performance Levels of Alternative Technologies				
			A_1	A_2	A_3	A_4	A_5
ET	(0.79,0.85,0.94,0.98)						
ET1	(0.4,0.47,0.62,0.68)	(0.01,0.04,0.81,0.86)	(0.07,0.11,0.19,0.24)	(0.27,0.35,0.51,0.57)	(0.36,0.42,0.58,0.64)	(0.01,0.04,0.07,0.12)	(0.59,0.66,0.81,0.86)
ET2	(0.61,0.67,0.79,0.84)	(0.27,0.35,0.84,0.9)	(0.63,0.68,0.84,0.9)	(0.63,0.68,0.84,0.9)	(0.41,0.48,0.65,0.72)	(0.4,0.47,0.62,0.68)	(0.41,0.48,0.65,0.72)
ET3	(0.77,0.8,0.86,0.88)	(0.27,0.35,0.99,1)	(0.66,0.72,0.83,0.87)	(0.95,0.99,0.99,1)	(0.61,0.67,0.79,0.84)	(0.49,0.56,0.73,0.79)	(0.49,0.54,0.69,0.75)
ST	(0.45,0.53,0.69,0.76)						
ST1	(0.95,0.99,0.99,1)	(0.27,0.35,0.94,0.98)	(0.49,0.56,0.73,0.79)	(0.79,0.85,0.94,0.98)	(0.4,0.47,0.62,0.68)	(0.41,0.48,0.65,0.72)	(0.49,0.56,0.73,0.79)
ST2	(0.13,0.18,0.3,0.36)	(0.27,0.35,0.99,1)	(0.72,0.78,0.92,0.97)	(0.95,0.99,0.99,1)	(0.74,0.8,0.9,0.94)	(0.27,0.35,0.51,0.57)	(0.49,0.56,0.73,0.79)
ST3	(0.45,0.53,0.69,0.76)	(0.31,0.38,0.99,1)	(0.54,0.61,0.77,0.83)	(0.95,0.99,0.99,1)	(0.36,0.43,0.56,0.62)	(0.41,0.48,0.65,0.72)	(0.49,0.56,0.73,0.79)
TP	(0.84,0.87,0.93,0.95)						
TP1	(0.98,0.99,0.99,1)	(0.27,0.35,0.99,1)	(0.27,0.35,0.51,0.57)	(0.98,0.99,0.99,1)	(0.88,0.92,0.97,0.99)	(0.54,0.61,0.77,0.83)	(0.61,0.67,0.79,0.84)
TP2	(0.95,0.99,0.99,1)	(0.31,0.36,0.99,1)	(0.35,0.41,0.55,0.6)	(0.95,0.99,0.99,1)	(0.79,0.85,0.94,0.98)	(0.36,0.42,0.58,0.64)	(0.54,0.61,0.77,0.83)
TP3	(0.52,0.6,0.71,0.77)	(0.06,0.08,0.97,0.99)	(0.07,0.11,0.19,0.24)	(0.77,0.8,0.91,0.94)	(0.88,0.92,0.97,0.99)	(0.12,0.17,0.26,0.32)	(0.73,0.79,0.85,0.88)
TP4	(0.63,0.68,0.84,0.9)	(0.18,0.24,0.96,0.99)	(0.49,0.56,0.73,0.79)	(0.86,0.91,0.96,0.99)	(0.36,0.42,0.58,0.64)	(0.18,0.24,0.37,0.43)	(0.27,0.35,0.51,0.57)
TP5	(0.79,0.85,0.94,0.98)	(0.07,0.11,0.96,0.99)	(0.31,0.38,0.52,0.58)	(0.79,0.85,0.94,0.98)	(0.07,0.11,0.19,0.24)	(0.86,0.91,0.96,0.99)	(0.74,0.8,0.9,0.94)
ITS	(0.88,0.92,0.97,0.99)						
ITS1	(0.67,0.73,0.88,0.93)	(0.27,0.35,0.88,0.93)	(0.27,0.35,0.51,0.57)	(0.49,0.56,0.73,0.79)	(0.67,0.73,0.88,0.93)	(0.27,0.35,0.51,0.57)	(0.32,0.41,0.58,0.65)
ITS2	(0.86,0.91,0.96,0.99)	(0.45,0.53,0.99,1)	(0.45,0.53,0.69,0.76)	(0.95,0.99,0.99,1)	(0.86,0.91,0.96,0.99)	(0.72,0.78,0.92,0.97)	(0.67,0.73,0.88,0.93)
ITS3	(0.95,0.99,0.99,1)	(0.54,0.61,0.99,1)	(0.54,0.61,0.77,0.83)	(0.95,0.99,0.99,1)	(0.86,0.91,0.96,0.99)	(0.54,0.61,0.77,0.83)	(0.54,0.61,0.77,0.83)

Table 4 and Table 5 illustrate the evaluation results by the generalized Choquet integral for α=0 and α=1. For the sub-criteria, Eq.(2) is used. Eq.(3) is used for the main criteria. In Table 4, for instance, the value [0.105, 0.615] of "alternative 1 and sub-criterion ET1" is obtained in this way:

$$f, f_i^{\alpha} = \left[f_{i,\alpha}^{-}, f_{i,\alpha}^{+}\right] = \frac{[0.07,0.24] - [0.01,0.86] + [1,1]}{2} = [0.105,0.615]$$

The aggregated Choquet integral values for the main criterion ET are calculated as follows. Tables 4 and 5 demonstrate the normalized discrepancies and alternative technology values (Choquet integrals).

$$(C)\int f^{-}_{\alpha=0} dg^{-}_{\alpha=0} \quad = 0.3401$$

$$(C)\int f^{+}_{\alpha=0} dg^{+}_{\alpha=0} \quad = 0.8108$$

That is,

$$(C)\int \tilde{f} d\tilde{g} = [0.3401, 0.8108]$$

Table 4. Evaluation results by the generalized Choquet Integral for α=0.

Criteria	**Individual importance of criteria** $[g_i^{-}, g_i^{+}]$	**The normalized discrepancy** $\bar{f}_i = [f_i^{-}, f_i^{+}]$ **and alternative technology value** $[(C)\int f^{-}\mathrm{d}g^{-}, (C)\int f^{+}\mathrm{d}g^{+}]$				
		A_1	**A_2**	**A_3**	**A_4**	**A_5**
ET		[0.3401, 0.8108]	[0.4417, 0.8586]	[0.2932, 0.8036]	[0.2396, 0.7519]	[0.2969, 0.8654]
ET_1	[0.4,0.68]	[0.105,0.615]	[0.205,0.78]	[0.25,0.815]	[0.075,0.555]	[0.365,0.925]
ET_2	[0.61,0.84]	[0.365,0.815]	[0.365,0.815]	[0.255,0.725]	[0.25,0.705]	[0.255,0.725]
ET_3	[0.77,0.88]	[0.33,0.8]	[0.475,0.865]	[0.305,0.785]	[0.245,0.76]	[0.245,0.74]
ST		[0.2745, 0.7924]	[0.4414, 0.8586]	[0.2296, 0.7518]	[0.2138, 0.725]	[0.2545, 0.76]
ST_1	[0.95,1]	[0.255,0.76]	[0.405,0.855]	[0.21,0.705]	[0.215,0.725]	[0.255,0.76]
ST_2	[0.13,0.36]	[0.36,0.85]	[0.475,0.865]	[0.37,0.835]	[0.135,0.65]	[0.245,0.76]
ST_3	[0.45,0.76]	[0.27,0.76]	[0.475,0.845]	[0.18,0.655]	[0.205,0.705]	[0.245,0.74]
TP		[0.222, 0.8]	[0.4897, 0.9547]	[0.4422, 0.9408]	[0.4004, 0.9564]	[0.3674, 0.9345]
TP_1	[0.98,1]	[0.135,0.65]	[0.49,0.865]	[0.44,0.86]	[0.27,0.78]	[0.305,0.785]
TP_2	[0.95,1]	[0.175,0.645]	[0.475,0.845]	[0.395,0.835]	[0.18,0.665]	[0.27,0.76]
TP_3	[0.52,0.77]	[0.04,0.59]	[0.39,0.94]	[0.445,0.965]	[0.065,0.63]	[0.37,0.91]
TP_4	[0.63,0.9]	[0.25,0.805]	[0.435,0.905]	[0.185,0.73]	[0.095,0.625]	[0.14,0.695]
TP_5	[0.79,0.98]	[0.16,0.755]	[0.4,0.955]	[0.04,0.585]	[0.435,0.96]	[0.375,0.935]
ITS		[0.2678, 0.655]	[0.475, 0.7748]	[0.43, 0.8258]	[0.3474, 0.7589]	[0.3259, 0.7395]
ITS_1	[0.67,0.93]	[0.17,0.65]	[0.28,0.76]	[0.37,0.83]	[0.17,0.65]	[0.195,0.69]
ITS_2	[0.86,0.99]	[0.225,0.655]	[0.475,0.775]	[0.43,0.77]	[0.36,0.76]	[0.335,0.74]
ITS_3	[0.95,1]	[0.27,0.645]	[0.475,0.73]	[0.43,0.725]	[0.27,0.645]	[0.27,0.645]

Table 5. Evaluation results by the generalized Choquet Integral for α=1.

Criteria	**Individual importance of criteria** $[g_i^-, g_i^+]$	**The normalized discrepancy** $\bar{f}_i = [f_i^-, f_i^+]$ **and alternative technology value** $[(C)\int f^- \mathrm{d}g^-, (C)\int f^+ \mathrm{d}g^+]$				
		A_1	**A_2**	**A_3**	**A_4**	**A_5**
ET		[0.3932, 0.7406]	[0.478, 0.8093]	[0.3354, 0.7475]	[0.2983, 0.6799]	[0.3622, 0.8023]
ET_1	[0.47,0.62]	[0.15,0.575]	[0.27,0.735]	[0.305,0.77]	[0.115,0.515]	[0.425,0.885]
ET_2	[0.67,0.79]	[0.42,0.745]	[0.42,0.745]	[0.32,0.65]	[0.315,0.635]	[0.32,0.65]
ET_3	[0.8,0.86]	[0.365,0.74]	[0.5,0.82]	[0.34,0.72]	[0.285,0.69]	[0.275,0.67]
ST		[0.3253, 0.7209]	[0.4829, 0.8073]	[0.2898, 0.6766]	[0.2698, 0.6498]	[0.3097, 0.6898]
ST_1	[0.99,0.99]	[0.31,0.69]	[0.455,0.795]	[0.265,0.635]	[0.27,0.65]	[0.31,0.69]
ST_2	[0.18,0.3]	[0.395,0.785]	[0.5,0.82]	[0.405,0.775]	[0.18,0.58]	[0.285,0.69]
ST_3	[0.53,0.69]	[0.31,0.695]	[0.5,0.805]	[0.22,0.59]	[0.245,0.635]	[0.285,0.675]
TP		[0.2712, 0.7375]	[0.5, 0.9139]	[0.471, 0.9058]	[0.4502, 0.9121]	[0.4143, 0.8911]
TP_1	[0.99,0.99]	[0.18,0.58]	[0.5,0.82]	[0.465,0.81]	[0.31,0.71]	[0.34,0.72]
TP_2	[0.99,0.99]	[0.21,0.595]	[0.5,0.815]	[0.43,0.79]	[0.215,0.61]	[0.31,0.705]
TP_3	[0.6,0.71]	[0.07,0.555]	[0.415,0.915]	[0.475,0.945]	[0.1,0.59]	[0.41,0.885]
TP_4	[0.68,0.84]	[0.3,0.745]	[0.475,0.86]	[0.23,0.67]	[0.14,0.565]	[0.195,0.635]
TP_5	[0.85,0.94]	[0.21,0.705]	[0.445,0.915]	[0.075,0.54]	[0.475,0.925]	[0.42,0.895]
ITS		[0.3096, 0.58]	[0.5, 0.7284]	[0.46, 0.759]	[0.3874, 0.6904]	[0.3646, 0.6726]
ITS_1	[0.73,0.88]	[0.235,0.58]	[0.34,0.69]	[0.425,0.765]	[0.235,0.58]	[0.265,0.615]
ITS_2	[0.91,0.96]	[0.27,0.58]	[0.5,0.73]	[0.46,0.715]	[0.395,0.695]	[0.37,0.675]
ITS_3	[0.99,0.99]	[0.31,0.58]	[0.5,0.69]	[0.46,0.675]	[0.31,0.58]	[0.31,0.58]

In Table 6, using the calculation for Choquet integral just above, the overall m-commerce technology values are obtained. In this table, all trapezoidal fuzzy numbers are also given as crisp numbers.

Table 6. Defuzzified overall values of alternative m-commerce technologies using generalized Chouqet Integral.

Criteria	$(C)\int \tilde{f} d\tilde{g}$					Defuzzified $(C)\int \tilde{f} d\tilde{g}$				
	A_1	A_2	A_3	A_4	A_5	A1	A2	A3	A4	A5
Overall tech. value	**(0.3251, 0.3768, 0.5816, 0.6564)**	**(0.4867, 0.4996, 0.7303, 0.7766)**	**(0.4375, 0.4667, 0.7605, 0.827)**	**(0.3898, 0.4384, 0.6926, 0.7609)**	**(0.3602, 0.4063, 0.6748, 0.7415)**	0.485	**0.623**	0.622	0.570	0.545
ET	**(0.340. 0.393. 0.740. 0.810)**	**(0.441. 0.47. 0.809. 0.858)**	**(0.293, 0.335, 0.747, 0.803)**	**(0.239. 0.298. 0.679. 0.751)**	**(0.296. 0.362. 0.802. 0.865)**	0.571	**0.646**	0.544	0.492	0.581
ET_1	(0.105. 0.15. 0.575. 0.615)	(0.205. 0.27. 0.735. 0.78)	(0.25. 0.305. 0.77. 0.815)	(0.075. 0.115. 0.515. 0.555)	(0.365. 0.425. 0.885. 0.925)	0.361	0.497	0.535	0.315	**0.65**
ET_2	(0.365. 0.42. 0.745. 0.815)	(0.365. 0.42. 0.745. 0.815)	(0.255. 0.32. 0.65. 0.725)	(0.25. 0.315. 0.635. 0.705)	(0.255. 0.32. 0.65. 0.725)	0.586	**0.586**	0.487	0.476	0.487
ET_3	(0.33. 0.365. 0.74. 0.8)	(0.475. 0.5. 0.82. 0.865)	(0.305. 0.34. 0.72. 0.785)	(0.245. 0.285. 0.69. 0.76)	(0.245. 0.275. 0.67. 0.74)	0.558	**0.665**	0.537	0.495	0.482
ST	**(0.2745. 0.3253. 0.7209. 0.7924)**	**(0.4414. 0.4829. 0.8073. 0.8586)**	**(0.2296. 0.2898. 0.6766. 0.7518)**	**(0.2138. 0.2698. 0.6498. 0.725)**	**(0.2545. 0.3097. 0.6898. 0.76)**	0.528	**0.647**	0.487	0.464	0.503
ST_1	(0.255. 0.31. 0.69. 0.76)	(0.405. 0.455. 0.795. 0.855)	(0.21. 0.265. 0.635. 0.705)	(0.215. 0.27. 0.65. 0.725)	(0.255. 0.31. 0.69. 0.76)	0.503	**0.627**	0.453	0.465	0.503
ST_2	(0.36. 0.395. 0.785. 0.85)	(0.475. 0.5. 0.82. 0.865)	(0.37. 0.405. 0.775. 0.835)	(0.135. 0.18. 0.58. 0.65)	(0.245. 0.285. 0.69. 0.76)	0.597	**0.665**	0.596	0.386	0.495
ST_3	(0.27. 0.31. 0.695. 0.76)	(0.475. 0.5. 0.805. 0.845)	(0.18. 0.22. 0.59. 0.655)	(0.205. 0.245. 0.635. 0.705)	(0.245. 0.285. 0.675. 0.74)	0.508	**0.656**	0.411	0.447	0.486
TP	**(0.222. 0.2712. 0.7375. 0.8)**	**(0.4897. 0.5. 0.9139. 0.9547)**	**(0.4422. 0.471. 0.9058. 0.9408)**	**(0.4004. 0.4502. 0.9121. 0.9564)**	**(0.3674. 0.4143. 0.8911. 0.9345)**	0.507	**0.714**	0.69	0.679	0.651
TP_1	(0.135. 0.18. 0.58. 0.65)	(0.49. 0.5. 0.82. 0.865)	(0.44. 0.465. 0.81. 0.86)	(0.27. 0.31. 0.71. 0.78)	(0.305. 0.34. 0.72. 0.785)	0.386	**0.668**	0.643	0.517	0.537
TP_2	(0.175. 0.21. 0.595. 0.645)	(0.475. 0.5. 0.815. 0.845)	(0.395. 0.43. 0.79. 0.835)	(0.18. 0.215. 0.61. 0.665)	(0.27. 0.31. 0.705. 0.76)	0.406	**0.658**	0.612	0.417	0.511
TP_3	(0.04. 0.07. 0.555. 0.59)	(0.39. 0.415. 0.915. 0.94)	(0.445. 0.475. 0.945. 0.965)	(0.065. 0.1. 0.59. 0.63)	(0.37. 0.41. 0.885. 0.91)	0.313	**0.665**	0.707	0.346	0.643
TP_4	(0.25. 0.3. 0.745. 0.805)	(0.435. 0.475. 0.86. 0.905)	(0.185. 0.23. 0.67. 0.73)	(0.095. 0.14. 0.565. 0.625)	(0.14. 0.195. 0.635. 0.695)	0.525	**0.668**	0.453	0.356	0.416
TP_5	(0.16. 0.21. 0.705. 0.755)	(0.4. 0.445. 0.915. 0.955)	(0.04. 0.075. 0.54. 0.585)	(0.435. 0.475. 0.925. 0.96)	(0.375. 0.42. 0.895. 0.935)	0.457	0.678	0.31	**0.698**	0.656
ITS	**(0.2678. 0.3096. 0.58. 0.655)**	**(0.475. 0.5. 0.7284. 0.7748)**	**(0.43. 0.46. 0.759. 0.8258)**	**(0.3474. 0.3874. 0.6904. 0.7589)**	**(0.3259. 0.3646. 0.6726. 0.7395)**	0.453	**0.619**	0.618	0.546	0.525
ITS_1	(0.17. 0.235. 0.58. 0.65)	(0.28. 0.34. 0.69. 0.76)	(0.37. 0.425. 0.765. 0.83)	(0.17. 0.235. 0.58. 0.65)	(0.195. 0.265. 0.615. 0.69)	0.4088	0.517	**0.597**	0.408	0.441
ITS_2	(0.225. 0.27. 0.58. 0.655)	(0.475. 0.5. 0.73. 0.775)	(0.43. 0.46. 0.715. 0.77)	(0.36. 0.395. 0.695. 0.76)	(0.335. 0.37. 0.675. 0.74)	0.4325	**0.62**	0.593	0.552	0.53
ITS_3	(0.27. 0.31. 0.58. 0.645)	(0.475. 0.5. 0.69. 0.73)	(0.43. 0.46. 0.675. 0.725)	(0.27. 0.31. 0.58. 0.645)	(0.27. 0.31. 0.58. 0.645)	0.4512	**0.598**	0.572	0.451	0.451

As Table 6 indicates, Alternative 2 is generally better than the other alternatives. This alternative is the best option in terms of all criteria except three criteria. It is not the best at ET_1, TP_5, and ITS_1. Alternative 5 is the

best at ET_1, Alternative 4 is the best at TP_5, and Alternative 3 is the best at ITS_1.

Figure 3 illustrates the main criteria for the sensitivity analysis. In this analysis, only one criterion is taken each time and these criteria are given (0,0,0,0) and (1,1,1,1) values, respectively. Then the new values of alternatives are obtained by solving the problem again with the new value of this criterion.

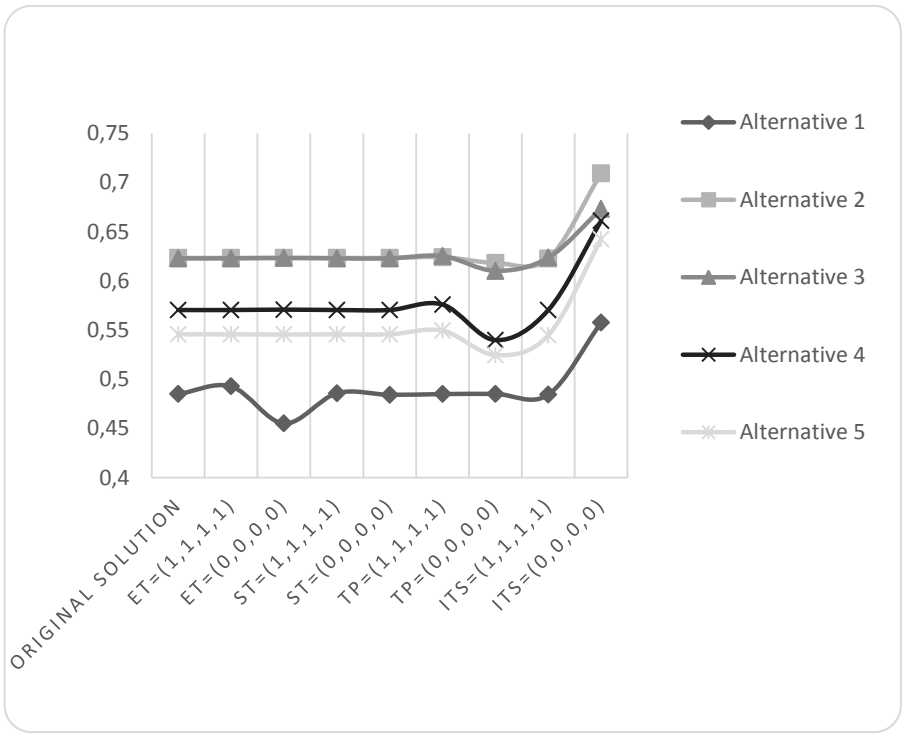

Figure 3. Sensitivity analysis.

From Figure 3, it is seen that Alternative 2 is almost insensitive to the changes in the values of the considered criteria. Alternative 1 is also insensitive and it is the worst among all.

An analysis of the results sets 3G and Upper Version as the best alternative. Wireless Networks is the second best; SMS and MMS, having similar

results, are slightly worse than Wireless Networks. GSM is in the last place by being the worst alternative in each case. It can be seen from the sensitivity analysis study carried out that the best alternative maintains its first position in different criterion weights.

6. CONCLUSION

Constructed from the concept of fuzzy measure, Choquet integral is capable of taking into account the interaction between criteria. When criteria are independent, it identifies with the weighted arithmetic mean. M-commerce makes it possible for users to access the Internet without having to find a place to plug in. M-commerce evaluation criteria have many interactions. So the m-commerce technologies is evaluated by using Choquet integral. The sensitivity analysis shows that m-commerce technologies have low sensitivity. An alternative saves its position in all the cases of sensitivity analysis. For further research, I suggest different MCDM techniques to be used and the obtained results be compared with this paper's. Furthermore, the output of this paper can be taken into account and the weak points of suggested technologies can be eliminated for improvement.

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THE DETERMINANTS OF E-CONFERENCE ACCEPTANCE DURING COVID-19 PANDEMIC*

Emrah KÖKSALMIŞ[1]
Serhat AYDIN[2]

[1]*National Defence University, Hezarfen Aeronautics and Space Technologies Institute, Istanbul, Turkey,*
ekoksalmis@hho.edu.tr; ORCID: 0000-0003-4922-2125

[2]*National Defence University, Turkish Air Force Academy, Department of Industrial Engineering, Istanbul, Turkey,*
saydin3@hho.edu.tr; ORCID: 0000-0003-0861-8297

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ABSTRACT

With the impact of the COVID-19 pandemic continuing to be felt globally, it is essential that people quickly adapt to a new virtual business landscape, in order to continue to provide a valuable conference experience. E-conference, in other words web conference or virtual conference, is an online conference that involves people participating in a conference through a virtual environment on the web, rather than meeting in a physical location. The objective of this paper is to inspect several reasons of behavioural intention to use an e-conference system by utilizing the modified technology acceptance model (TAM). Together with primary elements of TAM, in this particular paper, additional constructs such as satisfaction, time, price savings, technical support, mobile anxiety, social influence and convenience are taken into account. Total of 203 questionnaires is gathered through academicians in Turkey. To evaluate the data and examine the proposed hypotheses, the Structural Equation Modeling (SEM) methodology is implemented by utilizing SmartPLS 3.2.7. The results indicate that convenience, mobile anxiety, satisfaction, perceived usefulness and social influence are significantly predicting the behavioural intention. This paper enables theoretical and practical implications for authorities seeking to implement an e-conference.

Keywords: *E-conference, Structural Equation Modeling, Technology Acceptance Model, Price Savings, Mobile Anxiety.*

COVID-19 PANDEMİ SÜRESİNCE E-KONFERANS KABULÜNÜN BELİRLEYİCİLERİ

ÖZ

Küresel olarak hissedilmeye devam eden COVID-19 salgınının etkisiyle, insanların yeni bir sanal iş ortamına, yani yüz yüze görüşmeden sanal toplantı formatına, geçişe hızla adapte olması oldukça önemli. E-konferans, diğer bir deyişle web konferansı veya sanal konferans, fiziksel bir yerde toplantı yapmak yerine web üzerindeki sanal bir ortam aracılığıyla bir konferansa katılan kişileri içeren çevrimiçi bir konferanstır. Bu çalışmanın amacı, değiştirilmiş teknoloji kabul modelini (TKM) kullanarak e-konferansı kullanmak için çeşitli davranışsal niyet faktörlerini incelemektir. TKM'nin temel unsurları ile birlikte, bu makalede memnuniyet, zaman, fiyat tasarrufu, teknik destek, mobil kaygı, sosyal etki ve kolaylık gibi ek yapılar dikkate alınmıştır. Türkiye'deki akademisyenler aracılığıyla toplam 203 anket toplanmıştır. Verileri değerlendirmek ve önerilen hipotezleri test etmek için SmartPLS 3.2.7 yazılımı kullanılarak Yapısal Eşitlik Modelleme (YEM) metodolojisi uygulanmıştır. Sonuçlar, kolaylık, mobil kaygı, memnuniyet, algılanan yararlılık ve sosyal etkinin davranışsal niyeti anlamlı şekilde etkilediğini göstermiştir. Bu makale, e-konferansı uygulamak isteyen yetkililer için teorik ve pratik birtakım çıkarımlar sağlamaktadır.

Anahtar Kelimeler: *E-konferans, Yapısal Eşitlik Modellemesi, Teknoloji Kabul Modeli, Fiyat Tasarrufu, Mobil Kaygı.*

1. INTRODUCTION

COVID-19 (Novel coronavirus) is first documented at the end of 2019 in Wuhan, China as the fastest-growing epidemic of coronavirus in the last decades (World Health Organization, 2020a). Compared to other epidemics, both in China and the whole globe, COVID-19 is unique in terms of its extraordinary morbidity and mortality (World Health Organization, 2019). At the end of January 2020, the World Health Organization confirmed the epidemic as a worldwide general health emergency (World Health Organization, 2020b). Therefore, it is vital to understand the progress of scientific information about COVID-19 to direct the future studies and policy-making.

In the literature, there are numerous studies on COVID-19, which are mainly focused on developing mathematical or decision-making models, in different disciplines. For instance, Whitelaw et al. (2020) proposes an agenda for the novel digital tools in managing pandemic, and mentions countries that have implemented these tools successfully. Mbunge (2020) analyzes the possible opportunities and challenges of integrating emerging technologies into COVID-19 contact tracing. Zolfani et al. (2020) proposes a gray-based decision support framework to select a site for hospitals for COVID-19 patients in Istanbul, Turkey. Mollenkopf et al. (2020) examines the supply chain management of the food industry during COVID-19 pandemic. Rizou et al. (2020) reviews the transmission ways of COVID-19. Marelli et al. (2021) evaluates the psychological impact of COVID-19, specifically sleep quality, on administration staff and students in Italy. Tirkolaee et al. (2021) presents a mathematical model in order to manage waste management during the pandemic. Albahri et al. (2020) develops a model for the convalescent plasma transfer to the COVID-19 patients using machine learning and multi-criteria decision-making methods (MCDM). Lastly, Bonifati et al. (2020) shares their decisions, experiences, and lessons learned from the conference that moved to a fully synchronous online experience due to the COVID-19 outbreak.

Technology is now at its height and it is the key component of the everyday lives of people. Technology is an unavoidable element, whether it is in business or for homes. One of the new additions that has really benefited researchers, scholars, business owners to a great extent is e-conference or

electronic conference. With the effects of the pandemic, like COVID-19, still being felt worldwide, it was important for individuals to adapt rapidly to a modern virtual work environment, in order to maintain the valuable conference experience. The definition of e-conference is an electronic meeting in which individuals join a conference via an electronic medium. While individuals sit and discuss any problems with each other in a conventional conference, two or more individuals are together in a virtual realm in the event of an e-conference. Therefore, people can also attend from different parts or corners of the world for a meeting or conversation without taking a flight or driving long distances.

Due to its infinite advantages, the e-conference system is becoming extremely important. Firstly, a huge amount of money and time has been saved by e-conferencing by cutting the expenses of flights and accommodation. Furthermore, it may take more time and effort to arrange conventional meetings than to simply invite participants to an e-conference. In e-conferences, the host of the meeting does not have to spend a huge amount of effort to reserve a conference room, to prepare the agenda and to schedule a date that will be suitable for everybody, which are inevitable in conventional ones. Thirdly, it is not really easy for individuals to drive such long distances to attend a conventional meeting that is unexpectedly scheduled. E conference allows you to communicate anytime and anywhere. All you need is a good connection to the internet and a computer such as a laptop or tablet. Finally, e-conference systems are frequently used to minimize the impact of the negative situations brought about by the Covid-19 epidemic.

In spite of the fact that the usage of e-conference systems increases, studies on acceptance of e-conference system are limited. Hence, our objective is to fill this gap by discovering reasons affecting academicians' preferences of the e-conference system in Turkey. So as to develop a theoretical model to examine the e-conference acceptance, the TAM was utilized.

The remaining of this study is provided as follows: The next section reviews the background of the subject. Then, research methodology and hypotheses are provided. Lastly, results and recommendations for further study are presented in the last sections.

2. LITERATURE REVIEW

As already mentioned in the previous part, there are many advantages of using e-conference systems. However, users' attitudes about adopting and accepting the e-conference systems may be positive or negative. These attitudes are very important in evaluating the system overall performance since the acceptance of new technology can only be achieved by user acceptance. At that point, it should be clarified that the experienced, talented and innovative individuals may have a positive attitude about these systems at the first sight. On the other hand, these kinds of users should also be supported by activities such as technical support, training, etc. Therefore, antecedents of adoption of the e-conference systems must be surveyed carefully to understand the possible problems better.

In literature, a wide variety of methods; for instance, theory of reasonable action, theory of planned behavior and technology acceptance model (TAM) have been proposed to determine the factors affecting the users' attitudes. However, in order to interpret the behavioural intention to use information systems e.g. e-conference systems, researchers commonly employ the TAM since it emerged from both theory of reasonable action and, theory of planned behavior (Sternad & Bobek, 2013).

Davis et al. (1989) has developed the TAM to enlighten the behavior of users towards adoption or usage of the information technologies. The method contains two specific beliefs such as perceived ease of use (PEOU) and perceived usefulness (PU). According to Davis et al. (1989), these two beliefs are the main determinants of intention to use. In this study, researchers also show that the most significant factors for accepting a new technology are PEOU and PU. Lee et al. (2011) prove that these factors also play an essential role in reducing the user resistance to adoption.

TAM is now a widespread analytical technique for evaluating acceptance of new systems in several businesses; for instance, healthcare, energy, education, etc. Some of the researches in TAM can be briefly summarized as follows: wireless internet systems (Lu et al., 2003), internet banking (Lai & Li, 2005), online shopping and e-commerce (Ha & Stoel, 2009; Pavlou, 2003), smartphones (Özbek et al., 2014), enterprise resource planning (Hancerliogullari Koksalmis and Damar, 2021), e-learning and m-learning

(Gómez-Ramirez et al, 2019; Al-Adwan et al., 2018), green roof systems (Hancerliogullari Koksalmis & Pamuk, 2021), social media (Rauniar et al., 2014), e-hospitals (Chang et al., 2015), telemedicine (Kowitlawakul, 2011), medical devices (Koksalmis, 2019), e-commerce (Hancerliogullari Koksalmis & Gozudok, 2021).

Structural Equation Modeling (SEM) observes the connections between independent and dependent variables, statistically (Ulucan, 2018). It contains two essential phases. Initially, a series of regression equations represent the causal processes. In the second stage, the structural relationships are formed visually to show the relations in a better way (Byrne, 2011). SEM aims to determine whether the formed theoretical model is supported by the existing data. Also this technique utilizes the hypothesis testing to examine the theoretical models and thus uncover the relationships between constructs (Schumacker & Lomax, 2012). The existing data is evaluated using a multivariate analysis approach, the partial least squares structural equation modeling (PLS-SEM), for statistical analyses. PLS-SEM method has many benefits. Some of these benefits include not requiring specific assumptions related to data and distributions for variables; assuming errors are not correlated; not requiring large samples (Sternad et al., 2011).

However, when we surveyed the literature, we observed that there is a scarce of literature about the factors affecting the behavioural intention to use e-conference systems. In spite of the increasing practice of e-conference systems, studies about factors affecting the acceptance of e-conference systems are very limited. In response to this shortage, we contribute to the related literature by developing an integrated model to examine users' intention to use e-conference through the TAM. The PLS-SEM method has been applied. We aim to fill the gap in literature by exploring the dynamics that impact the acceptance of an e-conference system in Turkey during COVID-19 pandemic.

3. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

While building our research outline, we apply the TAM Original TAM involves PU, PEOU, actual use (AU) and behavioural intention to use (BI). From the perspective of TAM, the behavioural intention to use is suggested

to be influenced by both perceived usefulness and perceived ease of use. It studies the user's acceptance for an information system and one of the most influential models in this subject (Lee et al., 2003; Venkatesh & Davis, 1996). Fig. 1 depicts the developed research model.
BI is "the degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour" (Venkatesh, 2000). This implies likelihood that a person is occupied with a specific behaviour (Ajzen & Fishbein, 1980).

CON refers "individual's preference for convenient products and services." (Hsu & Chang, 2013). In other words, a system is considered to be convenient when it saves time for a user. Several researches have shown the link between convenience and BI (Hsu & Chang, 2013; Hazen et al., 2015). So, the following hypothesis is proposed:

H1: *"Convenience is positively linked to the behavioural intention to use e-conference."*

SI is "a person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975). In theory of reasonable action and Extended TAM, social influence, which directly impacts BI, is indicated as a subjective rule. Throughout the initial phases of personal interaction with the technology, social influence is a key. It is suggested that the effect of SI on BI is positive. Users want to use an e-conference system if it's used or suggested to be used by their relatives, networks or colleagues. So, the following hypothesis is proposed:

H2: *"Social influence is positively linked to the behavioural intention to use e-conference."*

SAT is well-defined as "a state when individuals feel satisfied, neutral, or dissatisfied when outcomes are greater, equal to, or below expectations or desires" (Amoroso & Lim, 2017). The more the user is fulfilled and satisfied, the more he/she has a tendency to have a positive demeanor towards using. As Ho (2010) proposed, satisfaction is positively related to intention and attitude. Numerous studies provide a connection between satisfaction and attitude in the literature (Basak & Calisir, 2015; Ho, 2010; Liao et al., 2009).

So, hypothesize is developed as follows:

H3: *"Satisfaction will have a positive impact on the behavioural intention to use e-conference."*

TIME effectiveness is a proportion of the exchange time costs. According to Becker (1965), the shopper amplifies their utility subject to pay requirements as well as time imperatives (Dellaert et al., 1998). By diminishing data asymmetry and amazements, for example, conveying incorrectly items and missing conveyance dates, clients find web based shopping simple to utilize and less tedious. If e-conference is time effective, users are going to be satisfied with the overall performance of the electronic channel. Earlier research has exposed that time positively affects behavioural intention to use (Devaraj et al., 2002). So, the following hypothesis is proposed:

H4: *"Time is positively linked to the satisfaction of e-conference."*

PR is a proportion of store ability in light of the fact that as administrative costs decline, reserve funds could be given to purchasers (Konana et al., 2000). If e-conference is price saving, users are going to be satisfied with the overall performance of the electronic meeting. Earlier research has shown that price savings positively affects satisfaction. Therefore, the following hypothesis is proposed:

H5: *"Price savings is positively linked to the satisfaction of e-conference."*

PU is "the extent to which a person believes that using a particular technology will enhance her/his job performance," (Davis, 1989). This definition emphasizes the users' efficiency expectations. Therefore, one of the core constructs of the TAM is perceived usefulness (Lee, 2010). On the other hand, many researchers indicate that perceived usefulness positively affects the continuance intention (Baker-Eveleth & Stone, 2015; Lee, 2010; Roca et al., 2006; Bhattacherjee, 2001). So, hypothesizes are developed as follows:

H6: *"Perceived usefulness is positively linked to the satisfaction of e-conference."*

H7: *"Perceived usefulness is positively linked to the behavioural intention to use e-conference."*

PEOU is "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). It implies the scholarly power important for not only acquiring but also utilizing the innovation (Arasanmi et al., 2017). A user, who feels it will be easy to use the e-conference, is positive about using it. So, hypothesizes are developed as follows:

H8: *"Perceived ease of use is positively linked to the behavioural intention to use e-conference."*

H9: *"Perceived ease of use is positively linked to the satisfaction use e-conference."*

H10: *"Perceived ease of use is positively linked to the perceived usefulness of e-conference."*

MA is a person's apprehension, anxiety, or bad emotion in real or expected interplay with the mobile devices such as computers (Heinssen et al., 1987; Venkatesh & Morris, 2000). In literature numerous studies revealed that mobile anxiety became determinants of BI and PEOU (Gefen & Straub, 2000; Pedersen & Nysveen, 2003; Gefen et al., 2003; Koksalmis, 2019). Therefore, the following hypotheses are established as:

H11: *"Mobile anxiety will have a negative impact on behavioural intention to use e-conference."*

H12: *"Mobile anxiety will have a negative impact on perceived ease of use e-conference."*

TS is "assistance provided to users of computer hardware and software products by knowledgeable people" (Son et al., 2012). It involves specialized instruction, supervision, tutoring, and consultation in using technology (Pijper et al., 2001). Several studies showed that technical support positively affects PEOU and PU (Son et al., 2012). So, hypothesizes are developed as follows:

H13: *"Technical support will have a positive impact on perceived ease of use of e-conference."*

H14: *"Technical support will have a positive impact on perceived usefulness of e-conference.*

Our model, which contains 10 constructs, specifically, behavioural intention to use, convenience, mobile anxiety, perceived ease of use, perceived usefulness, price savings, satisfaction, social influence, time and technical support, is provided in Figure 1.

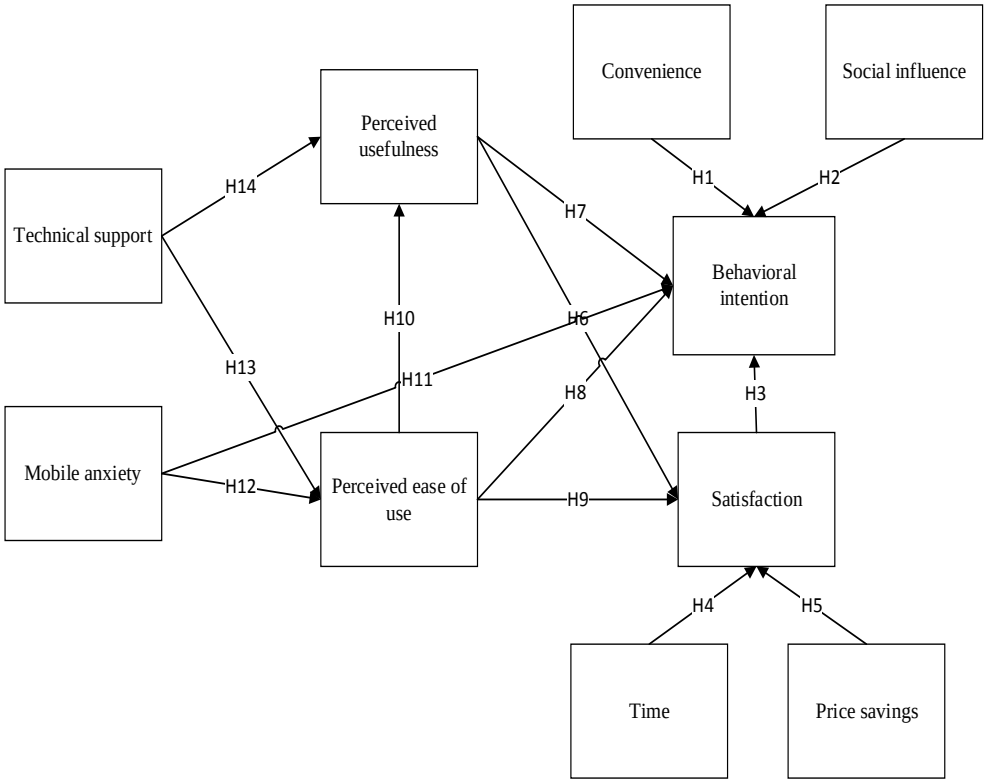

Figure 1. Research model.

4. RESEARCH METHODOLOGY

The current paper uses the survey method in order to gather the data and verify the conceptual model. By doing so, relationships between constructs and the individual responses are examined in a more suitable way (Newsted et al., 1998). The data was gathered through an online survey system which

has several benefits including wide-ranging sample space. Academicians in Turkey were our potential respondents.

The survey was raised as two main parts. The first includes questions associated with the demographic information; especially, age of the respondents, sex, education level, work, internet usage, e-conference experience. The second part includes the questions linked to the items measuring BI, CON, MA, PU, CS, PEOU, SAT, SI, TIME and TS.

203 questionnaires were collected and all of them were used for the analysis. Overall, 39.4% of respondents were women, and the respondents have an average age of 42.3 years. Survey also shows that only 8% have had an experience about e-conference. Table 1 provides the summary of demographic data of the respondents.

Table 1. Demographics.

Age (years)		
Max: 60	Min: 29	Average: 42.3
Gender (%)		
Female: 39.4	Male: 60.6	
E-conference Experience (%)		
Yes: 8	No: 92	

In this study, we tried to confirm our theoretical model by implementing the PLS-SEM, which is a multivariate investigation technique in multi-disciplines (Hair et al., 2012). The data is analyzed with the help of SmartPLS 3.2.7 software program.

The items related to constructs are gathered from the existing studies as we use a literature-based model. In this study, so as to quantify the factors, we use the five-point Likert scale. Table 2 shows the details about the items and constructs.

Table 2. Constructs and items.

Construct	Code	Sources	Items
Perceived ease of use	PEOU1 PEOU2 PEOU3 PEOU4	(Venkatesh & Davis, 1996) (Koufaris, 2002)	"Learning to operate e-conference would be easy for me." "My interaction with e-conference would be clear and understandable." "It would be easy for me to become skillful at using e-conference." "I would find e-conference easy to use."
Perceived usefulness	PU1 PU2 PU3 PU4	(Venkatesh & Davis, 1996) (Pavlou, 2003) (Park et al., 2004) (Fortes & Rita, 2016)	"Using e-conference would increase my productivity." I think e-conference is valuable to me. "E-conference provides me access to a wide variety of products and services." "Overall, I find e-conference useful."
Satisfaction	SAT1 SAT2 SAT3 SAT4	(Pavlou, 2003; Bhattacherjee, 2001)	"I am satisfied in general with my past transactions with e-conference." "My overall experience of using e-conference is very satisfied." "My overall experience of using e-conference is very pleased." "My overall experience of using e-conference is very delighted."

Continuation of the Table 2.

Time	TIME1 TIME2 TIME3	(Devaraj et al., 2002)	"E-conference helps me to accomplish tasks more quickly." "I did not have to spend too much time to complete the transaction." "I did not have to spend too much effort to complete the transaction."
Price savings	PR1 PR2 PR3	(Vasić et al., 2018)	"E-conference saves money in comparison to traditional commerce." "E-conference is cheaper than traditional commerce." "E-conference significantly reduces expenses per transaction in comparison to traditional commerce."
Behavioural intention to use	BI1 BI2 BI3	(Lam et al., 2007)	"I intend to use e-conference more in the future." "I want to use e-conference for my everyday living." "It is likely that I will use e-conference for my future everyday living."
Convenience	CON01 CON02 CON03 CON04	(Chau et al., 2019)	"Learning to use the e-conference system would be easy for me." "My interaction with the e-conference system would be clear and understandable." "I have access to the e-conference system anytime." "I have access to the e-conference system everywhere."

Continuation of the Table 2.

Mobile anxiety	MA01 MA02 MA03	(Chang et al., 2017)	"E-conference systems do not scare me at all." "E-conference systems make me feel uncomfortable." "Working with E-conference systems makes me nervous."
Social influence	SI01 SI02 SI03 SI04 SI05 SI06	(Venkatesh et al., 2003; Moore & Benbasat, 1991)	"People who influence my behaviour think that I should use the e-conference system." "People who are important to me think that I should use the e-conference system." "I use the e-conference system because of the proportion of coworkers who use the e-conference system" "People in my organization who use the e-conference system have more prestige than those who do not." "People in my organization who use the e-conference system have a high profile." "Having the e-conference system is a status symbol in my organization."

Continuation of the Table 2.

Technical support	TS01 TS02	Son et al. (2012)	"I have technical difficulties in using e-conference system, the technical support personnel will be easy to reach at any time." "If I have technical difficulties in using an e-conference system, the technical support personnel will provide a satisfying response"

5. RESULTS

Confirmatory factor analysis was implemented to examine the model. We assessed the reliability and validity of the constructs by investigating content, discriminant and convergent validities. The content validity is measured through associated studies and pilot testing the scale (Sheikh et al., 2017).

The convergent validity was estimated by assessing the values of the Cronbach's alpha, average variance extracted (AVE), factor loadings and composite reliability (CR) (Sheikh et al., 2017; Anderson & Gerbing, 1992). The Cronbach's alpha is implemented to evaluate the consistency of each construct. The higher is the better for Cronbach's alpha value. CR shows how well an assigned item measures a construct. AVE is a strict measure of convergent validity. "It evaluates the shared variance in a latent variable and provides evidence about convergence of items" (Basak & Calisir, 2015). AVE includes a variance which is obtained by partition of the total squared factor loadings and the number of items (Koksalmis & Damar, 2019; Bayraktar et al., 2017; Götz et al., 2010). The threshold values for Cronbach's alpha, factor loadings, CR and AVE are 0.7, 0.6, 0.5, and 0.7, respectively (Hair et al., 1998; Fornell & Larcker, 1981). The values of convergent validity and reliability are shown in Table 3; all items are above satisfactory level which implies good internal consistency, convergent validity and reasonable reliability of the measurement model.

Table 3. Reliability and convergent validity results.

Constructs	Items	Factor Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Behavioural intention to use	BI01	0.923	0.838	0.902	0.755
	BI02	0.842			
	BI03	0.393			
Convenience	CON01	0.933	0.853	0.901	0.696
	CON02	0.814			
	CON03	0.789			
	CON04	0.793			
Mobile anxiety	MA01	0.928	0.811	0.888	0.726
	MA02	0.803			
	MA03	0.820			
Perceived ease of use	PEOU01	0.929	0.887	0.914	0.642
	PEOU02	0.764			
	PEOU03	0.778			
	PEOU04	0.792			
Price savings	PS01	0.932	0.827	0.895	0.741
	PS02	0.825			
	PS03	0.821			
Perceived usefulness	PU01	0.926	0.892	0.916	0.611
	PU02	0.758			
	PU03	0.745			
	PU04	0.747			
Satisfaction	SAT01	0.932	0.838	0.892	0.676
	SAT02	0.806			
	SAT03	0.786			
	SAT04	0.757			
Social influence	SI01	0.923	0.883	0.911	0.633
	SI02	0.798			
	SI03	0.758			
	SI04	0.772			
	SI05	0.748			
	SI06	0.764			
Time	TIME01	0.933	0.836	0.901	0.752
	TIME02	0.820			
	TIME03	0.844			
Technical support	TS01	0.925	0.808	0.885	0.721
	TS02	0.803			

After calculating the composite measures, discriminant validity was evaluated. "Cross-loadings" and "Fornell & Larcker criterion" allow us to assess the discriminant validity of the measurement constructs. All corresponding correlations should be less than the square root of the AVE according to Fornell and Larcker (1981). Moreover, for the cross-loadings, "an indicator's outer loading on the related variable should be higher than all its correlations on other variables" (Al-Emran et al., 2020). Table 4 and Table 5 demonstrate that the discriminant validity is satisfied.

Table 4. Reliability and convergent validity results.

	BI	**CON**	**MA**	**PEOU**	**PS**	**PU**	**SAT**	**SI**	**TIME**	**TS**
BI	**0.869**									
CON	0.649	**0.835**								
MA	-0.661	-0.565	**0.853**							
PEOU	0.365	0.359	-0.349	**0.801**						
PS	0.520	0.424	-0.365	0.267	**0.861**					
PU	0.663	0.513	-0.496	0.616	0.377	**0.782**				
SAT	0.639	0.496	-0.532	0.326	0.624	0.470	**0.823**			
SI	0.603	0.491	-0.471	0.265	0.377	0.449	0.482	**0.796**		
TIME	0.428	0.334	-0.383	0.233	0.450	0.314	0.640	0.350	**0.868**	
TS	0.255	0.238	-0.245	0.585	0.181	0.379	0.214	0.183	0.187	**0.849**

Table 5. Cross loadings.

	BI	**CON**	**MA**	**PEOU**	**PS**	**PU**	**SAT**	**SI**	**TIME**	**TS**
BI01	**0.923**	0.671	-0.660	0.404	0.510	0.672	0.675	0.622	0.433	0.296
BI02	**0.843**	0.497	-0.536	0.280	0.407	0.539	0.508	0.458	0.374	0.175
BI03	**0.839**	0.501	-0.509	0.245	0.430	0.495	0.453	0.471	0.295	0.173
CON01	0.690	**0.934**	-0.591	0.341	0.399	0.529	0.521	0.529	0.346	0.231
CON02	0.495	**0.814**	-0.424	0.284	0.336	0.421	0.394	0.361	0.282	0.222
CON03	0.461	**0.789**	-0.404	0.246	0.313	0.377	0.370	0.367	0.257	0.161
CON04	0.479	**0.793**	-0.435	0.323	0.363	0.357	0.343	0.348	0.211	0.174
MA01	-0.694	-0.584	**0.929**	-0.352	-0.411	-0.518	-0.552	-0.487	-0.390	-0.250

Continuation of the Table 5.

MA02	-0.468	-0.410	**0.803**	-0.251	-0.241	-0.357	-0.390	-0.344	-0.250	-0.200
MA03	-0.490	-0.422	**0.820**	-0.275	-0.251	-0.365	-0.390	-0.350	-0.322	-0.167
PEU01	0.416	0.388	-0.369	**0.930**	0.271	0.651	0.330	0.313	0.224	0.558
PEU02	0.245	0.243	-0.272	**0.765**	0.211	0.452	0.238	0.170	0.164	0.462
PEU03	0.271	0.281	-0.297	**0.779**	0.204	0.460	0.265	0.234	0.198	0.482
PEU04	0.295	0.295	-0.260	**0.792**	0.190	0.507	0.252	0.209	0.231	0.446
PS01	0.553	0.418	-0.420	0.276	**0.932**	0.406	0.677	0.420	0.479	0.184
PS02	0.396	0.364	-0.245	0.177	**0.825**	0.272	0.455	0.215	0.307	0.125
PS03	0.355	0.297	-0.234	0.223	**0.822**	0.266	0.422	0.305	0.345	0.152
PU01	0.672	0.530	-0.521	0.622	0.398	**0.926**	0.499	0.476	0.340	0.398
PU02	0.491	0.347	-0.381	0.427	0.278	**0.759**	0.350	0.330	0.215	0.247
PU03	0.443	0.357	-0.343	0.426	0.257	**0.746**	0.314	0.290	0.186	0.229
PU04	0.455	0.353	-0.306	0.454	0.270	**0.748**	0.325	0.319	0.273	0.283
SAT01	0.668	0.526	-0.549	0.307	0.626	0.483	**0.930**	0.512	0.660	0.188
SAT02	0.480	0.349	-0.412	0.302	0.491	0.396	**0.806**	0.334	0.513	0.227
SAT03	0.496	0.393	-0.424	0.249	0.426	0.371	**0.787**	0.408	0.468	0.170
SAT04	0.420	0.335	-0.333	0.203	0.487	0.267	**0.757**	0.300	0.427	0.115
SI01	0.652	0.488	-0.486	0.283	0.392	0.478	0.511	**0.923**	0.370	0.193
SI02	0.468	0.367	-0.360	0.193	0.320	0.331	0.378	**0.798**	0.327	0.179
SI03	0.415	0.387	-0.355	0.179	0.262	0.327	0.321	**0.759**	0.224	0.068
SI04	0.437	0.340	-0.322	0.178	0.239	0.331	0.292	**0.771**	0.188	0.144
SI05	0.430	0.348	-0.348	0.180	0.293	0.313	0.365	**0.748**	0.225	0.138
SI06	0.420	0.396	-0.346	0.233	0.268	0.326	0.395	**0.764**	0.306	0.130
TIME01	0.468	0.375	-0.419	0.245	0.486	0.336	0.676	0.376	**0.933**	0.170
TIME02	0.319	0.236	-0.269	0.128	0.351	0.213	0.458	0.247	**0.821**	0.115
TIME03	0.298	0.230	-0.283	0.218	0.308	0.248	0.495	0.265	**0.845**	0.199
TS01	0.267	0.278	-0.262	0.634	0.197	0.397	0.238	0.180	0.190	**0.926**
TS02	0.176	0.156	-0.194	0.404	0.119	0.285	0.187	0.178	0.134	**0.803**

In this study, PLS-SEM through SmartPLS 3.2.7 is utilized to examine the hypotheses. Assessment criteria (Non-parametric) depends on bootstrapping is achieved with 5000 iterations (Henseler et al., 2009; Chin, 1998). The analyses of hypotheses are provided in Table 6.

According to the analysis below, convenience, social influence, satisfaction and PU affect BI positively; on the other hand, mobile anxiety affects BI and PEOU negatively; time, price savings, PU are significant determinants of satisfaction; PEOU affects PU positively; technical support is a significant antecedent of PEOU but not PU. Our results also show that the effect of PEOU on BI and satisfaction is insignificant.

Table 6. Test results.

Hypothesis	**Relationship**	***β* Coefficient**	**t-value**	**Supported (Yes/No)**
H1	CON → BI	0.196	2.818	Yes
H2	SI → BI	0.175	2.729	Yes
H3	SAT → BI	0.215	3.223	Yes
H4	TIME → SAT	0.413	6.221	Yes
H5	PS → SAT	0.360	5.348	Yes
H6	PU → SAT	0.198	2.119	Yes
H7	PU → BI	0.339	3.807	Yes
H8	PEOU → BI	0.108	1.410	No
H9	PEOU → SAT	0.012	0.124	No
H10	PEOU → PU	0.599	7.274	Yes
H11	MA → BI	-0.224	3.201	Yes
H12	MA → PEOU	-0.219	2.661	Yes
H13	TS → PEOU	0.532	9.665	Yes
H14	TS → PU	0.029	0.301	No

Figure 2 displays R-Square values, standardized path coefficients as well as descriptive power for dependent variables of the model. R-Square shows the proportion of total variance of the dependent variable. According to this study, the proposed research model explains the 70.2% (R-Square = 0.702) of total variance of BI, 58.5% (R-Square = 0.585) of total variance of satisfaction, 38.7% (R-Square = 0.387) of total variance of PEOU and 37.9% (R-Square = 0.379) of total variance of PU.

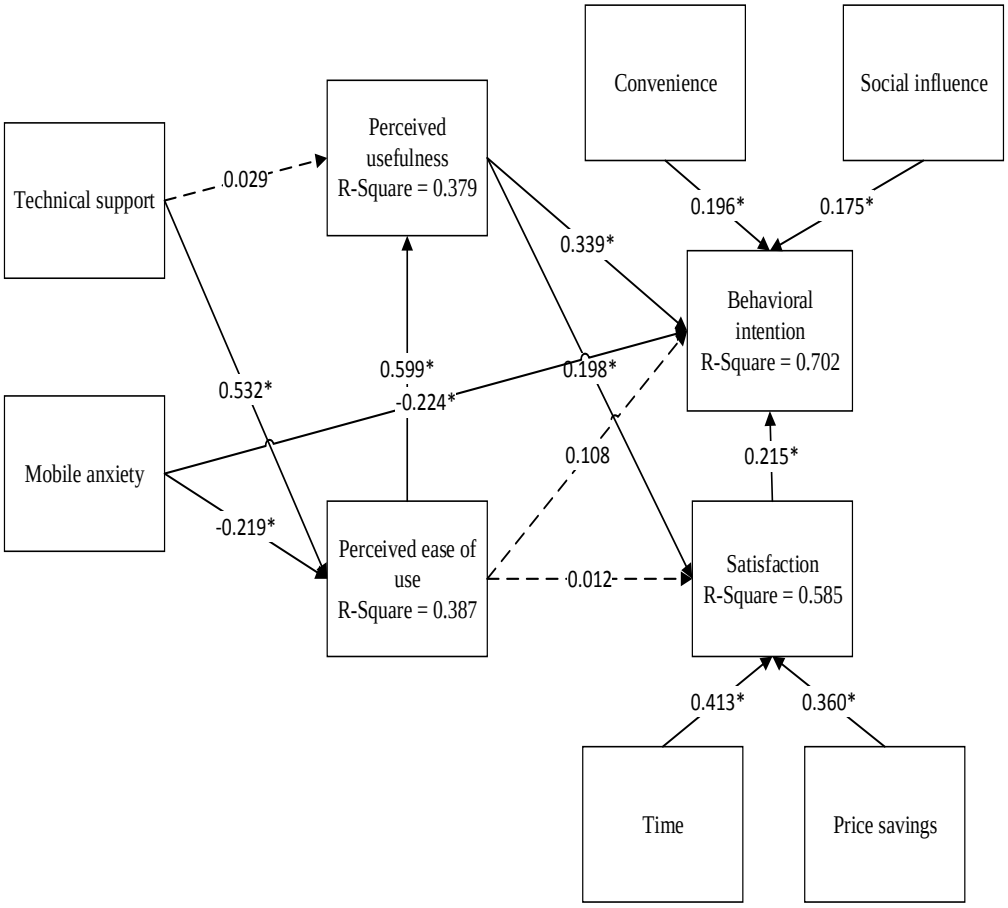

Figure 2. PLS algorithm results.

6. CONCLUSION

This research study aims to explore the acceptance of e-conference technologies by implementing the TAM as the theoretical framework, and participate main determinants, such as SAT, TIME, PS, TS, MA, SI and CON. 203 surveys were gathered from the academicians in Turkey, and all of them were taken into account in the analysis. In an attempt to examine the developed research model, we applied structural equation modeling

which uses PLSM mainly because it is practiced in multiple disciplines in the literature. SmartPLS software is used to evaluate the collected survey data. This research study is the first inclusive research to the authors' best knowledge, to integrate the constructs mentioned in the previous sections to identify the antecedents of e-conference system acceptance in Turkey.

The proposed research model clarifies the 70% of total variance of BI of e-conference systems. In this model, fourteen hypotheses are developed and eleven of them are supported. The findings are also similar to the existing studies by presenting that PU is the significant determinant of BI e-conference systems. In addition to the PU, factors such as convenience, satisfaction and mobile anxiety are playing an important role in users' BI e-conference systems. The results show that social influence affects BI e-conference systems significantly as well. The thoughts of generations and coworkers are crucial among the e-conference systems users. Among them, PU has the strongest impact on BI e-conference systems. Similarly, perceived usefulness, time and price savings are significant determinants of satisfaction which indicates that users tend to be satisfied with the e-conference systems if they believe that they save time and money, and it is useful. According to the results of the analysis, providing technical support impacts PEOU positively. Furthermore, e-conference systems are not easy for users who have mobile anxiety. The current research also shows that while PEOU affects PU; however, it does not affect BI. Likewise, PEOU does not affect satisfaction significantly. In addition, the effect of technical support on PU is not significant.

Our paper study can be used as a guide in theory and practice for e-conference systems, and it is going to be an important guide to understand behavior of academicians toward e-conference systems and what affects positively or negatively this behavior. The findings of this paper will be a potential source for future e-conference organizations. The results of this paper would be useful for e-conference attendees, academicians, students and organization companies.

A network analysis supported that most of the outcomes are consistent with literature in the information system. It also shows that PU is important while determining behavioural intention to use e-conference system. External

factors such as CON, SI, SAT and MA are also important in predicting peoples' behavioural intention to use e-conference systems.

Even though there are several contributions, some limitations should be considered for further studies. First, our research is conducted in only Turkey so the analysis might be different if the proposed model is tested in another country. Second, although a significant amount of the dependent variables is clarified, about 70% of BI is described through our model; hence, additional constructs, which might be related to e-conference, can be taken into consideration in further studies. Last, this study did not incorporate demographic features as constructs in the model. Hence, factors such as gender, education level and age can be used in the proposed model as a future work.

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LITERATURE REVIEW

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INVESTIGATION OF THE EFFECTS OF PASSIVE EXOSKELETONS ON WEIGHTLIFTING*

Zeynep Cansu TÜRKSELÇİ[1]
Adnan AKKURT[2]

[1]*Gazi University, Faculty of Technology, Department of Industrial Design Engineering, Ankara, Turkey,*
zcturkselci@gmail.com; ORCID: 0000-0003-0993-7513

[2]*Gazi University, Faculty of Technology, Department of Industrial Design Engineering, Ankara, Turkey,*
aakkurt@gazi.edu.tr; ORCID: 0000-0002-0622-1352

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ABSTRACT

Exoskeletons are technologies that are constantly developed to be used in different areas to reduce pain and periodic deformation felt under heavy loads. A great number of researchers and technology companies have been working on developing exoskeleton systems that augment human mobility to achieve several benefits in human life. This study includes current studies of passive exoskeletons which are specifically tested. The effects of passive exoskeleton systems reducing the load on the spine have been investigated for various lifting positions. In addition, reducing the biomechanical loads affecting the user's joints, muscles and soft tissues have been mentioned. In the conclusions section, the importance of researchers from the different branches to work on exoskeleton technology is emphasized.

Keywords: *Passive Exoskeleton, Wearable Systems, Assistive Devices, Lifting Devices.*

PASİF DIŞ İSKELETLERİN AĞIRLIK KALDIRMAYA ETKİLERİNİN ARAŞTIRILMASI

ÖZ

Dış iskeletler, ağır yükler altında hissedilen ağrı ve periyodik deformasyonu azaltmak için farklı alanlarda kullanılmak üzere sürekli geliştirilen teknolojilerdir. İnsan yaşamında çeşitli faydalar elde etmek amacıyla, insan hareketliliğini artıran dış iskelet sistemleri geliştirmek için çok sayıda araştırmacı ve teknoloji firması bu konuda çalışmaktadır. Bu çalışma, pasif dış iskeletler üzerine yapılan güncel çalışmaları içermektedir. Pasif dış iskelet sistemlerinin omurga üzerindeki yükü azaltmasının etkileri, çeşitli kaldırma pozisyonları için araştırılmıştır. Ayrıca kullanıcının eklem, kas ve yumuşak dokularına etki eden biyomekanik yüklerin azaltılmasından bahsedilmiştir. Sonuçlar kısmında, farklı branşlardan araştırmacıların dış iskelet teknolojisi üzerinde çalışmasının önemi vurgulanmıştır.

Anahtar Kelimeler: *Pasif Dış İskelet, Giyilebilir Sistemler, Yardımcı Cihazlar, Kaldırma Cihazları.*

1. INTRODUCTION

Bionics and exoskeletons have become more study in the last decade instead of prosthetics and orthotics. Exoskeletons, spread from the medical sector to military platforms, will be more common concepts in the near future. Researchers point to the approaching of the days when people moved around in their communities with the help of wearable exoskeletons (Sawicki et al., 2020). When designing an industrial exoskeleton, the aim is to ensure the worker with additional strength that is also comfortable to use to decrease the possibility of injury while performing their duties (Karfidova et al., 2020).

There are some points in exoskeletons that are considered negative and are still considered as disadvantages in current studies. Issues such as difficulty in donning and taking off, the discomfort of length and short settings, limitation of range of motion, or the weight of the device are still the most cited disadvantages of exoskeleton designs. However, the support these systems provide to the user during lifting is the mainstay behind most academic studies and the success story of commercially available products. Studies examining the effect of exoskeletons to decrease the load on the spine during lifting are available in the literature. In this study, findings emerging from different opinions and test results were compiled.

The development of exoskeletons also brought along branching. For example, with the increasing developments in the military field, the Super Warrior-2019 Exoskeleton Competition was organized in Beijing in October 2019. The competition contained munitions loading, light shunting, material handling, tapped walking, hurdle climbing, ditch crossing, and weapon operation, which are meticulous tests of current exoskeleton designs (Jia-Yong et al., 2020). As it is useful for soldiers to carry the necessary equipment and weapons with less effort (Lowe et al., 2019), it will be beneficial to use the exoskeleton system in sectors where repetitive work is done, such as the construction sector (Kim et al., 2019). Mass manufacturing companies also measure their performance to achieve the same quality every time in repetitive tasks. (Maurice et al., 2020) argued in

their study that an exoskeleton should increase user performance and capacity while performing the task, as productivity decline brings additional cost and quality drop to companies.

Exoskeleton is not only decreasing metabolic cost of energy, may also reduce muscle pain for works under the same conditions. It is stated that wearing exoskeleton reduces energy consumption as much as 17% during repetitive lifting that fulfilled by 11 healthy men in 5 minutes (Baltrusch et al., 2019a). In another study, wearing exoskeleton were reduced muscle activities during repetitive lifting and that causes to decrease lower metabolic cost of energy by 22% (Wei et al., 2019). Reduction of energy consumption has been observed that kinematic movements do not affect significantly (Baltrusch et al., 2019b).

As a result of modeling human mobility and neuroscience inspiring electromechanical systems, exoskeletons reached a level that can perform some tasks. If the functions underlying human balance and movement are understood, it can be adapted to legged robots, motor learning models, and prosthetic and orthotic devices (Fasola et al., 2019).

2. PASSIVE EXOSKELETON RESEARCH

Passive exoskeletons can continue to work for a long time since no external power supply is needed. The use of such devices in active life can unite the advantage of flexible human operate with a constant reduction in workers' postural load (Luger et al., 2019a). Most of the exoskeletons designed for industrial use were produced to reduce the load on the spine. Passive wearable exoskeletons aim to store and recycle energy from the lower limbs to help the wearer perform a specific movement (Pardoel & Doumit, 2019).

Passive exoskeletons are devices that increase human movement through the specific use of mechanical elements such as springs, hoists, hoops, and clutches. At the same time, semi-passive exoskeletons counties on exterior power to merely modify the passive behavior of the exoskeleton, such as the modification of spring stiffness at the joint or control the position of

clutches, while still counting on only mechanical elements for actuation (Lovrenovic & Doumit, 2019). As the wearer leans forward, their potential energy is stored in the spring and then returns as they stand up again (Alemi et al., 2019). One of the reasons why springs are used in passive exoskeletons is to stabilize the weight of user limbs or the user body (Zhou et al., 2020).

Exoskeletons can provide users with the following advantages: more durable by dispensing mechanical energy to avoid damage during activities that may cause serious problems such as quick cutting maneuvers or falling from excessive heights, more decisive by modulating the sensory-motor reaction of neuromuscular systems to disturbances, more nimble and faster by rising the relative strength capacity of their muscles (Sawicki et al., 2020).

2.1. Improvement of Lifting with Passive Exoskeletons

In this section, the contributions of recent studies on the removal task are reviewed.

A person needs lower limb movements to perform daily activities such as sitting, walking, running, and to use body functions (He et al., 2007). During lifting, kinematic factors such as moment and power generation from the hip, ankle, knee, and waist joints contribute (Hwang et al., 2009). Failure to maintain strong coordination of upper and lower limbs during lifting causes chronic back pain (Pranata et al., 2018). For this reason, various methods have been adopted to prevent back pain, such as weight restriction and lifting instructions (Bush-Joseph et al., 1988). Because the lifting technique can affect the occurrence of the low back pain (Kingma et al., 2006).

The spine is a structure that achieves its balance from the lower limb (particularly the hip joint) and supports the weight of the upper limb (McGregor & Hukins, 2009). The spine load is more effective in people

with low back pain, depending on the starting position and weight of the object to be lifted (Marras et al., 2004).

A group of researchers conducted trials on users with and without back pain, in which they tested the maximum number of lifts per 2 minutes with a weight of 20 kg and evaluated their results as shown in Figure 1 (Baltrusch et al., 2020c).

Test		Procedure	Objective outcome measure
1. Lifting		Lifting a box of 20 kilos for 2 minutes from ankle height as often as possible. Lifting technique and lifting speed is chosen by the participant.	Number of lifts in 2 mins.
2. Carrying		Carrying 20 kilos in a box for 10 meters. Time recording stopped when the participant passed the 10-meter mark.	Performance time (s)
3. Static forward bending		Standing with flexed trunk between 30 and 60 degrees. Trunk angle is chosen by the participant. Performing a simple manual task on a table at knee height, max 5 mins.	Maximal holding time (s)

Figure 1. Physiological performance tests to report the responses of healthy and low back pain groups to weightlifting (Baltrusch et al., 2020c).

4. 3 point kneeling position		Holding 3-point kneeling position with one hand on the floor. Performing a simple task on the floor, max 5 mins.	Maximal holding time (s)
5. 6 Minutes Walk Test		Walking as far as possible in 6 minutes.	Distance (m)
6. Sit to stand		Sitting down on a chair and getting up 5 times. Participant started in sitting position and time recording stopped when participant sat down the 5th time.	Performance time (s)
7. Stair Climbing		Climbing up- and downstairs as fast as possible for 20 steps. No use of handrails. Time recording stopped when both feet were on the floor again.	Performance time (s)
8. Ladder Climbing		Climbing up and down a ladder twice. Time recording stopped when both feet were on the floor again.	Performance time (s)
9. Bending the trunk		Bending forward as much as possible, knees extended.	Distance fingertip to floor (cm)
10. Wide Stance		Standing with feet 20 cm apart, gradually increasing distance by 20 cm.	Maximal distance (cm)
11. Rotation of the trunk		Rotating the trunk 5 times to both sides.	None
12. Squatting		Squatting down to the floor 3 times, leaving the heels on the ground.	None

Continuation of the Figure 1.

According to research, the healthy group and the low-back pain group did not differ in age (44 years vs. 43 years), weight (87kg vs. 78 kg) and height (180 cm vs. 175cm). Figure 2 shows a remarkable increase in performance when users wear the exoskeleton. (The maximum number of lifts in 2 minutes: 18 lifts ± 6 vs. 20 lifts ± 6)

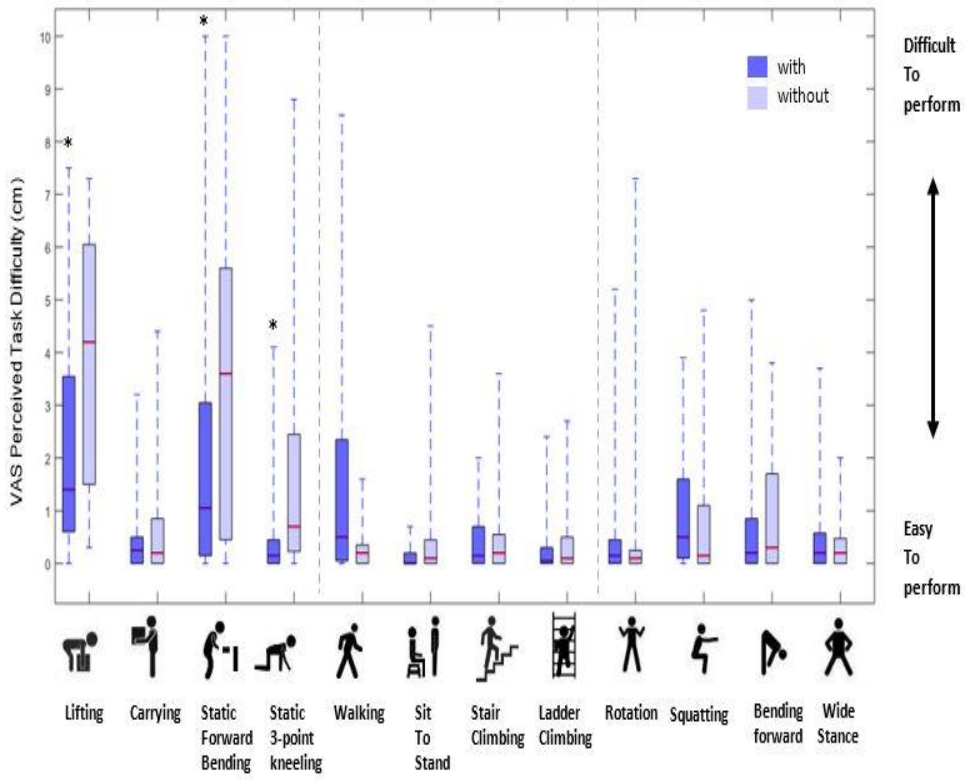

Figure 2. A series of changes in perceived task difficulty for diverse tasks. Such a rise indicates a negative effect and a reduction indicates a positive effect (Baltrusch et al., 2020c).

Baltrusch, Koopman, et al., (2019b) conducted a study where they measured metabolic cost, kinematics, mechanical joint work, and muscle activity during a 5-minute repetitive lifting task. In the study, participants underwent

a 10 kg box lifting at ankle joint height with and without an exoskeleton. The implantation of the exoskeleton they recommended reduced the net cost of metabolic removal by 18%. [Average (SD): 5.63 W / kg (1.26) - 4.64 W / kg (1.38); p = 0.000]. The researchers explained that the average muscle activity in the back muscles decreased significantly when wearing the exoskeleton in one lifting cycle. It was stated that the muscle movement in the abdominal muscles remained the same.

According to Xiong et al., (2019), aimed at lowering metabolic cost, the researchers showed that the metabolic cost of walking at 1.38 m / s with optimal assistance decreased by 7.6% compared to usual walking. They designed an assistive system emphasize hip joint. The total process of their assistance systems is controlled by the mechanical clutch. It also includes springs on the knee joint to assist flexors during the late swing phase.

In study of Zhou et al., (2020), it was proposed that a spring with high hardness and small bias stress or lower hardness and large bias stress can be chosen to stabilize the gravity of the human exoskeleton system. The study results explain that the extra torque necessary in the knee and hip joints will be smaller if springs with lower hardness and greater preload are used.

Koopman et al., (2019d) mentioned about exoskeletons have been shown to decrease back muscle activity by 10% to 40% during static forward bending in their study.

An exoskeleton not only may reduce the feeling of fatigue during the task, but is also safe during accidents. However, users may prejudice that the exoskeleton will be useless and uncomfortable (Hensel & Keil, 2019). On the other hand, Luger et al., (2019b) examined the effects of exoskeletons on user comfort in their study and calculated that the user comfort score was 7.9 out of 10 as a result of the survey. They also observed that sitting low was more comfortable than sitting high.

3. CONCLUSION

Studies have shown the potential of the exoskeleton to reduce the metabolic costs of lifting, thereby decreasing the risk of fatigue in the course of repetitive lifts. There are promising designs to decrease the load on the spine, especially low back pain caused by repetitive work.

The way exoskeletons protect the wearer could be summarized as reducing the biomechanical loads affecting the user's joints, muscles, and soft tissues. In the design of exoskeletons, certain test methods and standards will need to be established to provide capabilities that the user does not have.

In order to develop exoskeleton technology, deep research and experiments will be required in different branches such as physiology, psychology, engineering, and design. In this way, human and machine will be able to gain power and time in harmony.

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UNLAWFUL ACTS THREATENING MARITIME SECURITY AND SUA CONVENTION*

Murat Kağan KOZANHAN[1]

[1]*National Defence University, Naval War Institute, Department of Strategy and Security, Istanbul, Turkey, mkkozanhan@msu.edu.tr; ORCID: 0000-0003-1747-4723*

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ABSTRACT

Piracy is an illegal act that has existed since the beginning of the sea trade. However, efforts continue to be made to or to commit terrorist acts in the seas through piracy activities today. Piracy and terrorist acts at sea threaten/affect not only commercial security but also international maritime security and therefore international security. On October 7, 1985, the hijacking of the Achille Lauro ship brought up the necessity of making an international agreement and cooperation of states to prevent illegal acts at sea, and the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (1988 SUA Convention) and its Additional Protocol were signed. The terrorist acts of September 11, 2001, besides the acts of piracy, also led to the questioning of terrorism and international maritime security in this context and the actions that can be done at sea on 14 October 2005 were rearranged. Within this context, the development of the 1988 SUA Convention was examined in this study, and then the intervention made by the Russian Federation based on the SUA Convention and its Additional Protocol to the Arctic Sunrise ship, which operates on behalf of the Greenpeace Organization, and evaluations were made within the framework of the decisions made as a result of the case being brought to the judiciary.

Keywords: *Piracy, Privateering, Maritime Terrorism, Unlawful Acts on Sea, Arctic Sunrise.*

DENİZ GÜVENLİĞİNİ TEHDİT EDEN YASA DIŞI EYLEMLER VE SUA SÖZLEŞMESİ

ÖZ

Deniz haydutluğu, deniz ticaretinin başladığı ilk zamanlardan beri varlığını koruyan yasadışı bir fiildir. Ancak günümüzde deniz haydutluğu faaliyetleri ile denizlerde terör eylemleri yapılmaya veya yapılması için çaba sarf edilmeye devam edilmektedir. Denizlerde yapılan haydutluk ve terör eylemleri sadece ticari güvenliği değil, uluslararası deniz güvenliğini ve dolayısıyla uluslararası güvenliği de tehdit etmekte/etkilemektedir. 07 Ekim 1985 yılında Achille Lauro gemisinin kaçırılması, denizlerde yapılacak yasadışı fiillerin önlenmesi için uluslararası bir adlaşmanın yapılmasının ve devletlerin işbirliği içinde çalışmalarının gerekliliğini gündeme getirmiştir ve Denizde Seyir Güvenliğine Karşı Yasa Dışı Eylemlerin Önlenmesine Dair Sözleşme (1988 SUA Sözleşmesi) ve Ek Protokol imzalanmıştır. 11 Eylül 2001 tarihli terör eylemleri ise haydutluk fiillerinin yanı sıra, terörizm ve bu bağlamda uluslararası deniz güvenliğinin de sorgulanmasına sebep olmuştur ve 14 Ekim 2005 tarihinde denizde yapılabilecek fiiller yeniden düzenlenmiştir. Bu bağlamda çalışmada, 1988 SUA Sözleşmesinin gelişimi incelenmiştir ve ardından, Greenpeace Örgütü adına faaliyetlerde bulunan Arctic Sunrise gemisine, Rusya Federasyonu tarafından SUA Sözleşmesi ve Ek Protokolüne dayanarak yapılan müdahale ve olayın yargıya taşınması sonucunda verilen kararlar çerçevesinde değerlendirmelerde bulunulmuştur.

Anahtar Kelimeler: *Deniz Haydutluğu, Korsanlık, Deniz Terörizmi, Denizde Yasadışı Fiiller, Arctic Sunrise.*

1. INTRODUCTION

One of the oldest rules of the maritime law, which started to develop with the common law, is the principle of "freedom of high seas". This principle has been clearly defined in international legislation, Article 2 of the Convention on the High Seas, Geneva, 1958 and later in Article 87 of the United Nations Convention on the Law of the Sea, 1982 (UNCLOS) (Gündüz, 1994). Nearly 90% of the products imported and exported worldwide are transported by sea and maritime transportation is the most profitable transportation sector compared to land and air transportation, while the volume of maritime transportation is expanding day by day, the risks and threats encountered in maritime transportation are increasing at the same rate. In order to maintain sea transportation without interruption and without interruption, it is necessary to take necessary national and international measures/precautions for the prevention of illegal acts that may occur in the seas and for the navigation safety of the ships.

One of the unlawful acts that are supposed to begin with maritime history is piracy. The acts of piracy increased and faded at certain times in history. The piracy (LOC, n.d.), which lived its golden age between 1650 and 1726, was supported by the states in a certain period and until the Paris Declaration of 1856, some pirates began to roam the seas with the title of privateer. Privateer, on behalf of the states they pledged allegiance to; they took part in wars against enemy states in the seas and engaged in looting activities. However, as the states gradually lost their control over the privateers, privateering was prohibited upon not being able to prevent their actions.

Illegal acts at sea are not limited to piracy and privateering. Just like piracy, terrorist acts by terrorist organizations and by illegal criminal organizations; acts such as human / weapon / drug smuggling affect the sea and maritime transportation and the economic, social and national security of the states. In this article, the acts of piracy, privateering and terror in the seas, done/can be done, will be defined and the developments of these regulations and the new threat perceptions shaped in the world will be analyzed.

2. UNLAWFUL ACTS ON THE SEAS: PRIVATEERING, PIRACY AND TERRORISM AND THEIR PLACE IN INTERNATIONAL LAW

Illegal acts against the security of ships and crew at sea can be sorted as piracy, privateering and terrorist activities by illegal organizations. Piracy and privateering are different notions in terms of their elements and legal consequences. In the past, it's indicated that these notions were used in the same sense without distinction. Also, no source has been found that indicates precisely when these actions started. However, in a 2009 study, the earliest sources referring to piracy or privateering; it is stated that it was mentioned in the Roman Laws (Justinian Digest) compiled by the Roman Emperor Justinian I in 529 A.D. and in the King John's ordinance of 1201 (Zou, 2009).

In the past, attacking and looting the ships belonging to other states in war and peace was regarded not as a crime, but as an "honorable" act, and those who committed these actions were also identified as heroes (Doğru, 2017). The interests of a union or state in the sea, the protection of merchant fleets and the acquisition of spoils by reaching wealth in distant countries, the seizure / loot of merchant ships under the flag of other states, were carried out using privately owned ships. The use of these ships as if they were state ships was regulated by a document under the name of a permit issued by the states. With this document, the ships belonging to private individuals were given the authority to participate in naval wars with enemy states as if they were warships of the state (Topal, 2010). Private ships with permits became a part of the state navy due to their widespread participation in naval warfare under a state authority. In this context, an attack on enemy ships with a ship equipped by private persons with the permission of a state is called the act of privateering, the person who attacks enemy ships and lands with the permission of the union, authority or state to which he is affiliated is called a privateer, the ships used in such activities are called privateer ships (Bayıllıoğlu, 2011). The privateers authorized for their activities at sea had a mutual relationship of interest with the union, authority or state to which they were affiliated. The privateers had a certain share of the spoils they obtained as a result of their actions in the seas. Unions, authorities or states that did not have a navy or a sufficient naval power compensate for this need in the seas thanks to the privateers. In the 15th and 16th centuries, plundering was used as a method of privateering in the conflict between the

European Christian States and especially the Ottoman Empire and Muslim countries. However, as long as the pirates did not commit an act of injustice in the wars they participated in on behalf of the states they were affiliated to, they were considered prisoners of war if they were captured in war (Evin, 2012). Over time, the activities of privateers gradually shifted towards piracy, the control of unions, authorities or states over privateers and the damage to maritime trade led states to stop using privateers and privateering activities from the end of the 18th century (Evin, 2012), and privateering was prohibited with the Paris Declaration of 1856 (Azubuike, 2009).

Piracy, on the other hand, can be defined as illegal violent acts, which have no connection with any union, authority, or state, unlike privateering, by non-state actors or private individuals to take advantage of on their behalf with the ships and vehicles belonging to them or their organizations against merchant ships, cargoes, goods and people. As it is an important source of income, piracy has continued since previous periods, in the areas where sea trade routes are intensely used and with authority gaps, such as canals, straits, sea crossing nodes and uncontrolled sea areas. The basic international regulations regarding piracy are among Articles 14 and 22 of the Convention on the High Seas, 1958, and between Articles 100 and 107s of the United Nations Convention on the Law of the Sea, 1982 (UNCLOS). The issues specified in the aforementioned articles of the UNCLOS, 1982, are similar to the issues mentioned in the Convention on the High Seas, 1958.

In Article 100 of the UNCLOS, 1982 (Gündüz, 1994), it is stated that all States shall cooperate to the fullest possible extent in the repression of piracy on the high seas or in any other place outside the jurisdiction of any State. Since piracy is an illegal act committed in the seas from past to present and has a negative effect on sea trade, states take all necessary measures in cooperation to prevent piracy.

In Article 101 of the UNCLOS, 1982, piracy is defined as follows (Gündüz, 1994).

> "*Piracy consists of any of the following acts:"*

a. Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:

i. On the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;

ii. Any unlawful violence and arrest or any act of looting against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

b. Any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft,

c. Any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b).

Article 102 of the UNCLOS, 1982, states that the acts of piracy committed by a warship, government ship or government aircraft whose crew has mutinied and taken control of the ship or aircraft are assimilated to acts committed by a private ship or aircraft. In Article 103 of the convention, the definition of a pirate ship or aircraft is given. In Article 104 of the convention, retention or loss of the nationality of a pirate ship or aircraft is determined by the law of the State from which such nationality was derived (Gündüz, 1994) and in Article 105 of the convention, In the event of piracy acts, the prevention of the action and the punishment of the perpetrators are not limited by the authority of the state to which these persons, ships and aircraft were derived. In Article 110 of the UNCLOS, 1982, the right of visit is mentioned, provided that it is supported by reasonable provisions that the act of piracy of a ship.

Any state that detects any acts of piracy is equipped with disciplinary and jurisdiction over the ship or aircraft concerned (Gündüz, 1994). In short, ships detected to be piracy on the high sea or suspected of engaging in such acts can be stopped or inspected by state warships or other state / public ships and military/ public aircrafts authorized to use public force. The aforementioned third state ships and aircraft have the authority to seize the ships, planes and

seized goods used in the act of piracy, and to arrest the perpetrators and hand them over to the national judicial bodies in case of detection.

The notions of piracy and armed robbery at sea are also confused and sometimes used interchangeably. Piracy and armed robbery at sea do the same deeds against ships, personnel / passengers on board and cargo, the distinction between them is made according to the area of the sea in which the act was committed. In the second paragraph of article 2 of "Adoption of the Code of Practice for the Investigation of the Crimes of Piracy and Armed Robbery against Ships" which is accepted by International Maritime Organization (IMO) with the resolution A.1025 (26) dated January 18, 2010, the acts constituting the crime of armed robbery at sea are expressed (International Maritime Organization, 2010). From this point of view, armed robbery at sea includes acts committed in internal waters, archipelagic waters and territorial waters, briefly in the sea areas dominated by states, while piracy includes acts performed on the high seas. In terms of jurisdiction, armed robbery at sea is exclusively under the jurisdiction of the coastal state, as it is carried out in the territories of the states. Since piracy is carried out on the high seas outside the sovereignty of the states, every state has the authority to judge pirates (Gündüz, 1994). However, as in Somalia, obeying this rule is not considered possible today, as it puts states in a troubled process. The ships of the pirates captured by the naval forces of the states struggling with piracy in the Somalia region are released within the framework of the "Capture-Release Strategy" after their weapons are taken away and they are not involved in any trial press (Geib and Petrig, 2011).

Another illegal act committed at sea is terrorist acts committed by illegal organizations at sea. Piracy and armed robbery at sea are illegal crimes for financial gain, and the degree of violence used in these acts is as much as necessary and until reaching the goal. On the other hand, the act of terrorism acts with very different purposes, political / religious goals and ideologies, creates a state of fear in society and individuals, causes disruptions in the national / international functioning of states, destroys / destabilizes the existing government structure and prevents its functioning, and to damage private / public property. It can be defined as disproportionate and highly violent acts.

Terrorist activities at sea are the above-mentioned definition of acts of high violence for certain purposes against ships, oil platforms, port facilities, port hinterland in the marine environment. In this context, within the framework of the current dynamics and trends in international terrorism, terrorist acts that can be carried out in the marine environment can be listed as follows (Knyazeva and Korobeev, 2015):

a. Seajacking, seizure of ships, or control of them by force or in another way;

b. An act of violence against any person on board a ship (the port area) if that act is likely to endanger the safe navigation of the vessel (port security);

c. The destruction of a ship, inflicting damage to the ship or its cargo, or inflicting damage to a certain extent which might endanger the safe navigation of the vessel or port security;

d. Taking actions by placing any electronic device or explosive that could cause damage to that ship or its cargo, threaten to or endanger the safe navigation of the vessel or port security, inflict damage to a device or a system on board or port;

e. The use of vessels by members of international terrorist groups as an indirect object of the terrorist activity

f. The use of sea transport by crime syndicates/terrorist groups involved in illegal commercial activities such as human, weapon, drug etc. to gain pecuniary profit;

g. Making navigational facilitators such as mechanisms of the ship's wheel, gyro, radar etc. unusable by interfering with them and affecting the safe navigation of the ships;

h. Affected port security by the destruction or inflicting serious damage on port facilities, and endangering the safety of navigation and port security

i. Deliberately giving/spreading false information that could jeopardize the safety of navigation and port security;

j. Placing explosives in high-speed boats and causing damage by hitting ships or port facilities / oil platforms;

k. Capturing the navigation (gyro and radar) systems of ships through cyber-attacks and causing accidents or damaging them by changing their routes;

l. Attacks in narrow channels / straits, port entrances or ports where international commercial activity is intense, especially during the cruise of oil tankers and tankers loaded with Liquefied Gas (LNG) by using explosive drones / herd drones;

m. Attacks with drifting mines or floating handmade explosive devices,

n. Damage to ships or port facilities by means of equipment carried by swimmers / divers (Limpet Mine, etc.);

o. Attacks by using handmade explosive devices such as booby traps in ships / vessels to be visited, captured or confiscated based on the intelligence received by law enforcement forces;

p. Attacks to ports or ships using mini / midget submarines loaded with explosives, which are seen in activities such as drug trafficking and illegal immigrant smuggling.

The actions included in the issues mentioned above are actions that are done or can be done at sea. However, it should not be forgotten that the methods used in terrorist acts are limited to the human mind. In these actions, if oil tankers, LNG tankers or oil platforms are targeted, the intense and large amount of oil and its derivatives that will spread to the environment will cause major environmental disasters in addition to human life and economic losses.

3. CONVENTION FOR THE SUPPRESSION OF THE UNLAWFUL ACTS AGAINST THE SAFETY OF MARITIME NAVIGATION

On October 7, 1985, the cruise ship named Achille Lauro with the Italian flag was kidnapped by the members of the Palestine Liberation Front, which is affiliated with the Palestine Liberation Organization, during the Alexandria - Port Said expedition. The people involved in this incident got on the board as tourists from the Port of Genoa in Italy and took the ship's personnel and passengers as hostage by seizing the ship. The activists stipulated the release of 50 Palestinians imprisoned in Israel in order to put an end to their actions, and also stated that they would destroy the ship with explosives in case of a rescue

operation (Halberstam, 1988). The President of the United States of America considered the action as piracy. However, the act was labeled as an act of terrorism due to the fact that a second ship was not used and taking action within the frame of political purposes other than for the purpose of obtaining personal benefit as stated in the Convention on the High Seas, Geneva, 1958, and Article 101 of the UNCLOS,1982.

It has been seen that international law is insufficient in this and possible similar events as a result of the aforementioned action. The preparation of a convention for acts of maritime terrorism was proposed with the initiative of Italy and the participation of Austria and Egypt (Halberstam, 1988). Within this scope, the draft convention text was prepared and submitted to IMO by modeling the contents of the Hague Convention dated December 16, 1970 for the Suppression of Unlawful Seizure of Aircraft and the Montreal Convention for the Unification of Certain Rules for International Carriage by Air, and the International Convention against the taking of hostages of December 17, 1979.

A committee was established by IMO and started working on it to examine and mature the draft convention. As a result of the work carried out by the mentioned committee, in addition to Suppression of Unlawful Acts Against the Safety of Maritime Navigation (SUA), The Protocol for "the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf" was signed on March 10, 1988 and entered into force on March 01, 1992 (International Maritime Organization, 2021). The Convention, which aims to make amendments against acts of terrorism that can be carried out at sea, also covered offenses such as piracy and armed robbery at sea. On September 27, 1990, Turkey became a party to the 1988 SUA Convention by approving it (Turkish Ministry of Justice, 1998).

In the articles 3 and 4 of the SUA Convention, regulations were made for acts of piracy and armed robbery against ships except for the requirement of self-interest and the requirement of two ships and without distinction between the sea areas in which the act took place, as specified in the Convention on High Seas, Geneva, 1958, and the Maritime Law Convention, 1982. There were different points of view in some evaluation made within this framework.

Because the SUA and the conditions such as not committing an illegal act of violence on the high sea and the presence of a single ship during commitment of the action agreement was shown as an anti-terrorist agreement on the United Nations (UN) official website. Although it is possible that the act in question can be considered as piracy, the term piracy was not used in the convention. Therefore, it is a controversial issue whether the SUA Convention changed the definition of piracy, mentioned in the Convention on the High Seas, Geneva, 1958 and UNCLOS, 1982 (Sterio, 2009).

In the event that any person commits one or more of the acts, defined in Article 3 of the SUA Convention and constitute a criminal element; in accordance with Article 6 of the convention, in cases of commitment of crime against a ship carrying the flag of its state or on this ship, in its country including the territorial waters of the state or by a citizen of that state, contracting states of the SUA Convention emphasize that they can take the necessary measures to establish their own jurisdiction over them. Again, in accordance with Article 6 of the convention, each contracting state specified that they can establish their own jurisdiction over cases of commission of the crime with the intention of compelling that state to do or prevent it from doing something such as: committed by stateless persons whose permanent residence is in that state; the detention, threatening, injury or murder of the citizen of that state during the commission of the crime, the commission of the crime with the intention of compelling that state to do something or prevent it from doing something.

With Articles 7, 8, 10 and 11 of the SUA Convention, the powers and obligations of the contracting states were determined regarding the detention, extradition, extradition conditions and trial of the suspects who committed the said crimes. Article 9 of the convention emphasizes that it will not in any way affect the international laws regarding the exercise of powers of investigation or enforcement on ships that do not carry their flag.

In Articles 12, 13 and 14, it is indicated that contracting states should cooperate with each other in all matters, collecting evidence to judge suspects who committed crimes and making cooperation agreements in order to prevent these crimes, to cooperate with each other in all matters in the absence of or not making such an agreement, including assistance in accordance with their

national laws, and every contracting state that believes that one of the crimes specified in Article 3 will be committed, should share the related information held within the framework of its national law.

Article 15 of the convention includes the transmission of the type of commission of the present crime, held in contracting states, procedure in accordance with the second paragraph of Article 13, the measures taken in relation to the offender or suspect, and in particular the consequences of extradition or any information about the results of other legal proceedings, in accordance with their national laws, to the UN Secretary General and the UN Secretary General to publish this information to the relevant units. In the 16th article of the contract, disputes and solution methods arising between two or more contracting states related to the interpretation or implementation of the contract are specified.

The SUA Convention consists of 22 articles in total. After Article 16, articles include the date of ratification, the process related to its entry into force, its sanction, approval, confirmation and the type of the accession to the convention, termination conditions and the issues related to the review or amendment of the convention. The regulated matters and the convention are binding only for the contracting states.

After the acts of terrorism in the United States of America on September 11, 2001, especially, the possibility of oil / LNG tankers and container ships' use for purposes of terrorism in ports and international straits and narrow waterways; tracking and controlling the ships to be used in terrorist activities; the need for more effective measures to prevent the spread and use of nuclear, biological and chemical weapons of mass destruction by sea were defended by other states, especially the USA.

The SUA Convention, 1988, does not give states parties the authority to interfere with ships, known or suspected of illegal acts, boarding, and prosecution of caught criminals on the high seas. Therefore, the provisions of the convention can be applied in the event that persons who commit or are suspected of illegal acts in the seas are caught in the territorial waters, internal waters or territorial land of the state’s party to the SUA convention. This situation was identified as an important deficiency of the SUA Convention and

it was necessary to amend the aforementioned convention in order to prevent acts of terrorism that can be carried out by sea or at sea, and to provide the legal basis for the measures and measures to be taken by the states against illegal activities.

Additionally, on 20 November 2001, IMO's resolution on "Review of Measures and Procedures to Prevent Acts of Terrorism which Threaten the Security of Passengers and Crew and the Safety of Ships" and numbered A.924 (22) was adopted and published expressed (International Maritime Organization, 2002). Within this scope:

- The resolution of IMO, A.924 (22),
- 1997 the International Convention for the Suppression of Terrorist Bombings,
- 1999 the International Convention for the Suppression of the Financing of Terrorism,
- 2005 the International Convention for the Suppression of Acts of Nuclear Terrorism,

The texts above-mentioned and deemed necessary to be added to the 1988 SUA Convention were amended and the 2005 SUA Protocol was prepared as an annex to the 1988 SUA Convention (Klein, 2011). The aforementioned Protocol and some articles in the 1988 SUA Convention were revoked or amended (Official Gazette of the Presidency of the Republic of Turkey, n.d.). In the aforementioned protocol, crimes of terrorism were included in detail, and prevention of the proliferation and use of weapons of mass destruction by sea was stated as one of the most important objectives. In short, the scope of the acts included in the 1988 SUA Convention was expanded with the Articles 3 bis, 3 ter and 3 quater of the 2005 protocol and the scope of the intervention opportunities to the ships / persons was increased with the regulations on the boarding regime with the 8 bis article (Bayıllıoğlu, 2011). The 2005 SUA Protocol is an important document for the legal framework to improve maritime security, as it enables the right to visit ships for crimes against terrorism and proliferation of weapons of mass destruction (Klein, 2011).

4. ARCTIC SUNRISE CASE WITHIN THE FRAMEWORK OF THE SUA CONVENTION AND ITS PROTOCOL

As a result of the melting of the glaciers in the Polar Regions together with the global climate change, the wealth that is assumed to be in the region has created an attraction area. In this context, the littoral countries of the Arctic and the global actors interested in the region have entered a race to get a share from the energy resources (oil, natural gas) in the high sea in recent years. All Arctic Ocean coastal states; The United States, Canada, Denmark / Greenland, Norway, and the Russian Federation have begun to license oil companies to operate in Arctic waters and have begun to establish offshore oil platforms to extract hydrocarbon resources presumed to be in the region. However, due to the risk of oil spills during the operation of oil platforms or as a result of accidents for the vulnerable Arctic ecosystem, for this reason, the environmental organizations such as World Wildlife Fund (WWF) and Greenpeace has been opposed these activities as much as possible.

The Prirazlomnaya oil platform is owned by the Russian oil company Gazprom that was established in the Barents Sea, which constitutes the part of the Arctic Ocean between Norway and Russia in the exclusive economic zone of the Russian Federation and it was established to drill the hydrocarbon resources in the region. On September 18, 2013, activists aboard the Dutch-flagged "Arctic Sunrise" owned by Greenpeace started their actions to protest the Prirazlomnaya oil platform and stop the operation of the platform for a certain period of time. The Russian Federation Coast Guard ship Ladoga notified the Arctic Sunrise crew that it would take the necessary measures to protect the security of the Prirazlomnaya oil platform within the framework of the 1982 UNCLOS provisions, and that it would not be allowed to enter the security zone of 500 meters around the platform and the navigation security area with a radius of 3 nautical miles around the oil platform (Greenpeace, 2018). On 19 September 2013, a total of 30 people, including 28 Greenpeace members (one of them a Turkish citizen) and two crew members of the ship, were detained by the Russian Coast Guard forces and were taken to the Russian port of Murmansk (Silveira and Garbaccio, 2019). The arrest of Arctic Sunrise and its crew by Russia was met with reaction from the flag state, the Netherlands. By the Netherlands;

- During the intervention of the Russian Federation to the ship, being of the Arctic Sunrise in the high sea, the restriction of the high sea navigation freedom of the ship with the intervention,
- The arrest and seizure of the personnel by Russian Coast Guard personnel upon boarding the ship without the consent of the Netherlands, the flag state of the Arctic Sunrise, not being in compliance under the 1982 United Nations Convention on the Law of the Sea (UNCLOS), were reported to the Russian Federation that the Netherlands' Arctic Sunrise ship violated its powers arising from being a flag state.

The protest activity carried out on the Prirazlomnaya oil platform by the environmental activists on the Arctic Sunrise ship was associated with the concept of piracy defined in 1982 UNCLOS article 101 by the Russian Federation and it was also stated that the same agreement could intervene in accordance with the issues mentioned in article 110. (Since the topic addressed in this study is the SUA Agreement, the SUA Agreement and related issues have been mentioned in detail in the Arctic Sunrise case.)

Based on this, in addition to the above-mentioned allegations based on the 1982 UNCLOS, the Russian Federation described the people on board the Arctic Sunrise as terrorist and the action taken as a terrorist activity within the context of the Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf. In this context, in accordance with the Article 2.1. of the aforementioned Protocol (United Nations Office on Drugs and Crime, 1988), if any person;

a. Seizes or seizes control of a fixed platform using force or threats or any form of intimidation; or,

b. Acts violently against a person on a fixed platform in a way that is likely to endanger the security of that platform; or,

c. Destroys or damages a stationary platform in such a way as to endanger its security; or,

d. Is deemed to have committed an offense, if the person places or puts a fixed platform, a device or substance that could destroy or endanger its security, on the fixed platform in any way.

Due to the demands of the Netherlands and the stance applied by Russia against the situation, diplomatic contacts between the two states could not contribute to the solution of the problem. Following the dispute, on 21 October 2013, within the scope of both countries being a party to the UNCLOS, the Netherlands requested provisional measures from the International Tribunal for the Law of the Sea (ITLOS) in Hamburg, and the immediate release of the Arctic Sunrise ship and its crew by the Russian authorities (ITLOS, 2013a). The Russian Federation, on the other hand, stated that the Netherlands did not accept the arbitration procedure and did not intend to attend the hearings in line with its position on arbitration on 21 October 2013 (ITLOS, 2013b).

This case has been dealt with by two courts and two decisions have been passed. The first hearing took place in ITLOS, then the decision on the boarding, the seizure and the detention of the Arctic Sunrise by Russian Coast Guard units was made by the International Court of Arbitration.

On 22 November 2013, ITLOS stated that the Netherlands should pay bail for the release of the Greenpeace activists and the Arctic Sunrise ship and its crew. Upon this, the Russian Parliament uncharged all persons on board, and then Greenpeace activists, the Arctic Sunrise ship and its crew were released. In the decision of the International Court of Arbitration on August 14, 2015, it was stated that the Russian Federation Coast Guard's boarding the Arctic Sunrise ship without the approval of the flag state, the detention of the ship and the arrest of the ship's personnel and Greenpeace member activists could not be associated with piracy, and the oil platform could not be recognized as a ship. Finally, in the decision of the International Court of Arbitration on 10 July 2017, the Russian Federation was found guilty on the grounds that the detention and detention activity it had made on the basis of the SUA Convention and its Additional Protocol was not appropriate and was sentenced to pay approximately 5,395,000 Euros (Permanent Court of Arbitration, 2017) to the Dutch Government (Silveira and Garbaccio, 2019).

5. CONCLUSION

The security of the seas and maritime routes, where 90% of the commercial goods are transported, signifies ensuring the security of trade on a global scale and this issue also affects the welfare, security and policies of the states. Since the beginning of mankind to use the seas for their purposes, seas have harbored various dangers and risks. Piracy and privateering as a state-supported activity are two of mentioned dangers at sea. Privateering was abolished with the Paris Declaration of 1856, but piracy still continues to be concentrated in the east and west of Africa and certain parts of Southeast Asia. However, the smuggling of weapons / drugs by illegal organizations and acts of terrorism, carried out by terrorist organizations in the sea areas, put seas into problematic areas and affect the security, policies and economies of the states.

In international law, it must involve violence, detention and plunder, be done on the high seas or outside the maritime jurisdictions beyond the jurisdiction of a state and for personal benefit, in order for an act to be defined as piracy. However, the criminal act must be committed against another ship by a private ship whose crew and passengers or crew mutiny, or a state ship which the state can no longer exercise control over. Except for situations that do not cover the aforementioned issues, commission of acts is considered as different acts such as armed robbery or terrorism.

Following the kidnapping of the Italian flagged Achille Lauro cruise on 07 October 1985, the necessity of a new regulation that will affect the decisions to be taken in similar events came to the agenda due to the inadequacy of the current international regulations. In this context, the 1988 SUA Convention was prepared and signed on March 10, 1988 and entered into force on March 1, 1992. The regulations introduced by the SUA Convention are binding only on the states that are parties to the convention. In the early 2000s, after the political developments in the world and the terrorist acts of September 11, 2001, the argument that a similar terrorist attack could be carried out from seas by ships became valid, and it has become necessary to make some updates in the contract in order to prevent such terrorist acts and to establish a legal basis for the intervention of those who will perform or performs these acts. The SUA Convention was adopted by preparing an additional protocol within this

framework. Turkey is a party to the protocol which crimes of terrorism are covered in a detailed way, prohibition and prevention of the use and proliferation of weapons of mass destruction by sea, the use and prevention are expressed in one of the most important objectives. Piracy and terrorist acts at sea bear similarities on many points. As in treaties / conventions regulating international law, this convention also does not provide a detailed definition of terrorism. Therefore, this convention makes it difficult to distinguish between piracy and terror at sea. However, the 2005 SUA Protocol is an important document added to the international legal framework for ensuring maritime security in the context of preventing terrorism and the proliferation of weapons of mass destruction in the maritime environment, preventing crimes, and enabling the right to visit ships, which is not specified in other international agreements and conventions.

In this context, the action carried out by Greenpeace, an environmentalist organization, on the Arctic Sunrise ship and the Prirazlomnaya oil platform of the Russian Federation in 2013 was examined as a case study within the scope of the SUA Convention and its additional Protocol. As a result of this review; based on the 1988 SUA Convention and its additional Protocol; the boarding Arctic Sunrise by the Russian Coast Guard Units, the arrest of Greenpeace activists and ship crew, and the detention of the Arctic Sunrise ship were brought to jurisdiction by the Netherlands, the flag state of the Arctic Sunrise. In the decision of the International Court of Arbitration on 10 July 2017, the Russian Federation was found guilty and sentenced to pay compensation to the Government of the Netherlands, stating that the detention and detention activities he had made on the basis of the SUA Convention and its Additional Protocol were not appropriate.

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JOURNAL OF NAVAL SCIENCES AND ENGINEERING (JNSE)
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Submission of Papers: Manuscripts which are submitted to the journal should not be published elsewhere or sent to be published. Authors are (preferably) requested to submit an electronic copy of their original works to the given "System Address" or one hard copy to the address and a soft-copy to the "E-mail Address" which have been given below. It is necessary for the authors to submit their manuscripts together with the "Copyright Release Form". "Copyright Release Form" can be downloaded from the "Copyright Page" of JNSE's Web Page. Authors are requested to obtain the relevant documents for their studies that require "Ethics Committee Approval and/or Legal/Special Permission" and submit these approval documents to the system together with their study.

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Milli Savunma Üniversitesi
Barbaros Deniz Bilimleri ve Mühendisliği Enstitüsü
Deniz Harp Okulu Yerleşkesi
34942 Tuzla/İstanbul/Türkiye

E-mail: *jnse@dho.edu.tr*

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- The content and layout format of manuscript are examined and the originality of study is checked by iThenticate Software Programme.
- The language and correlation of the English abstract with Turkish abstract are checked.
- Manuscript which has a similarity index above 40% is rejected. The author is informed about the manuscript which has a similarity index between 20% and 40% (must not contain more than 4% from a single source), which is not appropriate for the writing rules of JNSE or needs correction in English and Turkish abstracts and the author is requested to revise the manuscript within "two weeks". Otherwise, the article is considered as a retracted manuscript.

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- Editor is assigned by the Editor-in-Chief.
- The relevant reviewers are assigned by the Editors.
- As a result of the reviewer's evaluation, the manuscript may be rejected, accepted or a correction for the manuscript may be requested.
- If the negative feedback is given by major number of the reviewers the process is terminated and the article is rejected.
- If major/minor revisions are required for the manuscript, the author has to do this revision according to the reviewers' comments in "three weeks".
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The Workflow Diagram for the evaluation process can be accessed from the web page of the journal.

The articles submitted to JNSE to be published are free of article submission, processing and publication charges.

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DENİZ BİLİMLERİ VE MÜHENDİSLİĞİ DERGİSİ (DBMD)
YAYIN KURALLARI

Yazıların Gönderilmesi: Dergiye gönderilen makaleler başka bir yerde yayımlanmamış ya da yayımlanmak üzere gönderilmemiş olmalıdır. Yayımlanması istenilen yazılar (tercihen) aşağıda verilen "Sistem Adresi"nden yüklenmeli veya aşağıdaki adrese bir kopya kâğıda basılı olarak ve aynı zamanda "E-mail Adresi"ne dijital olarak gönderilmelidir. Dergimize makale gönderen yazarların makaleleriyle birlikte "Yayın Hakkı Devir Formu"nu da göndermeleri gerekmektedir. "Yayın Hakkı Devir Formu"na DBMD Web Sayfasındaki "Telif Hakkı" sayfasından erişilebilmektedir. Yazarların "Etik Kurul İzni ve/veya Yasal/Özel İzin" gerektiren çalışmaları için ilgili izin belgelerini temin etmesi ve bu izin belgelerini çalışmalarıyla birlikte sisteme yüklemeleri gerekmektedir.

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Adres:
Doç.Dr. Ertan YAKICI
Barbaros Deniz Bilimleri ve Mühendisliği Enstitüsü
Deniz Harp Okulu Yerleşkesi
34942 Tuzla/ İstanbul/Türkiye

E-mail: *jnse@dho.edu.tr*

Yazı Türleri: Dergide; orijinal yazılar, derlemeler, teknik notlar, kitap incelemeleri, editöre mektuplar ile konferans ve toplantıların genişletilmiş raporları yayımlanır.

Yazıların Değerlendirilme Süreci: Makalenin Ön Kontrol Süreci:

- Makalenin içeriği ve yazım formatı incelenir ve iThenticate Programı ile benzerlik taraması yapılır.
- Makalenin İngilizce özetinin, Türkçe öz ile uygunluğu ve yazım dili kontrol edilir.
- Benzerlik oranı %40'ın üzerinde olan makale reddedilir. Benzerlik oranı %20 ile %40 arasında olan (tek bir kaynakla benzerlik %5'ten fazla olmamalıdır), yazım formatına uymayan ya da İngilizce ve Türkçe özetinde düzeltme gereken makale yazara bildirilir ve "iki hafta" içerisinde makalenin düzeltilmesi istenir. Aksi takdirde makale geri çekilmiş kabul edilir.

Dergimiz, makale değerlendirme sürecinde **çift-kör** hakemlik sistemini kullanmaktadır. Buna göre değerlendirme sürecinde hakem ve yazarlar birbirlerinin bilgilerini görememektedir. Bu nedenle, yüklenen ön yükleme formatında yazar(lar)ın isim, adres ve bağlı olduğu kuruluş(lar) yer almamaktadır. Makale değerlendirme sürecindeki adımlar ise aşağıdaki gibidir;

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- Hakem görüşlerinin çoğunluğu doğrultusunda makale reddedilmiş ise süreç sonlandırılır ve makale reddedilir.
- Makale için majör / minör düzeltme istenirse hakem görüşleri doğrultusunda yazarın gerekli düzeltmeleri en geç "üç hafta" içerisinde yapması istenir.
- Revize edilmiş makale kabul alırsa düzenleme aşamasına geçilir.

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JOURNAL OF NAVAL SCIENCES AND ENGINEERING (JNSE)
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Ethics Committee Approval and/or Legal/Special Permission: The articles must state whether an ethical committee approval and/or legal/special permission is required or not. If these approvals are required, then it should be clearly presented from which institution, on what date and with which decision or number these approvals are obtained.

Body of Text: Follow this order when typing manuscripts: Title, Authors, Abstract, Keywords, Title (Turkish), Abstract (Turkish), Keywords (Turkish), Main Text, Appendix (if any), References.

Title: Title should reflect objectives of the paper clearly, be easily understandable and not exceed 15 words.

Abstracts: Each paper should have an abstract with 100-200 words and have a structured form, i.e. standard structure of an article (background, purpose, material and methods used, results, conclusion).

Paper Length: The manuscript should be minimum 2000 words or 5 pages, maximum 7000 words or 25 pages including references.

Keywords: Author must provide some keywords (between 3 and 5) that will be used to classify the paper.

Unit: International System of Unit (Système Internationale d'Unités; SI) (https://www.britannica.com/science/International-System-of-Units) should be used for all scientific and laboratory data.

References: References should be given according to the APA standard as effective from November, 2020 issue.

Abbreviations and Acronyms: Standard abbreviations and acronyms should be used for each related discipline. Acronyms should be identified at the first occurrence in the text. Abbreviations and acronyms may also be attached to main text as an appendix.

Equations and Formulas: Equations and formulas should be numbered consecutively. These numbers must be shown within parentheses being aligned to the right. In the text, equations and formulas should be referred with their numbers given in parentheses. Comprehensive formulas, not appropriate to be written in the texts, should be prepared in figures.

Figures and Tables: Figures and tables should be numbered consecutively. In the text referring to figures and tables should be made by typing "Figure 1." or "Table 1." etc. A suitable title should be assigned to each of them.

DENİZ BİLİMLERİ VE MÜHENDİSLİĞİ DERGİSİ (DBMD)
YAZIM KURALLARI

Genel Bilgiler: Yazılar; Microsoft Word'de tek satır aralığı ve iki yana yaslanarak hazırlanmalıdır. Yazı tipi: Times New Roman, 12 punto. Kenar boşlukları: sol 4,5 cm- sağ 3,5 cm- üst 5 cm- alt 7 cm- üst bilgi 3,25 cm- alt bilgi 6 cm, oluk 0. Kâğıt ölçüsü: A4. Sayfa numaraları sayfanın alt ortasında -1-, -2-, -3- vb. şeklinde yer almalıdır. Dipnot kullanılmamalıdır.

Etik Kurul İzni ve/veya Yasal/Özel İzin: Makalelerde etik kurul izni ve/veya yasal/özel izin alınmasının gerekip gerekmediği belirtilmiş olmalıdır. Eğer bu izinlerin alınması gerekli ise, izinlerin hangi kurumdan, hangi tarihte ve hangi karar veya sayı numarası ile alındığı açıkça sunulmalıdır.

Yazı Yapısı: Yazı şu sırada hazırlanmalıdır: Başlık, Yazarlar, Özet, Anahtar Kelimeler, Başlık (Türkçe), Özet (Türkçe), Anahtar Kelimeler (Türkçe), Ana Metin, Ek (varsa), Referanslar.

Başlık: Başlık; açık, net, anlaşılır olmalı ve 15 kelimeyi geçmemelidir.

Öz (Abstract): Yazı, 100-200 kelimelik, arka plan, amaç, yöntem, bulgular ve sonuçtan oluşan yapılandırılmış bir özeti içermelidir.

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Birimler: Yazının uluslararası alanlarda da kolay izlenebilir ve anlaşılabilir olması için Uluslararası Birim Sistemine (https://www.britannica.com/science/International-System-of-Units) uygun olarak hazırlanması gerekir.

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Şekiller ve Tablolar: Şekiller ve tablolar, ardışık olarak numaralandırılmalıdır. Bunlara metin içinde "Şekil 1." veya "Tablo 1." şeklinde atıfta bulunulmalıdır. Her bir şekil ve tablo için uygun bir başlık kullanılmalıdır.

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Journal of Naval Sciences and Engineering (hereafter JNSE) is a peer reviewed, international, inter-disciplinary journal in science and technology, which is published semi-annually in November and April since 2003. JNSE it is committed to provide a platform where highest standards of publication ethics are the key aspect of the editorial and peer-review processes.

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Following the completion of the editing stage, the manuscript is then scheduled for publication in an issue of the JNSE. The articles which are submitted to JNSE to be published are free of article submission, processing and publication charges. The accepted articles are published free-of-charge as online from the journal website and printed. The articles that are accepted to appear in the journal are made freely available to the public via the journal's website. The journal is also being printed by National Defence University Turkish Naval Academy Press on demand. The printed version can be accessed free of charge from the libraries of the Turkish Universities.

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-Authors should also include a statement in the manuscript that informed consent was obtained for experimentation with human participants. Because the privacy rights of human participants must always be preserved. It is important that authors have an explicit statement explaining that informed consent has been obtained from human participants and the participants' rights have been observed.

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-Peer review process has two fundamental purposes as follow: The first purpose is to decide whether the relevant article can be published in JNSE or not and the second purpose is to contribute to the improvement of the weaknesses of the related article before the publication.

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-Editors ensure that all the submitted studies have passed initial screening, plagiarism check, review and editing. In case the editors become aware of alleged or proven scientific misconduct, they can take the necessary steps. The editors have the right to retract an article. The editors are willing to publish errata, retractions or apologies when needed.

Etik İlkeler ve Yayın Politikası

Deniz Bilimleri ve Mühendisliği Dergisi (Bundan sonra DBMD olarak anılacaktır.); uluslararası düzeyde, hakemli, çok disiplinli, Nisan ve Kasım aylarında olmak üzere 2003 yılından bu yana yılda iki kez yayınlanan, bilim ve teknoloji dergisidir. DBMD yayın etiğinde en yüksek standartların, editoryal ve hakemlik süreçlerinin kilit unsuru olarak değerlendirildiği bir platform sunmayı taahhüt etmektedir.

DBMD'ne gönderilen her bir makale için değerlendirme sürecinde çift-kör hakemlik sistemi uygulanmaktadır. Buna göre, değerlendirme süreci boyunca hakem ve yazarlar birbirlerinin bilgilerini görememektedir. Dergiye gönderilen çalışmaların yazar-hakem ve hakem-yazar açısından süreçlerinde gizlilik esastır. DBMD'ne gönderilen makalelerin değerlendirme sürecindeki inceleme aşamasında kabul edilmeleri halinde, ilgili makaleler için düzenleme aşamasına geçilmektedir. Düzenleme aşamasında, ilgili makaleler yazım formatı ve dilbilgisel yönlerden incelenir. Makalelerin sayfalar üzerindeki biçimi ve yerleşimleri kontrol edilip düzenlenir. Ayrıca referans kontrolü yapılır. DBMD'nde kontrol edilen ve düzenlenen makaleler gizli tutulmaktadır.

DBMD'ne gönderilen makaleler, iThenticate intihal tespit programı aracılığıyla bilimsel çalıntı konusunda kontrol edilir. Editörler, iddia edilen veya kanıtlanmış bir bilimsel kötü kullanımdan ya da usulsüzlükten haberdar olurlarsa bu konuda gerekli adımları atabilirler. Bu anlamda, Editörler gerekli durumlarda DBMD'ne gönderilen ya da DBMD'nde yayınlanmış makaleleri geri çekme hakkına sahiptir.

Düzenleme aşamasının başarılı olarak sonuçlanmasını takiben, ilgili makaleler DBMD'nin bir sayısında yayınlanmak üzere saklı tutulur ve kayıt altına alınır. DBMD'ne yayınlanmak üzere gönderilen makaleler; yazılı materyal gönderme, işleme ve yayınlama süreçlerindeki tüm ücretlerden muaf tutulmaktadır. DBMD'nde yayınlanmak üzere kabul edilen makaleler, derginin internet sitesinden çevrimiçi olarak ücretsiz bir şekilde yayınlanır ve basılır. Dergide yayınlanması kabul edilen çalışmalar, derginin web sitesinden açık erişim ile erişilebilir kılınmıştır. Dergi ayrıca, Milli Savunma Üniversitesi, Deniz Harp Okulu Basımevi tarafından basılmaktadır. Derginin basılı haline Üniversite kütüphanelerinden erişilebilmektedir.

DBMD; editörü ve en az beş değişik üniversitenin öğretim üyelerinden oluşmuş danışman grubu ile açık erişim politikasını benimsemektedir. Buna göre, tüm içerikler ücretsiz olarak kullanıcılar veya kurumlar için ulaşılabilirdir. Kullanıcıların DBMD bünyesindeki makalelerin tam metinlerini okuma, indirme, kopyalama, dağıtma, yazdırma, arama veya bunlara bağlantı verme ve diğer yasal araştırma amaçları için kullanma hakları saklı tutulmaktadır.

DBMD'nin yayın etiği, temel olarak Yayın Etiği Komitesi (COPE), Dünya Mühendislik Kuruluşları Federasyonu (WFEO), Bilim Kurulu Editörleri (CSE) ve Elsevier'in Editörler için Yayın Etiği açıklamaları kapsamında yayınlanmış yönergelere ve önerilere dayanmaktadır.

Editörler, yazarlar ve diğer taraflar da dâhil edilebilecek şekilde yayın sürecindeki görev ve sorumluluklar aşağıdaki gibi tanımlanmıştır.

Yazarların Sorumlulukları:

-Yazarlar, dergide yayınlanan makalelerinin bilimsel, bağlamsal ve dilsel yönlerinden sorumlu tutulmaktadır. Dergide ifade edilen veya ima edilen görüşler, aksi belirtilmediği sürece, Enstitünün resmi görüşü olarak yorumlanamaz ve yansıtılamaz.

-Yazarlar çalışmalarında, DBMD'nin DergiPark internet sayfasında yer alan "Yazım Kuralları"nı dikkate almalıdır.

-Yazarlar araştırmalarını etik ve sorumlu bir şekilde yürütmeli ve ilgili tüm mevzuatları takip etmelidir.

-Yazarlar çalışmaları ve yayınlarının içeriği için ortak sorumluluk almalıdır.

-Yazarlar, yöntemlerin ve bulguların doğru bir şekilde raporlandığından emin olmak için yayınlarını her aşamada dikkatlice kontrol etmelidir.

-Yazarlar, başkalarına ait çalışmaları dolaylı alıntı, doğrudan alıntı ve referanslar ile doğru bir şekilde göstermelidir. Yazarlar, makalelerindeki fikirlerin şekillendirilmesinde etkili ya da bilgilendirici olmuş her türlü kaynağa referans vermelidir.

-Yazarlar çalışmalarındaki hesaplamaları, ispatları, veri sunumlarını ve yazı tiplerini dikkatlice kontrol etmelidir.

-Yazarlar çalışmalarının sonuçlarını dürüstçe; uydurma, çarpıtma, tahrifat veya uygunsuz manipülasyona yer vermeden sunmalıdır. Çalışmalardaki görsel kaynaklar yanıltıcı bir şekilde değiştirilmemelidir.

-Yazarlar, çalışmalarındaki bulguları açık ve net bir şekilde sunmak için araştırma yöntemlerini tanımlamalı ve paylaşmalıdır.

-Yazarlar, yayınlanmış makalelerinin telif haklarını DBMD yayıncısına devrettiklerini kabul etmektedir.

-Yazarlar çalışmalarına çeşitli görsel kaynakları, figürleri, şekilleri vb. dahil etmek için gerekli izinleri almakla yükümlüdür. İlgili çalışmada yer alması gereken resim, şekil vb. anlatımı destekleyici materyaller için gerekli kişilerden ya da kurumlardan izin alınması yazarın sorumluluğundadır.

-Çok yazarlı yayınlarda -aksi belirtilmedikçe- yazar sıralamaları sunulan katkılara göre yapılmalıdır.

-Yazarlar gönderdikleri çalışmada herhangi bir hata tespit ederlerse bu konuda derhal editörü uyarmalıdır.

-Yazarlar dergiye gönderdikleri makalelerin başka bir yerde yayımlanmamış ya da yayımlanmak üzere gönderilmemiş olmaları ile ilgili DBMD'nin DergiPark internet sayfasında yer alan "Yayın Kuralları"nı dikkate almalıdır.

-Yazarlar, ilgili çalışmaları DBMD'nde yayınlandıktan sonra hata tespit ederlerse bu konuda gerekli düzeltmelerin yapılabilmesi amacıyla derhal editör veya yayıncı ile iletişime geçip onlar ile birlikte çalışmalıdır.

-İlgili çalışmada, doğası gereği kullanımlarında olağandışı tehlikeler barındıran çeşitli kimyasallar veya ekipmanlardan yararlanılmış ise yazarların tüm bunları çalışmasında açıkça belirtmesi ve tanımlaması gerekmektedir.

-İnsanlar ve hayvanların katılımını gerektiren çalışmalar için, yazarlar tüm sürecin ilgili yasalara ve kurumsal yönergelere uygun olarak gerçekleştirildiğinden emin olmalıdır ve ilgili komitelerden etik onay alındığını çalışmalarında açık bir şekilde ifade edip belgelendirmelidir.

-İnsanların katılımını gerektiren çalışmalar için, yazarlar kurumsal etik kurul onayı almakla yükümlüdürler. Yazarlar, katılımcıların süreç ile ilgili olarak bilgilendirildiklerini ve bu anlamda, katılımcılardan gerekli izinlerin alındığını bildirmek ve belgelemek zorundadır. Yazarlar, katılımcıların haklarının gözetildiğini açıklayan açık bir bildirim sunmalıdır. Ayrıca bu süreçte, katılımcıların gizlilik hakları her zaman korunmalıdır.

-Yazarlar, hakemlerin değerlendirmelerini, yorumlarını ve eleştirilerini zamanında ve işbirliği içerisinde dikkate almalıdır ve bu konuda, gerekli güncellemeleri yapmalıdır.

Hakemlerin Sorumlulukları:

-Hakem değerlendirme sürecinin iki temel amacı vardır: İlk amaç, ilgili makalenin DBMD'nde yayınlanıp yayınlanamayacağına karar vermektir ve ikinci amaç, yayından önce ilgili makalenin eksik yönlerinin geliştirilmesine katkıda bulunmaktır.

-DBMD'ne gönderilen her bir makale için değerlendirme sürecinde çift-kör hakemlik sistemi uygulanmaktadır. Buna göre, değerlendirme süreci boyunca hakem ve yazarlar birbirlerinin bilgilerini görememektedir. Dergiye gönderilen çalışmaların yazar-hakem ve hakem-yazar açısından süreçlerinde gizlilik esastır.

-Hakemler, değerlendirme sürecinin gizliliğine saygı göstermelidir.

-Hakemler, değerlendirme sürecinde elde ettikleri bilgileri kendilerinin veya başkalarının çıkarları için kullanmaktan kaçınmalıdır.

-Hakemler, değerlendirme sürecinde yazar(lar)ın kimliğinden şüphe etmeleri ve bu bilginin herhangi bir potansiyel rekabet veya çıkar çatışması yaratacağını düşünmeleri halinde mutlaka DBMD ile iletişime geçmelidir.

-Hakemler, değerlendirme sürecinde şüphe ettikleri potansiyel rekabet veya çıkar çatışması durumlarını DBMD'ne bildirmelidir.

-Hakemler, uygun bir değerlendirme yapabilmek için gereken uzmanlığa sahip oldukları, çift-kör hakemlik sisteminin gizliliğine riayet edebilecekleri ve değerlendirme süreci ile ilgili detayları gizli tutabilecekleri çalışmaların hakemliğini kabul etmelidir.

-Hakemler makaleyi, ek dosyaları ve yardımcı materyalleri incelemelerini takiben bazı eksik belgelere ihtiyaç duymaları halinde bunları talep etmek üzere DBMD ile iletişime geçmelidir.

-Hakemler dergide yayınlanacak makalelerin akademik kalitesinin en temel tespit edicisi olduklarının bilinciyle davranmalı ve akademik kaliteyi arttırma sorumluluğuyla inceleme yapmalıdır.

-Hakemler, Etik İlkeler ve Yayın Politikası ile ilgili herhangi bir usulsüzlük tespit etmeleri halinde DBMD editörleri ile irtibata geçmelidir.

-Hakemler, kendilerine tanınan süre içerisinde makaleleri değerlendirmelidir. Şayet uygun bir zaman içerisinde değerlendirme yapamayacaklarsa, bu durumu en kısa zamanda DBMD'ne bildirmelidirler.

-Hakemler, değerlendirme sürecindeki çalışma için kabul etme / yeniden gözden geçirme / reddetme şeklindeki önerilerini DBMD tarafından sağlanan Hakem Değerlendirme Formu aracılığıyla bildirmelidir.

-Sonucu reddetme şeklinde olan değerlendirmeler için hakemler, ilgili çalışmaya dair eksik ve kusurlu hususları Hakem Değerlendirme Formu'nda açık ve somut bir şekilde ortaya koymalıdır.

-Hakem değerlendirme raporlarının, DBMD tarafından sağlanan Hakem Değerlendirme Formu'na uygun biçimde ve içerikte hazırlanması ve gönderilmesi gerekmektedir.

-Hakem değerlendirme raporları adil, objektif, özgün ve ölçülü olmalıdır.

-Hakem değerlendirme raporları, ilgili makale ile ilgili yapıcı eleştiriler ve tavsiyeler içermelidir.

Editörlerin Sorumlulukları:

-Editörler, derginin bilimsel kalitesini arttırmak ve yazarları bilimsel kalitesi yüksek araştırmalar üretmek için desteklemek ile sorumludur. Hiçbir koşulda, intihal ya da bilimsel kötüye kullanıma izin verilmemektedir.

-Editörler, dergiye gönderilen her çalışmanın çift-kör hakemlik sürecine ve diğer editoryal süreçlere tabi olmasını sağlamaktadır. DBMD'ne gönderilen her çalışma, çift-kör hakemlik sürecine ve nesnel değerlendirmeye dayalı editör kararına bağlı tutulmaktadır.

-DBMD'ne gönderilen her bir çalışma, uygunlukları açısından editör tarafından değerlendirilir ve daha sonrasında, incelenmesi ve değerlendirilmesi amacıyla en az iki uzman hakeme gönderilir.

-Editörler, yazarlar ile çıkar çatışması olmayan hakemleri, çalışmayı değerlendirmek üzere atamakla sorumludur. Çift-kör hakemlik süreci, editör için değerlendirme ve düzenleme aşamalarında katkı sağlamaktadır.

-Editörler, DBMD'ne gönderilen tüm çalışmaların ön kontrol, tarama, intihal kontrolü, değerlendirme ve düzenleme aşamalarından geçmesini sağlar. Editörler iddia edilen veya kanıtlanmış bilimsel kötü kullanımdan haberdar olurlarsa makaleyi geri çekebilirler. Editörler, gerekli durumlarda gönderilen çalışmayı düzeltme, geri çekme veya çalışma hakkında özür yayınlama hakkına sahiptir.

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