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## Determining The Impact of the COVID-19 Pandemic on Commercial Activities in Istanbul

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### ABSTRACT

The purpose of this study is to investigate the initial impacts of the COVID-19 pandemic on enterprises and identify differences in the effects of COVID-19 across scales and sectors. This study employed AHP to prioritize solution proposals, factor analysis to determine problem components by sectors and scales, and machine learning methods to estimate enterprise sector and scale based on survey data. The study included 255 statistically reliable samples collected between July to October 2020. Survey and comparison questions were used to determine the impact level of enterprise problems. Open-ended questions categorized pandemic-related commercial activity problems and solution proposals by enterprise scale and sector. The AHP analysis prioritized the same three problems across different scales and sectors, but machine learning-based classification analysis revealed varying criteria for determining sector and scale. Due to the fragility of developing markets public authorities expanding their economic activities during crises need to design appropriate different policies especially to protect SMEs and keep enterprises standing. This paper presents a unique and high-quality dataset collected through a survey, examining similar issues from a historical perspective, and providing insight into the initial impacts of COVID-19 on enterprises for policymakers. The study stands out for its analysis of COVID-19 from both scale and sector perspectives, with Istanbul providing a representative sample of all sectors and scales due to Istanbul having the highest diversity among the regions in Turkey in terms of enterprises.

### 1. Introduction

The atmosphere of uncertainty experienced due to the coronavirus pandemic caused global trade and supply chains to deteriorate rapidly; commodity prices to fluctuate, and governments and multinational enterprises to make critical decisions with limited information. For this reason, while the pandemic impacts continues, all countries need measures on a macro and micro scale as much as possible. However, the impact of COVID-19 on business lines on a micro-scale has not been fully

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determined. The relentless impact of the COVID-19 pandemic has sown seeds of uncertainty, precipitating a cascade of disruptions across global trade networks and supply chains. This upheaval has triggered a volatile flux in commodity prices while compelling pivotal yet uncertain decisions from governments and multinational corporations. As the pandemic endures, the imperative for nations transcends mere macro-level interventions; it necessitates meticulous attention to micro-level strategies. Despite concerted efforts, the full extent of how COVID-19 intricately shapes and molds the fabric of individual business operations remains an enigma waiting to be deciphered amidst this complex and evolving global scenario.

In the realm of economic management, pivotal decisions are historically rooted in data derived from national surveys involving households and businesses. Particularly during crisis periods, the quality of this data and the information gathered hold immense significance. They serve as the bedrock for navigating through crises, shaping policies, and fortifying measures adopted by economic governance. Understanding the challenges faced by vulnerable enterprises amid the uncertainty sparked by crises forms a critical roadmap. These insights become guiding beacons, illuminating the pathways for policymakers as they navigate the decision-making landscape.

The area where the direct effects of the vulnerabilities a country is exposed to are the changes in economic/financial business and transactions. The effects of the epidemic, which started in China in 2019, spread rapidly all over the world and caused public authorities, enterprises, and individuals to change their preferences and priorities. In the globalizing world, the fact that the contagion of crises will not only be through financial or economic resources, but once experienced through health problems, has increased the awareness of public authorities against crises. As of 2020, Türkiye has taken its place among the countries that have begun to be affected by the COVID-19 epidemic. The transformation of the health crisis into an economic crisis has taken place over time and there have been contractions/disruptions in the trade channels, and economic stakeholders have taken a new position with the rising inflation all over the world. Such a transformation has revealed different problems and solutions for enterprises during the epidemic period. In Türkiye, which is one of the developing countries, how enterprises meet the crisis and what kind of solutions they produce are also important.

Understanding the problems faced by enterprises in Türkiye will undoubtedly guide the problems of emerging markets. In this study, the problems and solution proposals of companies during the COVID-19 period were analyzed in order to understand and find a new path to solve unexpected problems. Employing the Analytical Hierarchy Process (AHP) constituted the primary methodology to ascertain the hierarchy of problem importance and establish the priorities for proposed solutions. This methodological approach facilitated a systematic evaluation, enabling the categorization of issues based on their significance and providing a structured framework to prioritize and address these concerns effectively. Secondly, the "principal component factor analysis" method was employed to determine changes in the component of problems by scales and sectors. Finally, machine learning methods were used to estimate the sector and scale of enterprises based on survey data. In this study, the number of statistically reliable samples was determined as 255 surveys. The survey's answers were collected between July to October 2020. Then, the impact level of the problems of the enterprises is determined by using survey questions and comparison questions. In addition, it has been provided to reveal the impact levels for enterprises' scales and fields of activity. The open-ended questions used in the survey enabled the categorization of the problems encountered in commercial activities during the pandemic period and the solution proposals. Based on secondary data, similar issues are examined from a historical perspective, and policy recommendations are presented.

## 2. Literature

The literature in COVID-19 pandemic context generally aims to reveal the economic impact of the COVID-19 crisis and generally focuses on the general economic structure. Thus, we grouped the literature into three parts. The first one is the studies focused on general macroeconomic implications, second is sectoral studies which try to examine the effects of pandemic on sectors or a specific sector, and lastly enterprise-based analysis which take the several enterprises in various sectors as sample and generally analyzed performance of enterprises. Those three groups are important for our study because we try to examine the differences of the pandemic effects on both different sectors and enterprises for different scales.

The studies on analyzing the effect of the pandemic on macroeconomic variables contain diverse analyses ranging from examining the economic losses incurred by specific economies to the intricate relationships between pandemic dynamics and various economic indicators. Notably, these analyses scrutinize the consequences of the pandemic on global economies, stock markets, and industries through different methodologies such as regression models, cointegration tests, and event studies. They reveal intricate connections between pandemic-related factors like the number of cases or deaths and their influence on financial market behaviors, including stock prices, crude oil prices, and exchange rates. Furthermore, some studies extend their analysis to explore the interplay between pandemics and economic decisions, highlighting the balance between imposing restrictions to control the virus and the subsequent economic impact. These investigations, often grounded in theoretical models or empirical data, offer valuable insights into the complex interrelationships between health crises and economic variables, providing a nuanced understanding of the pandemic's pervasive effects on diverse economic spheres. Some of them as follows; Ayitney et al. [1] investigated the effects of the COVID-19 pandemic on China and the world economy in their study. In the study, it is stated that for the first quarter of 2020, the Chinese economy will suffer a loss of approximately 62 billion dollars and the world economy will incur a loss of more than 280 billion dollars. Albulescu [2] examines the impact of the COVID-19 outbreak on crude oil prices and the impact of financial fluctuation and US economic policy uncertainty. In the study, the results were obtained with the help of ARDL model by using crude oil prices, VIX index, Economic Uncertainty Index (EPU) and numbers of daily Corona virus cases for the period of 21 January 2020 - 09 March 2020. In the study, it was concluded that the daily number of COVID-19 cases causes a negative effect on crude oil prices in the long run. In addition, it was stated that the COVID-19 outbreak had an impact on the dynamics of crude oil prices by increasing the volatility of financial markets. Eichenbaum, Rebelo, and Trabandt [3] analyzed the relationship between pandemics and economic decisions. In the study, the classical SIR model proposed by Kermack and McKendrick [4] was extended to examine the equilibrium interaction between economic decisions and pandemic dynamics. According to the research findings, reducing the work and consumption of individuals reduced the severity of the pandemic. It was stated that the imposed restrictions not only increased the economic recession, but also saved the lives of nearly half a million people for the USA.

Guerrieri et al. [5] theoretically investigates how the negative supply shock caused by the COVID-19 pandemic will affect demand in the context of Keynesian supply shocks and which policy tools should be applied to eliminate this effect. The study focuses on the idea that a supply shock in production and employment may trigger a demand shortage that causes a larger contraction than itself. As a result of the study, it was stated that the negative supply shock due to the pandemic may cause excessive decreases in demand and that the most appropriate policy is loose monetary policy and social expenditures.

McKibbin and Fernando [6] used a modelling technique developed by Lee and McKibbin [7] and further extended by McKibbin and Sidorenko [8] to determine the possible economic consequences

of the COVID-19 outbreak that has wreaked havoc on the Chinese economy and spread rapidly globally. They explored seven different scenarios for how the pandemic could evolve in 2021. According to the results showing the effects of different scenarios on macroeconomics and financial markets, it has been determined that even a closed pandemic can significantly affect the global economy in the short term. Considering these scenarios, it becomes evident that increased investment in public health systems across all economies, especially in underdeveloped regions with high population density, could lead to cost reductions. Therefore, several policy recommendations are presented. In the short term, central banks and treasury bonds emphasized the need to ensure that deteriorated economies continue to operate while the pandemic continues. Furthermore, this shock transcends mere demand management; it constitutes a complex crisis demanding interventions across monetary, fiscal, and health policies.

In their study, Şit and Telek [9] examined the relationship between the gold ounce price and the dollar exchange rate index in the COVID-19 pandemic for the period from 1 March 2020 to 7 May 2020 with the cointegration test and causality test. As a result of the analysis using the daily number of cases and deaths, it was determined that the number of cases and deaths were cointegrated with the dollar index and that the positive shocks in the number of cases and deaths caused shocks on the gold ounce price and the dollar index.

Zeren and Hizarci [10] examined the relationship between the COVID-19 pandemic and the stock market with cointegration analysis for the period of 23 January 2020 - 13 March 2020. In the study using daily data from China, Italy, France, Germany, Spain, and South Korea, which are the countries where COVID-19 is most common, it was concluded that the deaths due to the COVID-19 pandemic and the stock markets act together in the long term.

Batrancea [11], financial performance's impact on long-term financial stability was examined using data obtained from 34 large companies traded on the New York Stock Exchange and operating in a wide range of industries and sectors worldwide. Spanning a decade, the analysis encompassed two significant crises, the Financial Crisis, and the proximate COVID-19 pandemic, both pivotal events in the early 21st century. Through panel data modeling, the study unveiled substantial correlations between various financial performance indicators and the short-term and long-term financial standings of these publicly traded entities. Notably, metrics like the current ratio, quick ratio, and debt/equity ratio exhibited significant sensitivity to different financial performance markers, delineating their impact on overall financial stability.

Singh, Dhall, and Narang [12] conducted a study examining the impact of the COVID-19 pandemic on G-20 countries' stock markets. Utilizing an event study methodology and panel data regression, they analyzed indices from these countries. Their investigation spanned 58 days following the pandemic's international media coverage, with an estimation window of 150 days prior to this event. The findings revealed statistically significant negative abnormal returns across four sub-event windows within the 58-day period. This trend of negative abnormal returns was observed consistently across both developed and developing nations. Negative abnormal returns were found to be significant for both developed and developing countries. The findings of this study figure out the consequences of increasing panic in the stock markets due to COVID-19-positive cases in G-20 countries. It is seen that after a large stock price correction due to COVID-19, the stock markets may recover. Additionally, panel data analysis confirms that the stock markets have recovered from the negative effects of COVID-19.

The second group of literature refers to the studies on a sectoral basis. These studies put forth the effect of pandemic on various sectors. This type of study is also important because the effect of pandemic has different effects and impacts on different sectors. COVID-19, as evidenced by a myriad of sectoral studies, has wielded diverse and far-reaching impacts across industries globally. From the

discernible consequences on tourism, hospitality, and transportation to fluctuations in sectors like mining, agriculture, and finance, the pandemic has induced a spectrum of challenges. Studies highlight pervasive short-term disruptions, including reduced demand, fluctuations in productivity, and employment uncertainties, while also revealing sector-specific vulnerabilities and transformations. Despite variances in effects across sectors, these investigations collectively stress the imperative for adaptable, targeted strategies to navigate and recover from the multifaceted impacts of this global crisis. Some of the important studies are as follows.

Furceri et al. [13] presents novel insights into the potential repercussions of the COVID-19 Crisis by empirically analyzing the dynamic effects of recessions on Total Factor Productivity (TFP) across 24 sectors in 18 developed economies. Their findings suggest that severe recessions have a lasting impact, leading to a permanent decline in total factor productivity. This enduring effect is attributed to misallocated resources among sectors. The study reveals that deep recessions not only result in sustained reductions in output and production input but also entail enduring losses in TFP. Specifically, the research highlights a significant drop in TFP following deep recessions, with the effect persisting at a level between 3 to 4 percent for 3 to 5 years in the aftermath. While the study offers critical insights, it acknowledges the need for further research to ascertain whether COVID-19 will lead to comparable losses. Moreover, the study underscores the crisis's pronounced impact on sectors such as tourism, restaurants, communication, informatics, and those reliant on face-to-face interactions, signifying the heightened vulnerability of these sectors in the wake of the crisis.

Laing [14] evaluated the economic effects of the COVID-19 outbreak in the mining sector. It has been stated that there has been a decrease in the prices of these items since March 2020, with the decrease in demand for metals and minerals. The study compared the fluctuations of the gold in the period of COVID-19 with the 2008 Crisis. Laing's evaluation of the economic effects within the mining sector suggests short-term impacts on prices, production, and reduced sector profitability. However, Laing highlights a considerable level of uncertainty regarding the medium to long-term effects on the industry.

Gunay, Bayraktaroglu and Ozkul [15] examined the effects of COVID-19 on tourists within the framework of scenario analysis using monthly data from 2020. As a result of the study, it was stated that the number of tourists coming to Türkiye in 2020 will decrease by 5%-53%, while tourism revenues will decrease by \$1.5 billion in the best scenario and \$15.2 billion in the worst-case scenario.

In the study by Lin and Zhang [16], the impact of COVID-19 on agricultural export companies in China was investigated using firm-level survey data. While on average, agricultural enterprises experienced declines in exports, it was found that some agricultural products, especially grains and various oils, maintained strong export performance, with even increased demand for these products. This suggests that the pandemic has led to an increase in demand for basic food items. In addition to basic food products, there was also a significant increase in the export of medicinal plants during the pandemic, but the export of goods such as edible mushrooms and horticultural products sharply decreased. Furthermore, the results indicate that the impact of COVID-19 on small firms was more severe than on larger firms.

Shabir, et. al. [17] investigated the impact of the COVID-19 pandemic on the performance and stability of the banking sector. Data from 2,073 banks in 106 countries from 2016Q1 to 2021Q2 are used as the sample. The findings reveal that the COVID-19 pandemic has significantly reduced the performance and stability of banks. The analysis results suggest that the negative impact of COVID-19 is dependent on the characteristics of the bank and market structure and that a better regulatory environment, institutional quality, and financial development significantly enhance the strength and resilience of banks.

In the study conducted by Ayati, Saiyarsara, and Nikfar [18], the short and long-term effects of the developments during the COVID-19 period on the pharmaceutical sector are evaluated. The short-term effects of the COVID-19 pandemic are discussed in areas such as demand changes, regulatory revisions, and changes in the research and development process. The long-term effects of the COVID-19 pandemic are examined through fields such as slowing growth in the sector, approval delays, the transition to self-sufficiency in the drug manufacturing supply chain, and changes in consumption trends of health market products. The study provides various recommendations for the short and long-term effects experienced in these fields.

Biswas, et. al. [19] studied the relationship between stagnation in the construction sector due to the pandemic and other economic indicators. Construction and engineering projects have been endangered in various ways due to the COVID-19 outbreak, and many projects have come to a standstill. As a result, financial stagnation due to disruptions in the construction sector has been observed in almost all countries, and there has been an increase in unemployment rates. As a result, the study attempts to explain the global impact of the pandemic on the construction sector by considering selected countries. The study also explains how construction work can continue during the pandemic. According to the analysis of the study, it is emphasized that if construction activities continue, economic stagnation will decrease and there is a possibility of a decrease in unemployment rates.

Hoque, et al. [20] investigated the impact of COVID-19 on the tourism industry in China during the pandemic. The findings of the research indicate that people from other countries are afraid of blending with the Chinese population because COVID-19 started in China. It is believed that global tourists cancel their travel plans to China, and Chinese tourists are banned from visiting overseas countries, leading to cultural restrictions. As a result of this fear, the country's tourism industry has been affected domestically and internationally. Therefore, it is considered that the concentration of the coronavirus has had a long-term impact on the country's tourism industry.

Bortoló, Valdés and Nicolas-Sans [21] examined the impact of the COVID-19 pandemic on the use and transformation of big data, artificial intelligence, and new technologies across different sectors. The study aims to evaluate the use and standardization of big data in the public and private sectors and assess how this process has contributed to modernization. The main objectives of the article are: 1) to understand the impact of new technologies on society during lockdowns; 2) to comprehend the use of big data for the creation of new products and businesses; and 3) to evaluate which companies and economic sectors have emerged, transformed, or disappeared during the pandemic.

Henseler, Maisonnave, and Maskava [22] discussed the impact of the COVID-19 pandemic on the tourism sector and its relationship with other sectors, as well as the macroeconomic effects on the Tanzanian economy, which heavily relies on tourism for its gross domestic product. The tourism sector typically links local sectors such as transportation, accommodation, beverages, food, and retail trade, playing a significant role in household income. The study evaluates the macroeconomic effects of COVID-19 on the tourism sector and the Tanzanian economy, using a general equilibrium model framework to simulate the economic effects quantitatively. The results show that the negative shocks caused by COVID-19 have had an adverse impact on the growth rates of the selected country. The decrease in tourism demand, coupled with the decline in transportation and communication services, is forcing sectors to reduce their production and lay off workers. Additionally, these sectors are reducing their intermediate demands, adversely affecting other sectors.

Mack, Agrawal, and Wang [23] analyzed the employment effects of the pandemic on transportation workers compared to workers in other sectors, as well as within different sub-sectors of the transportation industry. The study finds that the transportation sector experienced more

unemployment cases compared to other sectors. Additionally, the study highlights the heterogeneity of employment effects within the transportation sector.

Slavković, Ognjanović, and Bugarčić [24] assessed the sustainability of human capital productivity in the hotel industry, including the early effects of the COVID-19 pandemic. Using a value-based approach, the study calculates the human capital productivity coefficient from a sample of 157 hotels over five years, including the year of the pandemic declaration. The research findings show a change in the trend of human capital productivity in the hotel industry in 2020, indicating the impact of the pandemic on the sustainability of human capital productivity in this sector.

Demirhan and Sakin [25] conducted a study to analyze the effects of the COVID-19 pandemic on the profitability of publicly traded firms, using dynamic panel data analysis to examine the persistence of firm profits. The sample for the study consisted of non-financial firms, including both manufacturing and non-manufacturing firms, listed on the Istanbul Stock Exchange, excluding holding companies, banks, and investment trusts. The findings demonstrate that COVID-19 had different effects on profitability measures, with varying impacts on manufacturing and non-manufacturing firms.

In the study conducted by Gu, Ying, and Zhang [26], the daily electricity consumption data of 34,040 businesses in Suzhou, China, were examined to understand the economic activities during the COVID-19 period. The study found that sectors such as construction, information transmission, computer services, and software, as well as health and social services, were positively impacted by COVID-19, while the manufacturing sector was the most negatively affected.

Wang and Zhang [27] suggested that the insurance market was significantly affected by the outbreak of COVID-19. Their results unveiled stark declines in commercial insurance premium income, the year-on-year premium growth rate on a monthly basis, insurance density, and insurance depth due to the pandemic's effects. Notably, adverse consequences were observed in property and personal insurance domains. The study suggests that elevating social security measures and advancing digital insurance infrastructures could potentially alleviate the negative repercussions of the pandemic on the insurance market.

In the study conducted by Mateev, Tariq, and Sahyouni [28] examined the impact of banking competition and capital levels on the risk-taking behavior of banking institutions in the Middle East and North Africa (MENA) region. The data from more than 225 banks in 18 countries were used to test whether increased competition during the COVID-19 period led to higher capital ratios for banks. The research, employing panel data analysis and distinguishing between Islamic and conventional banks, revealed an intriguing trend: banks exhibited elevated capital ratios in more competitive landscapes. Specifically, within the MENA region, banks showcased a propensity to bolster their capitalization levels when faced with heightened risk scenarios. Equally noteworthy was the observed trend of banks decreasing their capitalization levels in less competitive environments. This evidence suggests responsive behavior among banks, indicating a proactive approach to fortify capital reserves in riskier settings and a contrasting strategy in less competitive contexts.

Atayah, et al. [29] investigated the mutual relationship between the financial performance of logistics companies listed on the stock exchange and COVID-19 and compared the financial performance of logistics companies in G-20 countries during the pandemic. The research sample brings together data from 2010 to the fourth quarter of 2020. The study's findings revealed a notable increase in the financial performance of logistics companies in 2020. Overall, the study's outcomes supported specific country trends, highlighting a substantial surge in the financial performance of logistics companies across 14 out of the 20 countries analyzed during the pandemic. Yet, this research uncovered a contrasting narrative, revealing that logistics firms in six specific countries -Germany,

Korea, Russia, Mexico, Saudi Arabia, and the UK- reported adverse financial outcomes amid the COVID-19 period, aligning with the study's second proposition.

Nguyen, Hai, and Nguyen [30] conducted a comprehensive study examining the ramifications of COVID-19 preventive measures on the stock returns and liquidity of financial service companies in Vietnam. Their research employed panel data regression analysis, encompassing data from 50 companies operating in banking, insurance, and finance sectors, all listed on Vietnam's major stock exchanges—HNX and HOSE. The study scrutinized the period spanning from January 30, 2020, to May 15, 2021. Their findings unearth a notable correlation: a substantial adverse effect on both stock returns and liquidity was observed with each daily increase in confirmed COVID-19 cases, underscoring the pandemic's profound impact on these financial entities.

The third group of the literature is the studies on effects of COVID-19 pandemic on firms and firm performances. These types of analysis also have implications for the firms for different scales. These studies delve into how the pandemic has affected firms across various scales, shedding light on its implications for businesses of different sizes and within different sectors. They explore a wide array of aspects, ranging from financial constraints and global market relationships to the changes in firm behavior and government policies. These analyses aim to understand the challenges encountered by businesses during this period and often propose strategic recommendations to help firms navigate the post-pandemic landscape effectively.

Ferrando and Ganoulis [31] studied the spread of the shock caused by the pandemic to the financial conditions of enterprises. For a large sample of SMEs in the Eurozone, survey data collected at firm level from the end of February to the beginning of April 2020 were selected by random sampling method and analyzed by the ordinal logit regression method. The findings of the study, it was determined that in the first half of March, the expectations of enterprises regarding credit limits, bank loans and the availability of commercial loans deteriorated significantly.

Senol and Zeren [32] examined the effects of the COVID-19 on global markets with the Fourier Cointegration Test for the period of 21 January 2020 - 7 April 2020. The number of COVID-19 cases and deaths from Europe, emerging markets and G7 countries in MSCI were used. The research outcomes underscore a significant long-term relationship between stocks and the COVID-19 outbreak.

Corredera-Catalán, Pietro, and Trujillo-Ponce [33] stated the financing constraints in Spain in terms of COVID-19 pandemic. They put forth that public authorities can use guarantee schemes as a tool to improve SMEs' access to finance.

Aftab, Naveed, and Hanif [34] examined the impact of the COVID-19 pandemic on SMEs in Pakistan. They revealed the negative impacts faced by SMEs in Pakistan during this pandemic. These are shortage of goods, problems in transportation, and a decrease in demand for products and services. Others are also listed as a decrease in profits and sales, quarantine, and employee dismissal. Policy recommendations are presented for Pakistan. In their studies, it is emphasized that a separate analysis to be made on a sectoral basis, as in our study, will contribute to the literature.

Hu and Kee [35], examined the impacts of the COVID-19 on SMEs. In addition, SMEs examined how they should adapt to the new normal by expanding regionally and globally. It also reveals the tactical and strategic interventions that SMEs should take.

Turkson et al. [36] studied the repercussions of the COVID-19 pandemic on businesses, initially forecasting substantial losses—around 8.3 billion dollars—in Italy's service and manufacturing sectors. Utilizing panel data encompassing pre-pandemic and pandemic periods for 419 Italian firms, the study probed the influence of government policies on these entities. Their findings reveal a notable disparity: firms that received government aid specifically for COVID-19 saw an average 11% surge in sales revenue by June 2020 compared to those without grants. Moreover, the analysis



suggests that these disparities in sectoral performance were correlated with sales revenue, highlighting the efficacy of government policy, particularly within the service sector.

Achim et al. [37] conducted a study to assess the level of business performance during the COVID-19 pandemic by analyzing various key changes in organizational activities. To achieve this, panel data analysis was applied to 218 companies listed on the Romanian stock exchange from different industries and of different sizes (large and small) for the period between June 30, 2019, and June 30, 2020. The analysis showed a 37.43% contraction in the sectors during the period, but small companies engaged in agriculture, trade, construction, R&D, transportation, and storage were found to have better financial performance.

The results underscore the critical need for governments to comprehend businesses' responses during the pandemic. This understanding is vital in identifying sectors most susceptible to crisis effects and discerning key financial management strategies crucial for companies navigating such challenging times. By grasping how different sectors responded, governments can tailor more effective support measures and policies to bolster vulnerable industries and assist companies in making informed financial decisions amid crises.

Golubeva [38] investigated the impact of the COVID-19 pandemic on company performance by considering the financial structure of firms and country-specific indicators. The study was tested with regression analysis for businesses during the COVID-19 pandemic. The research was based on a dataset of 5,730 firms from 13 countries collected through enterprise surveys by the World Bank. The study confirms the importance of factors such as sector, size, participation in exports, and market demand for firms' products for company performance. The study also highlights the importance of country-specific factors for firm performance, including economic development level and institutional governance infrastructure.

Shen, et. al. [39] investigated the impact of COVID-19 on corporate performance using the financial data of selected Chinese companies. It is found that COVID-19 has a negative effect on firm performance. It is noted that the negative impact of COVID-19 on firm performance becomes more pronounced when a firm's investment scale or sales revenue is smaller. The analysis also highlights that the negative impact of COVID-19 on firm performance has a serious impact on fields but is more pronounced in specific industries.

Brancati and Brancati [40] examined the effects of the COVID-19 shock on Italian firms. Panel data from 7,800 firms during the period between January 2020 and March 2020, amid isolation policies, is utilized in the study. The analysis reveals that the effects are particularly significant for international firms. Additionally, it is noted that there are likewise impacts on long-term growth that operates through stronger shocks for innovative firms and disruption of pre-existing R&D plans.

This comprehensive body of literature illuminates the heterogeneous impacts of the pandemic, urging governments to comprehend sector-specific vulnerabilities, discern firms' diverse responses, and craft targeted policies and financial strategies to bolster resilience across sectors and enterprises of varying scales.

### **3. Methodology**

#### **3.1 Data Set**

In this study, it is aimed to reveal the first effects of the COVID-19 pandemic at the micro level, to obtain the order of importance of the identified problems, to create policy recommendations based on the solution proposals of the identified and prioritized problems of the enterprises in different scales and fields of activity. The data used for this purpose was obtained through survey. The survey included in the study consists of questions about the general characteristics of the enterprises, their problems in commercial activities, the level of impact of these problems on the

enterprise and the most important problems in terms of the sector they are in. The questions used in the related survey have been created based on the method that has already been put forward in the works of Aykac Alp and Yagmur [41-43] since 2014.

The results obtained from the Istanbul Chamber of Commerce Commercial Activity Expectation Index (CACI) survey conducted by Istanbul Ticaret University - Economy and Finance Application and Research Centre constituted the first step of the study in this period. CACI gathers 578 committee members at the monthly meetings of the 81 professional committees of the Istanbul Chamber of Commerce to provide information on the trend of commercial activities in Istanbul. One part of this study was used in the formation of the expectation index, and the other part was used in determining the problems and solution proposals according to their scale and production activity structure.

The problems shown in Table 1 and the solution suggestions given by those who were surveyed for these problems are available in the studies of Aykac Alp and Yagmur 2016, 2017, 2018. The study, which has been repeated over the years, presents existing problems, and offers solutions to these problems. The eight most important problems used in this study were selected based on the published studies of Aykac Alp, Yagmur [41-43].

**Table 1**  
 Problems encountered by enterprises and solution proposals.

Problems	Suggestions
Problems that slow the production process arising from the legislation	Following and informing the legislation, conveying the opinions of the committees to the public authority on the regulations to be made and the problems in implementation, taking into account the suggestions coming from the committees in the change of legislation.
Tax Burden	Compliance with EU norms, making arrangements similar to competing countries, especially in foreign trade; eliminating the difference between tax rates
Collection Problems	Regulation to eliminate the problems of return and payment in the check law
Exchange rate	Elimination of excessive fluctuations and uncertainty in exchange rates
Financing Problems	Providing more affordable loans from banks., reducing non-interest costs
Increase in costs	Improvement in price and tax policy
Decrease in demand	Supporting and increasing promotional and marketing activities, new markets studies were requested to be found.
Lack of Qualified Personnel	Taking initiative in vocational high school, associate degree, undergraduate education and certificate training, vocational courses

Source: Aykac Alp and Yagmur [43]

During COVID-19, these problems deepen, and the priority order of existing problems is subject to change. Through this study, it is planned to reveal the extent to which the information regarding the problems of the enterprises in the current structure has changed during the COVID-19. In addition, the planned surveys focus on determining the order of importance of the first 8 questions, which are the most important of the existing problems, which should be the priority in the solution process, and how.

### 3.2 Selection of Population and Sample

The structure in the chambers of commerce and industry has already been considered in the selection of the population and sample for Istanbul. There are 578 members in 81 professional committees elected to represent enterprises registered in the Istanbul Chamber of Commerce. Similarly, there are 55 occupational groups and 295 committee members selected for these groups in the Istanbul Chamber of Industry.

To ensure the representation of the professional groups/committees while conducting the surveys, there is a criterion of having at least one survey from each profession committee. Each member is an expert who has his own enterprise in that professional group, so reliable data and information can be obtained.

The first question of the survey is about determining the enterprise size of the responding expert. 42 micro scale, 92 small scale, 93 medium scale and 28 large scale surveys were answered. The number of answers regarding the field of activity of the enterprise, which is the second question, is 139 for the field of production, 50 for the field of trade and 66 for the field of service. The 4th question of the questionnaire, the question to measure the effect levels, was answered by 255 experts. The 5th question is an open-ended question, and the question was answered by all participants, and it was stated that there were 277 problems. However, it has been determined that 211 of 277 problems can be categorized and not classified as sector specific. 192 experts gave full answers to the 6th question of the survey and the comparative analysis.

### *3.3 Method*

The COVID-19 pandemic has caused global trade and supply chains to deteriorate rapidly, commodity prices to fluctuate, and governments and multinational companies to make critical decisions with limited information. Although it appears to be a health crisis, this crisis has started to test the world economic system. During this period, policymakers worked on additional policy proposals to reduce health problems and eliminate economic damage. In this study, the Analytical Hierarchy Process (AHP) approach was used to determine the order of importance of the problems and the order of the priorities order of the solution proposals during COVID-19 of enterprises. Then the factor analysis method was employed to determine changes in the component of problems by scale and field of activity. Finally, machine learning methods were employed to estimate the sector and scale of enterprises based on survey data.

AHP, developed by Saaty [44], is a powerful “multi-criteria decision-making” tool used in numerous applications in various fields of economics, politics, and engineering [45]. The AHP approach is used in literature on different subjects. It is used for studies in areas such as business decision-making, resource allocation, priority rating, and/or performance appraisal issues [46-49]. Economic sectors are interdependent. In this case, it affects sustainable development and inclusive growth by producing positive/negative spillover effects from small movements in the economy. However, this interdependent system is also faced with negative spillover effects, which are commonly caused by crises. While current studies pose the problem of interdependence and scarce resources, few of these studies measure by considering multi-sector prioritization and the importance of sectors. This study, which offers the opportunity to observe and prioritize the effects that will occur due to the current COVID-19 process, will both reveal the importance of the problems with the AHP approach and provide an opportunity for policymakers to focus on priority targets. The AHP approach evaluates alternatives in terms of criteria and sub-criteria to achieve a goal. Firstly, pairwise comparisons are made between goal measures in reciprocal matrix form and on a nine-point scale. Then, the sub-criteria are evaluated without previous processes, and this process continues until it reaches the lowest layer of alternatives [50]. In the study, the binary comparison criteria were determined according to the values to be obtained as a result of the survey.

The first stage of AHP is “problem identification”. It is the process in which the decision maker creates the hierarchical structure by determining the purpose and clarifying the decision points and criteria in line with this purpose. Then the process of “creating pairwise comparison matrices” is started. The comparison mentioned here is made by considering the degree of impact criteria suggested by Saaty [50]. This process is very important and for a process with  $n$  criteria, an  $n \times n$

dimensional matrix will be created. The diagonal of this matrix takes the value of 1 and for the points below the diagonal, values called "correspondence property" are obtained. The survey, which is the subject of the study, was used at this stage with the opinions of the participants and the opinions of the experts. In the next step, the "priority vector" is obtained by standardizing the matrix obtained. In the fourth step, in which the consistency of the obtained results in the comparisons is measured, the "consistency index (CI)" is created and divided by the "randomness index (RI)" and the consistency ratio is obtained [50-52]. It is expected to be  $CI/RI < 0.1$ , which shows that the pairwise comparisons made by the decision maker are consistent. At the last stage of the AHP approach, the priority vector is multiplied by the importance weights of the alternatives and the priority values are calculated for the alternatives, and the "best alternative" is determined.

Factor analysis is a statistical method used to identify underlying factors or dimensions that explain the pattern of correlations among a set of variables. It is a technique that is commonly used in psychology, sociology, marketing research, and other fields where researchers seek to understand the structure of complex data sets. The goal of factor analysis is to reduce the number of variables in a data set by identifying a smaller set of underlying factors that can account for the correlations among the variables. These factors are often interpreted as representing meaningful constructs or dimensions that are related to the variables in the data set [53, 54]. Principal component analysis (PCA) is a statistical method used to identify underlying patterns in a data set by reducing the dimensionality of the data. PCA transforms the original variables in a data set into a new set of variables, called principal components, that are linear combinations of the original variables. The first principal component explains the greatest amount of variance in the data, followed by the second principal component, and so on [55]. PCA can be a useful tool for data reduction and simplification, as well as for identifying meaningful patterns and relationships in complex data sets. However, it is important to use caution when interpreting the results of PCA, as the principal components may not always have clear interpretations in terms of the original variables in the data set.

Machine learning (ML) is the concept that refers to various algorithms that perform intelligent predictions based on a dataset. In ML methods, different learning approaches are used according to the desired result, and they are divided into three groups as supervised, unsupervised and reinforcement learning [56].

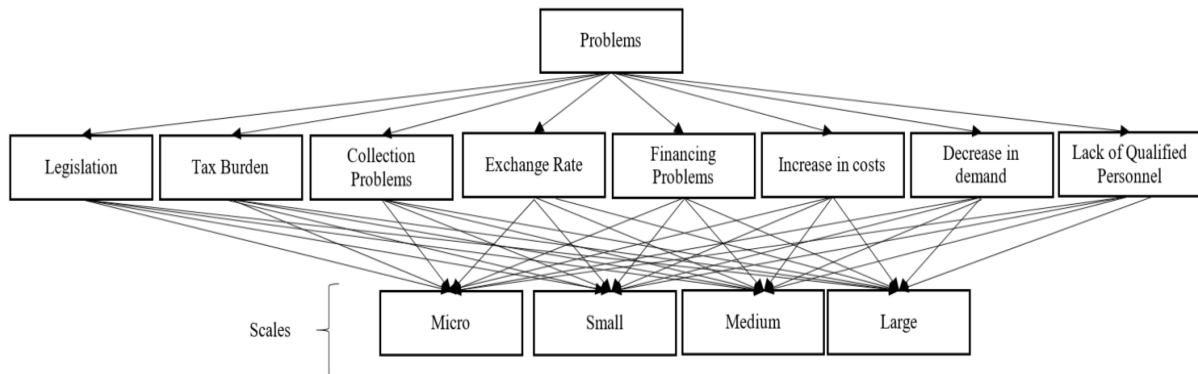
In supervised learning, a labeled dataset is required for training. Unsupervised learning uses hidden data patterns in an unlabeled dataset [57]. In reinforcement learning, data is not needed since the learning process is by interacting with the environment [58].

In this study, supervised learning algorithms were used because the classes of the enterprises were known. For the prediction of enterprise classes, Logistic Regression, k-Nearest Neighbors (kNN), Support Vector Machine, Artificial Neural Networks (ANN), Classification and Regression Tree (CART), Random Forest, and Gradient Boosting supervised learning algorithms were used.

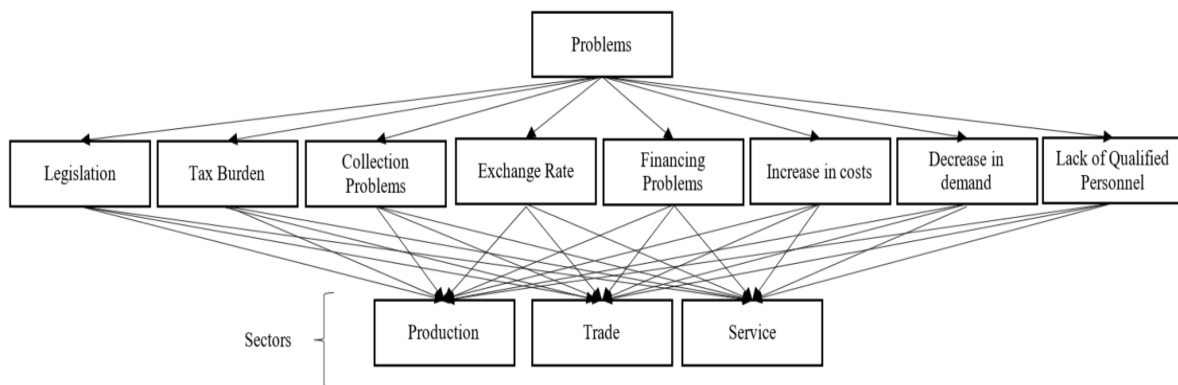
## **4. Results**

### **4.1 Results of the AHP**

In this study, the problems evaluated during the COVID-19 pandemic period were considered as criteria and the importance weights of the criteria were determined using AHP. The priority values of the problems for each scale and field of activity were obtained from the survey. As alternatives, the scales and fields of activity of the enterprises were considered and the importance weights of the criteria (problems) were calculated with AHP. The hierarchical structures created for AHP in this study are given below (Figures 1 and 2).



**Fig. 1.** Hierarchical structure by enterprise scale  
 Source: Authors calculation.

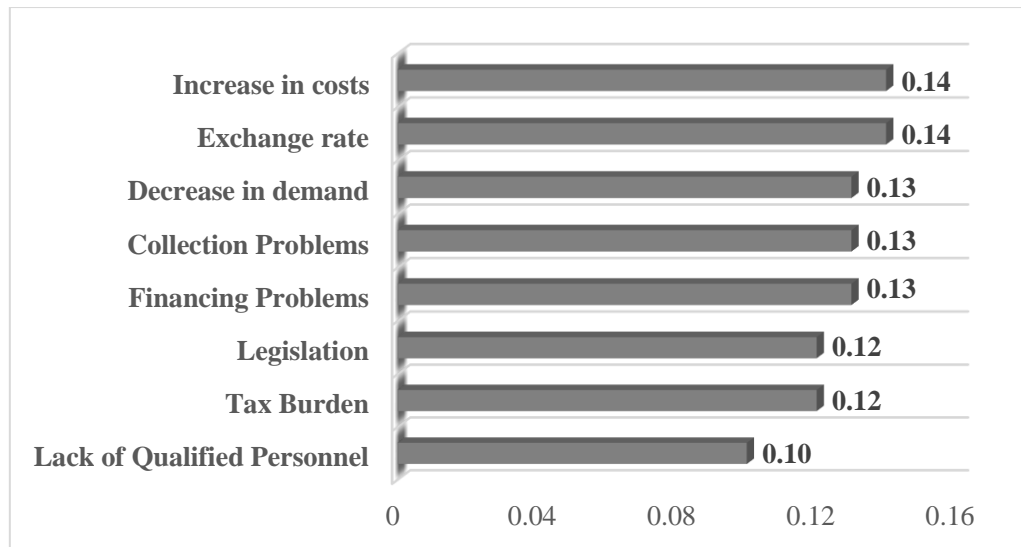


**Fig. 2.** Hierarchical structure by field of activity  
 Source: Authors calculation.

In the AHP approach, expert opinions are generally used while determining the importance weights of the criteria. There is no accepted general opinion in literature about the number of experts whose opinions will be consulted. In this study, the Istanbul Chamber of Commerce and the Istanbul Chamber of Industry professional committees and council members are the most important experts who can express their opinions on the economic situation, and a survey was conducted.

A survey was conducted by the reaching committee and/or council members to provide minimum criteria for enterprise sizes and fields of activity. The survey consisting of comparison and open-ended questions was applied. For the criteria weights obtained to be used in the analysis, the answers given by the experts to the comparison questions should be consistent. Data obtained from a total of 255 surveys with a consistency ratio of less than 0.10 were used in the study.

The importance weights of the criteria (problems) for Istanbul as a result of the AHP approach are given below.



**Fig. 3.** Rates of encountering problems for Istanbul in general  
 Source: Authors calculation.

As seen in Figure 3, the importance weights of the problems obtained as a result of the AHP are listed to form the first three categories of exchange rate, cost increase and financing problems. The importance weights of these problems are very close to each other. However, the difference between the exchange rate with the highest importance and the category of qualified personnel with the lowest importance is high.

#### 4.1.1 Results Obtained According to Enterprise Scales

The importance weights of the problems faced by the enterprises for Istanbul in general are given in Figure 3. The experts were also asked about the priority vector (degree of impact) of these problems on their enterprises. When the importance weights of the problems and the degree of their impact on the enterprises are multiplied, the priority values of the problems in terms of the characteristics of the enterprises (size scale and field of activity) are calculated.

**Table 2**

Weights of problems for enterprises different scales

Problems / Scale	Large	Medium	Small	Micro
Increase in costs	0.224	0.208	0.207	0.204
Decrease in demand	0.186	0.190	0.205	0.206
Exchange rate	0.167	0.161	0.156	0.158
Collection Problems	0.122	0.132	0.124	0.138
Financing Problems	0.118	0.123	0.126	0.115
Tax Burden	0.083	0.084	0.081	0.086
Lack of Qualified Personnel	0.050	0.053	0.050	0.042
Legislation	0.049	0.050	0.050	0.051

Source: Authors calculation.

As shown in Table 2, the problems obtained for micro-scale enterprises are primarily the decrease in demand with 21%, the cost increase with 20% in the second place, and the exchange rate volatility in the third place with 16%.

The priority values of the problems that were obtained for small-scale enterprises were in the first place with 21% cost increase, second with 20% contraction in demand, and the exchange rate in the third place with 16%.

In the ranking obtained based on the priority vector values of the problems and the importance weights (impact levels) determined for medium-sized enterprises, increase in cost is in the first place with 21%, the decrease in demand is in the second place with 19%, and the exchange rate volatility is in the third place with 16%.

In the ranking obtained from the priority vector values of the problems and the importance weights (impact levels) determined for large-scale enterprises, increase in cost is in the second place with 22%, the decrease in demand with 19% and the exchange rate volatility in the third place with 16%.

When the priority values of the problems are examined on the scales of the enterprises, it is seen that the increase in cost, the decrease in demand and the exchange rate volatility are the most important problems, even if their order changes. The problem of the decrease in demand was in the first place for micro-scale enterprises, and it was in the second place in other scales. Therefore, the decrease in demand during the COVID-19 pandemic period is a problem category that affects enterprises of all scales, but micro-scale enterprises were most severely affected. The problem of increase in cost was in the first place for small, medium, and large-scale enterprises, and it was in the second place for micro-scale enterprises. Therefore, it is seen that the increase in cost during the COVID-19 pandemic period is a problem that affects enterprises at all scales.

#### 4.1.2 Findings Obtained by the Field of Activity of the Enterprises

The importance weights of the problems faced by the enterprises for Istanbul in general are given in Figure 3. The experts were also asked about the priority vector (degree of impact) of these problems on their enterprises. When the importance weights of the problems and the degree of their impact on the enterprises are multiplied, the priority values of the problems in terms of the characteristics of the enterprises (size scale and field of activity) are calculated.

**Table 3**

The weights of the problems for enterprises in different sectors

Problems / Sector	Service	Trade	Production
Increase in costs	0.213	0.200	0.209
Decrease in demand	0.193	0.198	0.200
Exchange rate	0.150	0.164	0.162
Collection Problems	0.130	0.132	0.127
Financing Problems	0.124	0.122	0.121
Tax Burden	0.089	0.083	0.081
Legislation	0.053	0.050	0.049
Lack of Qualified Personnel	0.048	0.049	0.051

Source: Authors calculation.

As a result of the product of the priority vector of the problems and the importance weights determined for the enterprises in each field of activity, priority weights for each field of activity are obtained. The primary problems obtained for the production sector were the increase in cost, decrease in demand and exchange rate volatility. The increase in cost, which is the most important problem for the enterprises in the production area, was determined as 20% for the enterprises in the trade area and 21% for the enterprises in the service area. The primary problems obtained for the trade sector were the cost increase and demand contraction with 20%. The exchange rate is in third place with 16%. The priority values obtained for the service sector are respectively 21% increase in cost, then 19% decrease in demand, and finally 1% exchange rate volatility. The increase in cost which is the most important problem for the enterprises in the service area, was determined as 21% for the enterprises in the production sector and 20% for the enterprises in the trade sector (see Table 3).

Therefore, the increase in cost and decrease in demand in the COVID-19 period are the main problems affecting enterprises at all scales.

#### 4.1.3 Findings Obtained According to the Sector of Activity and Scales of the Enterprises

It has been observed that the categories of the first three important problems identified by the enterprises in the production sector are the same according to the scales. In the ranking obtained, increase in cost is in the first place with 21%, decrease in demand is in the second place with 20%, and exchange rate volatility is in the third place with 16% (see Table4).

**Table 4**

The weights of the problems according to the scales for the enterprises in the production sector

Problems / Scale	Large	Medium	Small	Micro
Increase in costs	0.220	0.210	0.208	0.204
Decrease in demand	0.197	0.199	0.202	0.200
Exchange rate	0.159	0.160	0.164	0.164
Collection Problems	0.123	0.132	0.122	0.133
Financing Problems	0.111	0.122	0.125	0.114
Tax Burden	0.090	0.078	0.081	0.088
Legislation	0.053	0.047	0.049	0.047
Lack of Qualified Personnel	0.048	0.053	0.049	0.049

Source: Authors calculation.

The order of the problems in the field of production activity does not differ according to the scales, but the weight varies. Therefore, Figure 5 is more fitting for observing the findings. In the analysis, as in truth, the number of enterprises varies according to the sector and scales. Therefore, despite the possibility that the differentiation of the weight of the problems is due to the numerical density, more meaning should not be attributed to it than necessary. Therefore, solutions specific to the field of activity can be produced by considering the order.

In the ranking obtained for the trade sector, increase in cost is in the first place with 20%, decrease in demand is in the second place with 20% and the exchange rate volatility is in the third place with 16%. It has been observed that the first three important problem categories identified in enterprise scales are the same for enterprises in the trade sector (see Table 5).

**Table 5**

The weights of problems by scale for enterprises in the trade sector

Problems / Scale	Large	Medium	Small	Micro
Increase in costs	0.221	0.209	0.196	0.189
Decrease in demand	0.171	0.176	0.205	0.223
Exchange rate	0.173	0.170	0.160	0.161
Collection Problems	0.112	0.131	0.134	0.137
Financing Problems	0.129	0.116	0.132	0.118
Tax Burden	0.087	0.089	0.075	0.085
Lack of Qualified Personnel	0.057	0.058	0.049	0.037
Legislation	0.049	0.051	0.049	0.051

Source: Authors calculation.

The order of the problems of the enterprises in the trade sector differs according to the scales. In large-scale enterprises, the ranking is as increase in cost, decrease in demand, exchange rate volatility, financing problems, collection problems, tax burden, qualified personnel and legislation. In medium-sized enterprises, the ranking is as increase in cost, decrease in demand, exchange rate volatility, collection problems, financing problems, tax burden, qualified personnel and legislation. In



small-scale enterprises, the ranking is as increase in cost, decrease in demand, exchange rate volatility, collection problems, financing problems, tax burden, qualified personnel and legislation. In micro-scale enterprises, the order is in the form of decrease in demand, increase in cost, exchange rate volatility, collection problems, financing problems, tax burden, qualified personnel and legislation.

In the ranking obtained for the service sector, increase in cost is in the first place with 21%, decrease in demand is in the second place with 19% and the exchange rate volatility is in the third place with 15%. It has been observed that the first three important problem categories identified in enterprises scales are the same for enterprises in the service sector (see Table 6).

**Table 6**

The weights of problems by scale for enterprises in the service sector

	Large	Medium	Small	Micro
Increase in costs	0.231	0.199	0.213	0.220
Exchange rate	0.178	0.156	0.136	0.151
Decrease in demand	0.176	0.176	0.211	0.192
Financing Problems	0.125	0.131	0.126	0.111
Collection Problems	0.124	0.131	0.124	0.145
Tax Burden	0.071	0.103	0.087	0.084
Lack of Qualified Personnel	0.052	0.046	0.051	0.042
Legislation	0.044	0.058	0.053	0.055

Source: Authors calculation.

Although the order of the problems in the service field of activity does not differ according to the scales, except for the micro-scale enterprises, the severity varies. In micro-scale enterprises, the ranking is as increase in cost, decrease in demand, exchange rate volatility, collection problems, financing problems, tax burden, legislation and qualified personnel. In other scales, the ranking is as increase in cost, decrease in demand, exchange rate volatility, financing problems, collection problems, tax burden, legislation and qualified personnel.

#### 4.2 Factor Analysis

The goal of the part was to determine changes in the component of problems by sectors and field of activity. The "principal component factor analysis" method was used in the study to create an "nxn" correlation matrix for each set of questions, and the results were obtained. Component matrices were subjected to rotation using the Varimax with Kaiser Normalization method. The factors obtained through factor analysis are crucial, and an axis rotation is performed to enhance their "independence, interpretability, and significance". This rotation process does not alter the fundamental mathematical properties of the solution. Once the axes are rotated, the items' loadings on one factor increase while the loadings on other factors decrease. As a result, the factors are better able to identify the items that have a strong correlation with them, making them easier to interpret [59, 60]. The suitability of factor analysis for the relevant data structure is examined using the Kaiser-Meyer-Olkin (KMO) coefficient and the Barlett Sphericity Test. The KMO test, proposed by Kaiser and Rice [61], indicates that values approaching 1 are suitable for factor analysis, while values below 0.5 are unsuitable for factorization. As show that Table 7, the study confirmed the suitability of factor analysis for all components used in each set of questions by verifying the KMO values for each of them.

**Table 7**  
 KMO and Bartlett's Test-Scale

		Micro	Small	Medium	Large
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.735	.874	.686	.740
Bartlett's Test of Sphericity	Approx. Chi-Square	137.024	278.941	156.814	139.413
	df	28	28	28	28
	Sig.	.000	.000	.000	.000

Source: Authors calculation.

The findings revealed that the problems encountered by enterprises during the COVID-19 process varied according to their scales. In determining the number of factors in the study, factors with an eigenvalue of 1 or higher were preferred. Accordingly, 2 factors were found to be suitable for micro and large-scale enterprises, while 3 factors were suitable for medium-sized enterprises. The total variance explained by the factors was sufficient, with percentages of 63.217%, 64.693%, 69.834%, and 75.389%, respectively, depending on the size of the enterprises (see Table A1). However, for small-scale enterprises, it was determined that the eight relevant issues were not differentiated and were grouped under the same factor.

It has been determined that the criteria in the first factor for micro-scale enterprises are the problems determined in the market with legal regulations, and the criteria in the second factor are the external problems that occur in the sector in which the enterprises are located. For small-scale enterprises, all criteria are similar and therefore not differentiated. According to the results of medium-sized enterprises, it has been determined that the criteria in the second factor are problems caused by legal regulations, and the criteria of increase in costs and decrease in demand in the third factor are problems that have emerged in all areas during COVID-19. Also, it has been determined that all other problems for medium-sized companies are combined in the first factor (see Table 8). This situation is parallel to the literature, where increases in cost and decreases in demand emerge as a general problem for SMEs. In large-scale enterprises, the increase in cost and the decrease in demand resulting from COVID-19, as well as the exchange rate indicating market fragility, are encountered in one factor while the others are in another factor. Generally, it is observed that problems show inter-factor variability depending on the fields of activity. As mentioned in the studies of Mack, Agrawal, and Wang [23], Demirhan and Sakin [25], and other sector analysis literature, it is understood that it is not only the scale but also the sectors, and the effects of COVID-19 indicate heterogeneity in the sectors.

**Table 8**  
 Rotated Component Matrix- Scale\*

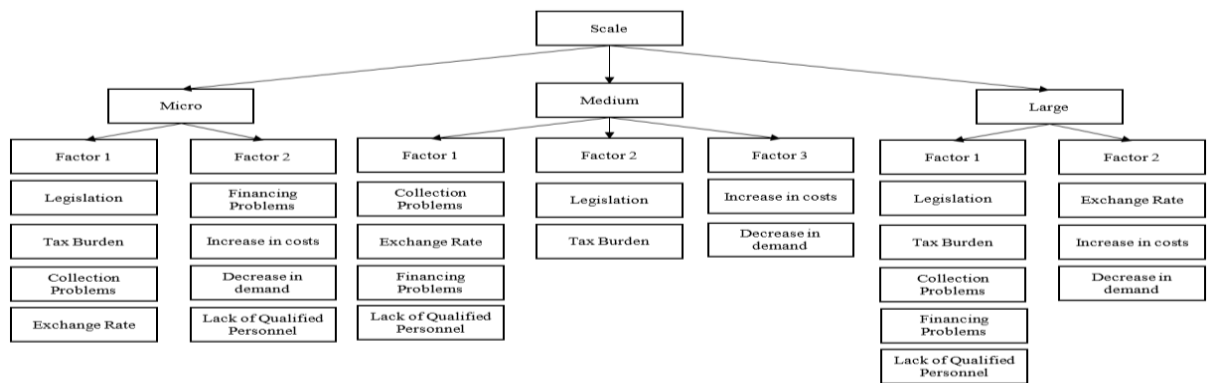
Criteria	Micro		Small*	Medium			Large	
	Component		Component	Component			Component	
	1	2	1	1	2	3	1	2
Legislation	.642		.684		.833		.762	
Tax Burden	.703		.787		.630		.865	
Collection Problems	.825		.730	.660			.712	
Exchange rate	.834		.648	.591				.911
Financing Problems		.608	.762	.724			.689	
Increase in costs		.599	.800			.765		.912
Decrease in demand		.829	.767			.818		.649
Lack of Qualified Personnel		.806	.523	.728			.829	

\* Only one component was extracted. The solution cannot be rotated

Source: Authors calculation.

\* The component matrix in Table A2 was transformed according to the varimax method.

The hierarchical structure factor analysis by enterprise scale is given in Figure 4.



**Fig. 4.** Hierarchical structure factor analysis by enterprise scale  
 Source: Authors calculation.

As show that Table 9, when examining the distribution of problems into factors according to sectors, the KMO values confirmed the suitability of separate factor analysis for all components used in each set of questions. It was determined that 2 factors were suitable for all sector groups. The total variance explained by the factors was sufficient, with percentages of 59.931% in production, 58.038% in trade, and 59.288% in services (see Table A3).

**Table 9**

KMO and Bartlett's Test-Sector

		Service	Trade	Production
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,839	,763	,825
Bartlett's Test of Sphericity	Approx. Chi-Square	161,102	124,215	366,542
	df	28	28	28
	Sig.	,000	,000	,000

Source: Authors calculation.

The primary impact of COVID-19 has been seen in all its weight in the service sector. Within the service sector, there are banks and financial institutions as well as sub-areas that are directly and at a higher level affected by closures such as tourism, transportation, restaurants, and hotels. With the effect of this situation, an increase in cost, decrease in demand, and Lack of Qualified Personnel problems have been grouped into the first factor while other issues have been grouped into the second factor. The trade sector encloses both production and service activities, and therefore, the factors that have arisen explain both structures. The distribution of the problems of the enterprises in the field of trade was such that one factor included only legal regulations, and the other factor included all the remaining problems. In the enterprises performing in the field of production, the first factor consists of the legislation, tax burden, collection problems, and decrease in demand, while the second factor consists of the exchange rate, financing problems, cost increase, and qualified personnel problems (see Table 10).

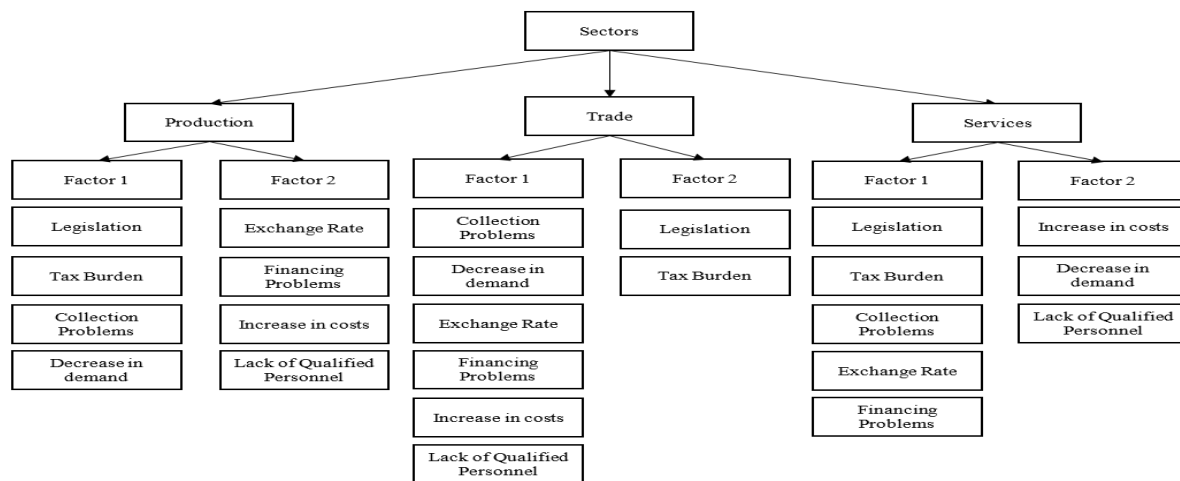
**Table 10**  
 Rotated Component Matrix- Sector

Criteria	Service		Trade		Production	
	Component		Component		Component	
	1	2	1	2	1	2
Legislation	,825		,841		,894	
Tax Burden	,733		,815		,620	
Collection Problems	,759		,817		,739	
Exchange rate	,548		,702			,645
Financing Problems	,603		,735			,545
Increase in costs		,721	,855			,739
Decrease in demand		,759	,574		,630	
Lack of Qualified Personnel		,765	,390			,763

Source: Authors calculation.

\* The component matrix in Table A4 was transformed according to the varimax method.

The hierarchical structure factor analysis by field of activity is given in Figure 5.



**Fig. 5.** Hierarchical structure factor analysis by field of activity  
 Source: Authors calculation.

The delineation of problems across sectors via factor analysis unveils intriguing patterns. The impact of COVID-19 reverberated distinctly within each sector, accentuating varying focal points of distress. Particularly, the service sector bore the brunt, encompassing subsets like banking, tourism, transportation, restaurants, and hospitality, profoundly affected by closures. This sector witnessed a pronounced clustering of issues, with escalated costs, reduced demand, and a dearth of skilled labor converging under the primary factor. Meanwhile, other challenges coalesced into the secondary factor. In the trade sector, a more nuanced picture emerged, amalgamating both production and service realms. One factor exclusively encapsulated legal regulations, while the other amalgamated a spectrum of remaining issues. The production-focused enterprises similarly demonstrated a dichotomy. The first factor encompassed legislative concerns, tax burdens, collection challenges, and reduced demand, while the second factor converged around exchange rates, financing woes, cost escalations, and workforce shortages. These delineations underscore how the pandemic's impact reverberated distinctly across sectors, elucidating the salient challenges that each facet grappled with in its aftermath.

### 4.3 Machine Learning Analysis

The results of the factor analysis showed differentiation in factors at the sector and scale levels. This correspondingly indicates that the effects of criteria on enterprises vary at different levels of sector and scale. Therefore, since it is not possible to make a classification that represents all sectors and scales, all criteria have been evaluated together in the classification process. The descriptive statistical values of the criteria are given in Table 11.

**Table 11**  
 Descriptive Statistical Values of the Criteria

Code	Features	count	mean	std	min	25%	50%	75%	max
F1	Legislation	255.0	6.043137	2.593546	1.0	5.0	6.0	8.0	10.0
F2	Tax Burden	255.0	6.133333	2.800075	1.0	5.0	6.0	8.0	10.0
F3	Collection Problems	255.0	6.784314	2.740149	1.0	5.0	7.0	9.0	10.0
F4	Exchange rate	255.0	7.333333	2.944812	1.0	5.0	8.0	10.0	10.0
F5	Financing Problems	255.0	6.850980	2.666752	1.0	5.0	7.0	9.0	10.0
F6	Increase in costs	255.0	7.282353	2.442787	1.0	5.0	8.0	9.5	10.0
F7	Decrease in demand	255.0	6.568627	2.881211	1.0	5.0	7.0	9.0	10.0
F8	Lack of Qualified Personnel	255.0	5.133333	2.995710	1.0	2.5	5.0	7.0	10.0

Source: Authors calculation.

Classification algorithms are used to determine which of the known classes a data belongs to. In this study, the sector and scale of the relevant company were predicted using machine learning methods (LR, kNN, SVM, ANN, CART, RF, and GB) based on the responses given to 255 surveys. The accuracy value was used to measure the prediction success of the machine learning algorithms. Table 12 shows the parameters and accuracy values used in the machine learning methods.

**Table 12**  
 Descriptive Statistical Values of the Criteria

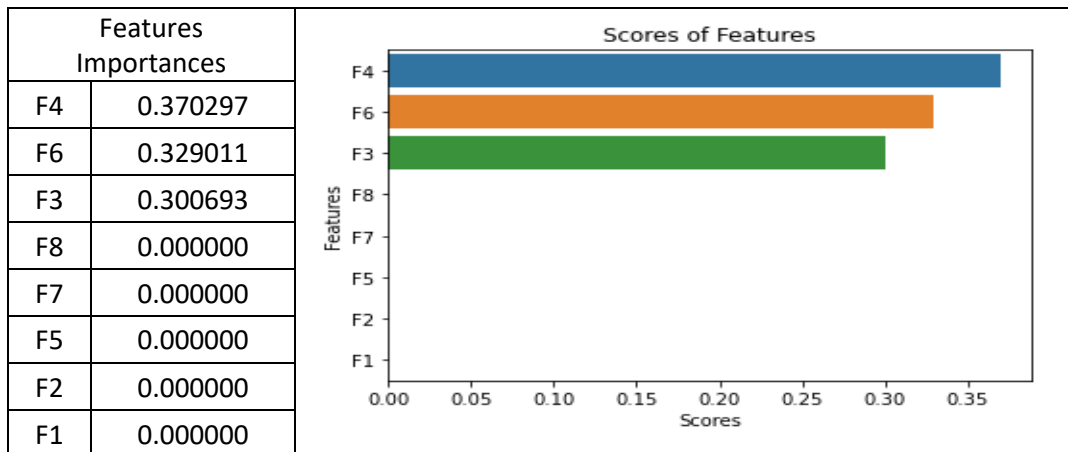
	Sector		Scale	
	Parameters	Accuracy	Parameters	Accuracy
Logistic Regression	test_size=0.20 random_state=30	0.6471	test_size=0.22 random_state=25	0.5088
kNN	k=33	0.5899	k=66	0.4416
Support Vector Machine	C=1 Kernel=linear	0.5900	C=5 Kernel=rbf	0.4675
ANN	test_size=0.20 random_state=30 solver = "lbfgs" activation='logistic' alpha=1 Hidden Layer=(10,8,6)	0.6667	test_size=0.20 random_state=30 solver = "adam" activation='relu' alpha=0.2 Hidden Layer=(6,6,6)	0.4902
CART	max_depth=2, min_samples_split=10	0.6667	max_depth=6, min_samples_split=5	0.5614
Random Forest	max_features= 6 min_samples_split=40 n_estimators=67	0.5882	max_features= 8 min_samples_split=40 n_estimators=63	0.5294
Gradient Boosting	learning_rate=0.002 max_depth=8 n_estimators=100	0.6078	learning_rate=0.001 max_depth=3 n_estimators=100	0.4902

Source: Authors calculation.

The highest Accuracy value was obtained with the CART method both in predicting the sector class and the scale size. The impact scores of the variables in the classification are given below for the CART method.

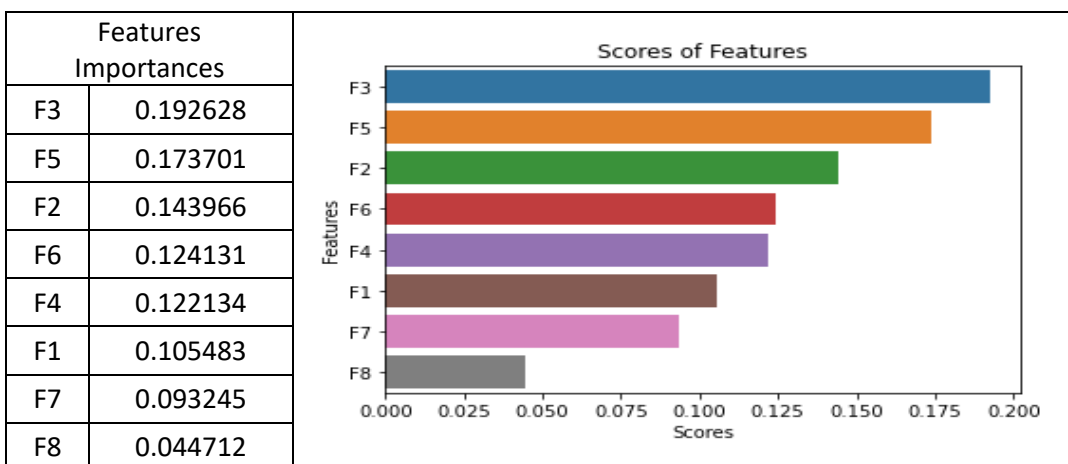
When examined by sector, it is seen that the most effective criteria in determining in which sector the company operates are Exchange Rate, Increase in Costs, and Collection Problems, respectively. These problems have affected companies in different sectors at different levels.

It can be stated that the impact of Regulations, Tax Burden, Financing Problems, Demand Contraction, and Qualified Personnel Problems on determining the sector in which the company operates was not significant, and therefore affected all companies in similar ways (see Figure 6).



**Fig. 6.** Features Importances of Sectors  
 Source: Authors calculation.

When examined based on scale, it was observed that the three most effective criteria in determining the size of the company, in order, were collection problems, financing problems, and tax burden. These problems can be said to affect companies at different levels depending on their size. The least effective criterion in determining the scale of the company, which is qualified personnel, can be expressed as affecting companies similarly (see Figure 7).



**Fig. 7.** Features Importances of Scale  
 Source: Authors calculation.

#### 4. Conclusion

For both individuals and enterprises to survive the COVID-19 process with minimal damage, it is necessary to identify the problems and solutions encountered and act according to the findings. By recognizing the specific problems encountered and devising strategies based on these findings,

individuals and businesses can better equip themselves to weather the challenges posed by the pandemic. This proactive approach is instrumental in mitigating the negative impacts and ensuring a more resilient response to the ongoing crisis. In this context, the study determined the differences in the impact of the COVID-19 epidemic on businesses of different scales and sectors. The research methodology involves the utilization of the AHP for prioritizing solution proposals, factor analysis to delineate problem components based on sectors and scales, and machine learning techniques to estimate enterprise sector and scale using survey data. This multifaceted approach aims to provide a comprehensive understanding of how the pandemic has affected businesses, offering valuable insights into tailored solutions, and highlighting the nuanced disparities experienced by enterprises of varying sizes and industries. Thus, although the problems experienced by businesses vary depending on their scale, it is possible to identify areas of fragility within each sector.

The AHP analysis both by the scale and by field of activity gave the same three results. The first three problems appear to be "increase in costs", "decrease in demand" and "exchange rate fluctuations". Except for the "exchange rate", these are the problems that come to the fore due to the fluctuations in the exchange rate during the crisis. Exchange rates have also had direct and indirect consequences for costs. Disruptions in the supply chain and problems experienced in the field of logistics can be listed as other possible reasons for the increase in costs.

The results of the CART analysis revealed that the criteria differed in determining the scales and fields of activity. It is seen that the most effective criteria in determining in which sector the company operates are Exchange Rate, Increase in Costs, and Collection Problems, respectively. These problems arise in the sectors as problems that make production difficult and increase the cost. As well as it was observed that the three most effective criteria in determining the size of the company, in order, were collection problems, financing problems, and tax burden. These problems can be said to affect companies at different levels depending on their size.

Similar results were obtained with the theoretical approach put forward in the Guerrieri et al. [5] study. The survey results revealed the supply shock in production and employment caused by the epidemic. They focus on the idea that such a supply shock can trigger a demand gap that causes a larger contraction than itself. Similarly, the contraction in demand is one of the most important factors that emerged in the survey results.

The solutions offered to the problems reported in this category are similar to the problems seen before COVID period. The business world states that the volatility should decrease, and it should be predictable in periods when it sees the exchange rate as a problem. When the macroeconomic indicators to which it is related are analyzed, it is remarkable that it is related to the monthly change rather than the value of the foreign currency and is sensitive to the rise in inflation. Similarly, Nair [62] study also emphasize this problem for SMEs in India. Increasing costs and financing problems are the other remarked problems in the surveys. It has been seen that stability in exchange rates and the positive effect of reliability are important in order to reduce the financing problem. According to the results, one of the most important problems is the financing problem in Türkiye as well as in the rest of the world. There are studies in literature pointing to similar problems such as Corredera-Catalán, Pietro and Trujillo-Ponce [33]. In this study, it was seen that the problem was not only a problem in SME but also on all scales. Decreasing demand and transaction volumes also showed their effect in Turkey. It is recommended to provide Enterprises with appropriate interest rates and long-term loans. Aftab, Naveed, and Hanif [34] found similar results for SMEs in Pakistan. Similar categories are also prominent in our study.

The public sector increases its economic efficiency in times of crisis and reveals how fragile the structure of emerging markets is in times of crisis. In order to protect SMEs, the authority needs to produce appropriate policies to keep sectors and businesses alive with different plans.

One of the most important problems is the employment of qualified personnel. Similar employee problems and unemployment problems are also evident in other studies. For example, Mack, Agrawal, and Wang [23] pointed to this problem for the transportation sector, Slavković, Ognjanović, and Bugarčić [24] for the hotel industry.

Drawing from numerous studies in the literature, our survey echoes similar sentiments emphasizing the astute utilization of incentive systems by policymakers and the imperative for companies to address their underlying structural issues. This convergence of suggestions underscores the significance of well-devised incentives in governmental policies and underscores the pivotal role of companies in addressing and rectifying their internal structural challenges. This alignment across various studies emphasizes the importance of these strategies in fostering resilience and sustainability amid challenging circumstances like those posed by the COVID-19 pandemic.

### **Author Contributions**

Conceptualization, E.A.A.; methodology, E.A.A., S.A. and M.F.E.; software, E.A.A., S.A., and M.F.E.; validation, E.A.A., S.A., and A.O.D.; formal analysis, S.A. and M.F.E.; investigation, E.A.A.; resources, E.A.A., and M.F.E.; data curation, S.A.; writing—original draft preparation, M.F.E.; writing—review and editing, E.A.A. and A.O.D.; visualization, S.A. and M.F.E.; supervision, E.A.A.; project administration, E.A.A. All authors have read and agreed to the published version of the manuscript.

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### **Data Availability Statement**

Archived datasets analyzed and created during the study available upon request.

### **Conflicts of Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors identify and declare any personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results. There is no role of the funders in the design of the study; in the collection, analyses or interpretation of data; even in the writing of the manuscript, or in the decision to publish the results.

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**Appendix**

**Table A1**  
 Total Variance Explained-Scale

Component		Total Variance Explained								
		Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Micro	1	4.001	50.012	50.012	4.001	50.012	50.012	2.778	34.724	34.724
	2	1.056	13.202	63.214	1.056	13.202	63.214	2.279	28.490	63.214
Small	1	4.120	51.503	51.503	4.120	51.503	51.503			
	2	2.851	35.633	35.633	2.851	35.633	35.633	2.053	25.657	25.657
Medium	2	1.317	16.456	52.089	1.317	16.456	52.089	1.645	20.564	46.220
	3	1.008	12.603	64.693	1.008	12.603	64.693	1.478	18.472	64.693
Large	1	4.544	56.795	56.795	4.544	56.795	56.795	3.427	42.838	42.838
	2	1.488	18.595	75.389	1.488	18.595	75.389	2.604	32.552	75.389

Source: Authors calculation.

**Table A2**  
 Component Matrix- Scale

Micro		Small		Medium			Large	
Component		Component		Component			Component	
1		1		1	2	3	1	2
F1	.684	F1	.684	F1	.538	-.513	F1	.755
F2	.787	F2	.787	F2		-.563	F2	.802
F3	.730	F3	.730	F3	.738		F3	.844
F4	.648	F4	.648	F4	.710		F4	.672 .634
F5	.762	F5	.762	F5	.739		F5	.814
F6	.800	F6	.800	F6		.691	F6	.676
F7	.767	F7	.767	F7	.580	.612	F7	.895
F8	.523	F8	.523	F8			F8	-.625

Source: Authors calculation.

**Table A3**  
 Total Variance Explained-Sector

Component		Total Variance Explained <sup>a</sup>								
		Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Services	1	3.736	46.702	46.702	3.736	46.702	46.702	2.616	32.706	32.706
	2	1.007	12.586	59.288	1.007	12.586	59.288	2.127	26.582	59.288
Trade	1	3.510	43.879	43.879	3.510	43.879	43.879	2.988	37.346	37.346
	2	1.133	14.158	58.038	1.133	14.158	58.038	1.655	20.692	58.038
Production	1	3.775	47.190	47.190	3.775	47.190	47.190	2.572	32.145	32.145
	2	1.019	12.741	59.931	1.019	12.741	59.931	2.223	27.786	59.931

Source: Authors calculation.

**Table A4**

Component Matrix- Sector

	Service		Trade		Production	
	Component		Component		Component	
	1	2	1	2	1	2
F1	.715		F1	.686	F1	.651
F2	.672		F2	.605	F2	.732
F3	.719		F3	.857	F3	.729
F4	.620		F4	.724	F4	.704
F5	.788		F5	.729	F5	.739
F6	.674		F6	.717	F6	.659
F7	.694		F7	.642	F7	.729
F8	.560	.530	F8	.431	F8	.552

Source: Authors calculation.

## References

- [1] Ayittey, F. K., Ayittey, M. K., Chiwero, N. B., Kamasah, J. S., & Dzuovor, C. (2020). Economic impacts of Wuhan 2019-nCoV on China and the world. *Journal of medical virology*, 92(5), 473. <https://doi.org/10.1002/jmv.25706>
- [2] Albuлесcu, C. 2020. Coronavirus and oil price crash. SSRN 3553452. <http://dx.doi.org/10.2139/ssrn.3553452>
- [3] Eichenbaum, M. S., Rebelo, S., & Trabandt, M. (2020). The macroeconomics of epidemics. NBER Working Papers 26882, National Bureau of Economic Research. <https://doi.org/10.1093/rfs/hhab040>
- [4] Kermack, W. O., & McKendrick, A. G. (1927). A contribution to the mathematical theory of epidemics. *Proceedings of the royal society of London. Series A, Containing papers of a mathematical and physical character*, 115(772), 700-721. <https://doi.org/10.1098/rspa.1927.0118>
- [5] Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2022). Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?. *American Economic Review*, 112(5), 1437-74. <https://doi.org/10.1257/aer.20201063>
- [6] McKibbin, W., & Fernando, R. (2021). The global macroeconomic impacts of COVID-19: Seven scenarios. *Asian Economic Papers*, 20(2), 1-30. [https://doi.org/10.1162/asep\\_a\\_00796](https://doi.org/10.1162/asep_a_00796)
- [7] Lee, J. W., & McKibbin, W. J. (2004). Globalization and disease: The case of SARS. *Asian economic papers*, 3(1), 113-131. <https://doi.org/10.1162/1535351041747932>
- [8] McKibbin, W. J., & Sidorenko, A. (2006). *Global Macroeconomic Consequences of Pandemic Influenza: Analysis*. Lowy Institute for International Policy.
- [9] Şit, A., & Telek, C. (2020). COVID-19 pandemisinin altın ons fiyatı ve dolar endeksi üzerine etkileri. *Gaziantep University Journal of Social Sciences*, 19(COVID-19 Special Issue), 1-13. <https://doi.org/10.21547/jss.742110>
- [10] Zeren, F., & Hizarci, A. (2020). The impact of COVID-19 coronavirus on stock markets: evidence from selected countries. *Muhasebe ve Finans İncelemeleri Dergisi*, 3(1), 78-84. <https://doi.org/10.32951/mufider.706159>
- [11] Batrancea, L. (2021). The nexus between financial performance and equilibrium: Empirical evidence on publicly traded companies from the global financial crisis up to the COVID-19 pandemic. *Journal of Risk and Financial Management*, 14(5), 2-12. <https://doi.org/10.3390/jrfm14050218>
- [12] Singh, B., Dhall, R., & Narang, S. (2020). The outbreak of COVID-19 and stock market responses: An event study and panel data analysis for G-20 countries. *Global Business Review*, <https://journals.sagepub.com/doi/full/10.1177/0972150920957274>
- [13] Furceri, D., Celik, S. K., Jalles, J. T., & Koloskova, K. (2020). Recessions and total factor productivity: evidence from sectoral data. *Economic Modelling*, 94, 130-138. <https://doi.org/10.1016/j.econmod.2020.09.025>
- [14] Laing, T. (2020). The economic impact of the Coronavirus 2019 (Covid-2019): Implications for the mining industry. *The extractive industries and society*, 7(2), 580-582. <https://doi.org/10.1016/j.exis.2020.04.003>
- [15] Günay, F., Bayraktaroğlu, E., & Özkul, K. (2020). Assessing the short-term impacts of COVID-19 pandemic on foreign visitor's demand for Turkey: A scenario analysis. *Journal of Ekonomi*, 2(2), 80-85.
- [16] Lin, B., & Zhang, Y. Y. (2020). Impact of the COVID-19 pandemic on agricultural exports. *Journal of Integrative Agriculture*, 19(12), 2937-2945. [https://doi.org/10.1016/S2095-3119\(20\)63430-X](https://doi.org/10.1016/S2095-3119(20)63430-X)

- [17] Shabir, M., Jiang, P., Wang, W., & Işık, Ö. (2023). COVID-19 pandemic impact on banking sector: A cross-country analysis. *Journal of Multinational Financial Management*, 67, 1-39. <https://doi.org/10.1016/j.mulfin.2023.100784>
- [18] Ayati, N., Saiyarsara, P., & Nikfar, S. (2020). Short and long term impacts of COVID-19 on the pharmaceutical sector. *DARU Journal of Pharmaceutical Sciences*, 28, 799-805. <https://doi.org/10.1007/s40199-020-00358-5>
- [19] Biswas, A., Ghosh, A., Kar, A., & Mondal, T. (2021). The impact of COVID-19 in the construction sector and its remedial measures. *Journal of Physics: Conference Series*, 1797(1), 1-12. <https://doi.org/10.1088/1742-6596/1797/1/012054>
- [20] Hoque, A., Shikha, F. A., Hasanat, M. W., Arif, I., & AbdulHamid, A. (2020). The effect of Coronavirus (COVID-19) in the tourism industry in China. *Asian Journal of Multidisciplinary Studies*, 3(1), 52-58.
- [21] Bortoló, G. M., Valdés, J. Á., & Nicolas-Sans, R. (2023). Sustainable, technological, and innovative challenges Post COVID-19 in health, economy, and education sectors. *Technological Forecasting and Social Change*(122424), 1-24. <https://doi.org/10.1016/j.techfore.2023.122424>
- [22] Henseler, M., Maisonnave, H., & Maskaveva, A. (2022). Economic impacts of COVID-19 on the tourism sector in Tanzania. *Annals of Tourism Research Empirical Insights*, 3(1), 1-12. <https://doi.org/10.1016/j.annale.2022.100042>
- [23] Mack, E. A., Agrawal, S., & Wang, S. (2021). The impacts of the COVID-19 pandemic on transportation employment: A comparative analysis. *Transportation Research Interdisciplinary Perspectives*, 12(100470), 1-13. <https://doi.org/10.1016/j.trip.2021.100470>
- [24] Slavković, M., Ognjanović, J., & Bugarčić, M. (2023). Sustainability of human capital efficiency in the hotel industry: Panel data evidence. *Sustainability*, 15(3), 2-16. <https://doi.org/10.3390/su15032268>
- [25] Demirhan, D., & Sakin, A. (2021). Has COVID-19 pandemic affected firm profitability? Dynamic panel data analysis of bist firms using dupont identity components. *PressAcademia Procedia*, 14(1), 42-47. [https://doi.org/10.1016/S0377-2217\(00\)00121-1](https://doi.org/10.1016/S0377-2217(00)00121-1)
- [26] Gu, X., Ying, S., & Zhang, W. (2020). How do firms respond to COVID-19 ? First evidence from Suzhou, China. *Emerging Markets Finance and Trade*, 56(10), 2181-2197. <https://doi.org/10.1080/1540496X.2020.1789455>
- [27] Wang, Y., & Zhang, D. (2020). How does COVID-19 affect China's insurance. *Emerging Markets Finance and Trade*, 56(10), 2350-2362. <https://doi.org/10.1080/1540496X.2020.1791074>
- [28] Mateev, M., Tariq, M. U., & Sahyouni, A. (2021). Competition, capital growth and risk-taking in emerging markets: Policy implications for banking sector stability during COVID-19 pandemic. *PloS one*, 16(6). <https://doi.org/10.1371/journal.pone.0253803>
- [29] Atayah, O. F., Dhiaf, M. M., Najaf, K., & Frederico, G. F. (2022). Impact of COVID-19 on financial performance of logistics firms: evidence from G-20 countries. *Journal of Global Operations and Strategic Sourcing*, 15(2), 172-196. <https://doi.org/10.1108/JGOSS-03-2021-0028>
- [30] Nguyen, C. T., Hai, P. T., & Nguyen, H. K. (2021). Stock market returns and liquidity during the COVID-19 outbreak: evidence from the financial services sector in Vietnam. *Asian Journal of Economics and Banking*, 5(3), 324-342. <https://doi.org/10.1108/AJEB-06-2021-0070>
- [31] Ferrando, A., & Ganoulis, I. (2020). Firms' expectations on access to finance at the early stages of the Covid-19 pandemic. ECB Working Paper No. 20202446. <http://dx.doi.org/10.2139/ssrn.3656265>
- [32] Şenol, Z., & Zeren, F. (2020). Coronavirus (COVID-19) and stock markets: The effects of the pandemic on the global economy. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi*, 7(4), 1-16.
- [33] Corredera-Catalán, F., di Pietro, F., & Trujillo-Ponce, A. (2021). Post-COVID-19 SME financing constraints and the credit guarantee scheme solution in Spain. *Journal of Banking Regulation*, 22(3), 250-260. <https://doi.org/10.1057/s41261-021-00143-7>
- [34] Aftab, R., Naveed, M., & Hanif, S. (2021). An analysis of COVID-19 implications for SMEs in Pakistan. *Journal of Chinese Economic and Foreign Trade Studies*, 14 (1), 74-88. <https://doi.org/10.1108/JCEFTS-08-2020-0054>
- [35] Hu, M. K., & Kee, D. M. H. (2022). Fostering sustainability: reinventing SME strategy in the new normal. *Foresight*, 24(3/4), 301-318. <https://doi.org/10.1108/FS-03-2021-0080>
- [36] Turkson, D., Adda, N. B., Chowdhury, F., & Mohammed, F. (2021). Government policies and firm performance in the COVID-19 pandemic era: A sectoral analysis. *SN Business & Economics*, 1(168), 1-22. <https://doi.org/10.1007/s43546-021-00170-6>
- [37] Achim, M. V., Safta, I. L., Văidean, V. L., & Borlea, N. S. (2022). The impact of COVID-19 on financial management: evidence from Romania. *Economic Research-Ekonomska Istraživanja*, 35(1), 1807-1832. <https://doi.org/10.1080/1331677X.2021.1922090>
- [38] Golubeva, O. (2021). Firms' performance during the COVID-19 outbreak: International evidence from 13 countries. *The International Journal of Business in Society*, 21(6), 1011-1027. <https://doi.org/10.1108/CG-09-2020-0405>
- [39] Shen, H., Fu, M., Pan, H., Yu, Z., & Chen, Y. (2020). The impact of the COVID-19 pandemic on firm performance. *Emerging Markets Finance and Trade*, 56(10), 2213-2230. <https://doi.org/10.1080/1540496X.2020.1785863>

- [40] Brancati, E., & Brancati, R. (2020). Heterogeneous shocks in the COVID-19 pandemic: Panel evidence from Italian firms. SSRN(3597650), 1-28. <http://dx.doi.org/10.2139/ssrn.3597650>
- [41] Aykaç Alp, E., Yağmur, M. 2016. Istanbul ticaret odası ticari faaliyet endeksi ve meslek komiteleri tespit ve önerileri. İstanbul: ITO Yayınları
- [42] Aykaç Alp, E., Yağmur, M. 2017. Istanbul ticaret odası ticari faaliyet endeksi ve meslek komiteleri tespit ve önerileri, -2016 verileri ile. İstanbul: ITO Yayınları
- [43] Aykaç Alp, E., Yağmur, M. 2018. Istanbul ticaret odası ticari faaliyet endeksi ve meslek komiteleri tespit ve önerileri, -2017 verileri ile. İstanbul: ITO Yayınları.
- [44] Saaty, T.L. (1980). Multicriteria Decision Making: The Analytic Hierarchy Process. New York: McGraw-Hill.
- [45] Leal, J. E. (2020). AHP-express: A simplified version of the analytical hierarchy process method. *MethodsX*, 7, 100748. <https://doi.org/10.1016/j.mex.2019.11.021>
- [46] Chwolkwa, A., & Raith, M. G. (2001). Group preference aggregation with the AHP—implications for multiple-issue agendas. *European Journal of Operational Research*, 132(1), 176-186. [https://doi.org/10.1016/S0377-2217\(00\)00121-1](https://doi.org/10.1016/S0377-2217(00)00121-1)
- [47] Beynon, M. (2002). An analysis of distributions of priority values from alternative comparison scales within AHP. *European Journal of Operational Research*, 140(1), 104-117. [https://doi.org/10.1016/S0377-2217\(01\)00221-1](https://doi.org/10.1016/S0377-2217(01)00221-1)
- [48] Lirn, T. C., Thanopoulou, H. A., Beynon, M. J., Beresford, A. K. C. (2004). An application of AHP on transshipment port selection: a global perspective. *Maritime Economics & Logistics*, 6(1), 70-91. <https://doi.org/10.1057/palgrave.mel.9100093>
- [49] Sadiq, R., & Tesfamariam, S. (2009). Environmental decision-making under uncertainty using intuitionistic fuzzy analytic hierarchy process (IF-AHP). *Stochastic Environmental Research and Risk Assessment*, 23(1), 75-91. <https://doi.org/10.1007/s00477-007-0197-z>
- [50] Saaty, T.L., & Vargas, L.G. (2012). The seven pillars of the analytic hierarchy process. In: *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*. International Series in Operations Research & Management Science, vol 175. Boston: Springer. [https://doi.org/10.1007/978-1-4614-3597-6\\_2](https://doi.org/10.1007/978-1-4614-3597-6_2)
- [51] Saaty, T.L. (2008). The Analytic Hierarchy and Analytic Network Measurement Processes: applications to decisions under risk. *European Journal of Pure and Applied Mathematics*, 1(1), 122-196. <https://doi.org/10.29020/nybg.ejpam.v1i1.6>
- [52] Saaty, T.L., & Vargas, L.G. (2012). The seven pillars of the analytic hierarchy process. In: *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*. International Series in Operations Research & Management Science, vol 175. Boston: Springer. [https://doi.org/10.1007/978-1-4614-3597-6\\_2](https://doi.org/10.1007/978-1-4614-3597-6_2)
- [53] Fabrigar, L. R., & Wegener, D. T. (2011). *Exploratory factor analysis*. Oxford: Oxford University Press.
- [54] Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in quantitative methods for psychology*, 9(2), 79-94. <https://doi.org/10.20982/tqmp.09.2.p079>
- [55] Abdi, H., & Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, 2(4), 433-459. <https://doi.org/10.1002/wics.101>
- [56] Dhanaraj, R.K., Rajkumar, K., & Hariharan, U. (2020). Enterprise IoT Modeling: Supervised, Unsupervised, and Reinforcement Learning. In: Haldorai, A., Ramu, A., Khan, S. (eds) *Business Intelligence for Enterprise Internet of Things*. EAI/Springer Innovations in Communication and Computing. Springer, Cham. [https://doi.org/10.1007/978-3-030-44407-5\\_3](https://doi.org/10.1007/978-3-030-44407-5_3)
- [57] Alloghani, M., Al-Jumeily, D., Mustafina, J., Hussain, A., Aljaaf, A.J. (2020). A systematic review on supervised and unsupervised machine learning algorithms for data science. In: Berry, M., Mohamed, A., Yap, B. (eds) *Supervised and Unsupervised Learning for Data Science*. Unsupervised and Semi-Supervised Learning. Springer, Cham. [https://doi.org/10.1007/978-3-030-22475-2\\_1](https://doi.org/10.1007/978-3-030-22475-2_1)
- [58] Hua, H., Qin, Y., Hao, C., & Cao, J. (2019). Optimal energy management strategies for energy Internet via deep reinforcement learning approach. *Applied energy*, 239, 598-609. <https://doi.org/10.1016/j.apenergy.2019.01.145>
- [59] Mvududu, N. H., & Sink, C. A. (2013). Factor analysis in counseling research and practice. *Counseling Outcome Research and Evaluation*, 4(2), 75-98. <https://doi.org/10.1177/2150137813494766>
- [60] Watkins, M. W. (2018). Exploratory factor analysis: A guide to best practice. *Journal of Black Psychology*, 44(3), 219-246. <https://doi.org/10.1177/0095798418771807>.
- [61] Kaiser, H.F., & Rice, J. (1974). Little Jiffy, mark IV. *Educ PsycholMeas* 1974, 34(1), 111–117.
- [62] Nair, S. T. G. (2021). Business adversity during the COVID-19 crisis and beyond: the way forward for small and medium enterprises in India. *Foresight*, 24 (3/4), 377-391. <https://doi.org/10.1108/FS-01-2021-0025>