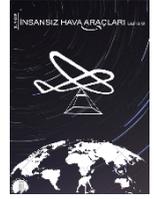




Türkiye İnsansız Hava Araçları Dergisi

<https://dergipark.org.tr/tr/pub/tiha>

e-ISSN 2687-6094



Implementing Drone Technologies in the Logistics Industry: An Innovation-Focused Study on UAV Pilots

Talha Burak Çalışkan *¹ & Ramazan Erturgut ¹

¹ Akdeniz Üniversitesi, Uygulamalı Bilimler Fakültesi, Uluslararası Ticaret ve Lojistik, Lojistik Yönetimi, Antalya, 07070, Türkiye
(talhaburakcaliskan@gmail.com; rerturgut@akdeniz.edu.tr)



*Corresponding Author:
talhaburakcaliskan@gmail.com

Research Article

Citation: Çalışkan, T. B. & Erturgut, R. (2025). Implementing Drone Technologies in the Logistics Industry: An Innovation-Focused Study on UAV Pilots. *Turkish Journal of Unmanned Aerial Vehicles*, 7(2), 64-76.

Received : 26.11.2025
Revised 1 : 13.12.2025
Accepted : 22.12.2025
Published : 27.12.2025

Abstract

The twenty-first century, often characterized as an era of rapid technological progression, has ushered in notable transformations across the business landscape, particularly within the field of logistics. As technological capabilities continue to advance, firms have increasingly directed their investments towards sophisticated logistics systems, contributing significantly to the expansion of international trade. Among the prominent technologies shaping this transformation, unmanned aerial vehicles (UAVs) have emerged as a key element of the broader digital shift. Widely recognized for their potential to enhance operational speed and reduce costs, UAVs are progressively being integrated into the strategic investment plans of numerous national and international companies. This study explores the relationship between the use of UAVs and logistics activities within the context of air transportation, drawing on the professional perceptions of licensed UAV operators. UAV utilization, as the independent variable, was assessed across the dimensions of Design, Perceived Ease of Use, Perceived Benefit, Performance Expectation, Safety and Job Relevance, while Logistics Effectiveness was identified as the dependent variable. Since the items related to Job Relevance loaded under the Design dimension during analysis, this dimension was removed from the model. The research sample comprised 301 UAV0-UAV1 pilots certified by the Turkish Directorate General of Civil Aviation. The findings demonstrate a positive relationship between UAV usage and logistics activities. In particular, the strongest relationship was observed between the Safety dimension of UAVs and the Logistics Effectiveness variable. The results indicate that UAV use within the logistics sector is generally perceived as safe, and existing operational procedures in the country are regarded as sufficient. Nevertheless, as UAV technologies continue to evolve, the necessity for ongoing enhancement of safety measures remains clear.

Keywords: Drone technologies, Unmanned aerial vehicles, Logistics, Air cargo.

Lojistik Sektöründe Drone Teknolojilerinin Uygulanması: İHA Pilotları Üzerine İnovasyon Odaklı Bir Çalışma

*Sorumlu Yazar:
talhaburakcaliskan@gmail.com

Araştırma Makalesi

Alıntı: Çalışkan, T. B. & Erturgut, R. (2025). Evaluation of Visual Lojistik Sektöründe Drone Teknolojilerinin Uygulanması: İHA Pilotları Üzerine İnovasyon Odaklı Bir Çalışma. *Türkiye İnsansız Hava Araçları Dergisi*, 7(2), 64-76. (in English).

Geliş :26.11.2025
Revize 1 :13.12.2025
Kabul :22.12.2025
Yayınlama :27.12.2025

Özet

Hızlı teknolojik ilerlemenin yaşandığı bir dönem olarak nitelendirilen yirmi birinci yüzyıl, iş dünyasında, özellikle lojistik alanında önemli dönüşümler getirmiştir. Teknolojik imkanlar gelişmeye devam ettikçe, şirketler yatırımlarını giderek daha sofistike lojistik sistemlerine yöneltmiş ve uluslararası ticaretin genişlemesine önemli katkıda bulunmuştur. Bu dönüşümü şekillendiren öne çıkan teknolojiler arasında, insansız hava araçları (İHA'lar) daha geniş kapsamlı dijital dönüşümün önemli bir unsuru olarak ortaya çıkmıştır. Operasyonel hızı artırma ve maliyetleri düşürme potansiyeli ile yaygın olarak tanınan İHA'lar, giderek birçok ulusal ve uluslararası şirketin stratejik yatırım planlarına entegre edilmektedir. Bu çalışma, lisanslı İHA operatörlerinin profesyonel algılarına dayanarak, hava taşımacılığı bağlamında İHA kullanımı ile lojistik faaliyetleri arasındaki ilişkiyi incelemektedir. Bağımsız değişken olarak İHA kullanımı, Tasarım, Algılanan Kullanım Kolaylığı, Algılanan Fayda, Performans Beklentisi, Güvenlik ve İşle İlgili Olma boyutları üzerinden değerlendirilirken, bağımlı değişken olarak Lojistik Etkinlik belirlenmiştir. Analiz sırasında İşle İlgili Olma ile ilgili öğeler Tasarım boyutuna yüklendiğinden, bu boyut modelden çıkarılmıştır. Araştırma örneği, Türkiye Sivil Havacılık Genel Müdürlüğü tarafından sertifikalandırılmış 301 İHA0-İHA1 pilotundan oluşmuştur. Bulgular, İHA kullanımı ile lojistik faaliyetleri arasında pozitif bir ilişki olduğunu göstermektedir. Özellikle, İHA'ların Güvenlik boyutu ile Lojistik Etkinlik değişkeni arasında en güçlü ilişki gözlemlenmiştir. Sonuçlar, lojistik sektöründe İHA kullanımının genel olarak güvenli olarak algılandığını ve ülkedeki mevcut operasyonel prosedürlerin yeterli görüldüğünü göstermektedir. Bununla birlikte, İHA teknolojileri gelişmeye devam ettikçe, güvenlik önlemlerinin sürekli olarak iyileştirilmesi gerekliliği açıkça ortadadır.

Anahtar Kelimeler: Drone teknolojileri, İnsansız hava araçları, Lojistik, Hava kargo.

1. Introduction

Logistics refers to the coordinated management of activities such as planning, sourcing, inventory control, and the efficient movement of materials and products to meet customer requirements, emphasizing end-to-end visibility and operational optimization in modern supply chains (CSCMP, 2022). In today's global business environment, increasing product variety, accelerating delivery expectations, and the rapid growth of e-commerce require firms to handle larger volumes with higher quality standards through faster, more flexible, and technology-driven distribution systems (Jazairy et al., 2024). Over time, accelerated shifts in market structures, product portfolios and technologies—as well as intensified competition—have fundamentally altered the logistics landscape (Turienzo et al., 2024). The rise of digital platforms, automation and global value-chains has transformed how logistics services are organized, delivered and managed (Nagy et al., 2023). In addition, the expansion of door-to-door and other last-mile delivery models has driven logistics activities toward highly integrated, technology-enabled systems, enabling real-time coordination and seamless end-to-end service flows (Deloitte, 2023). Air cargo transportation and related logistics operations have seen sustained growth in recent years, driven by the expansion of global e-commerce and the need for rapid, reliable delivery of high-value goods (Akar, 2025). According to the International Civil Aviation Organization (ICAO), air freight now accounts for about 34.6 % of world trade by value while representing roughly 1 % by volume, underscoring its role in high-value, time-sensitive shipments (ICAO, 2024). Furthermore, in 2023 air transport carried approximately 61.4 million tons of cargo and was valued at around US\$8 trillion, reflecting its strategic importance in the modern economy for fast, secure movement of goods (ATAG, 2024). In today's commercial landscape, air cargo is increasingly favored due to the strong growth in e-commerce, expanding logistics capabilities, product-portfolio diversification, and heightened competition among firms—where speed, reliability and agility are increasingly key differentiators (Stattimes, 2024; Flyportts, 2025). Unmanned aerial vehicles (UAVs) have rapidly transitioned from military origins into commercial, consumer and hobby applications within less than a decade, driven by advances in navigation, autonomy and regulatory support (Future Market Insights, 2025). As drones find expanding use across sectors—ranging from agriculture and mining to infrastructure inspections and delivery services—they offer distinct advantages in reducing labor costs and overcoming transport constraints in challenging

environments (IMARC Group, 2025). According to recent market studies, the global drone logistics and transportation market is projected to grow from roughly USD 2.1 billion in 2025 to USD 87.6 billion by 2035, underlining the massive potential of drone-powered solutions across industries (Future Market Insights, 2025). In this study; The question of whether there is a relationship between the Use of Drones and Logistics in air transportation as a mode of transportation has been evaluated in the context of their professional perceptions. However, despite the growing body of research on drone technologies, existing studies primarily focus on technical, regulatory and operational aspects, leaving a clear gap regarding how UAV pilots themselves perceive the integration of drones into logistics practices. This study was motivated by the need to address this gap and to provide practitioner-based insights into the relationship between UAV usage and logistics effectiveness in air transportation. Accordingly, the research aims to contribute empirical evidence on how professional UAV operators evaluate the opportunities and challenges associated with drone-supported logistics operations.

2. The Concept and Description of Logistics

The origins of logistics, historically rooted in military planning and resource coordination, date back thousands of years; however, the foundations of logistics as a scientific discipline began to form in the early twentieth century with the organized distribution of goods and the development of concepts such as time and place utility (Rushton et al., 2022).

Modern logistics has since evolved into a comprehensive system that manages the coordinated movement of products, services, financial resources, and information across all stages of the supply chain, from production to final consumption (Christopher, 2020). Logistics activities encompass an integrated set of processes—including transportation, inventory management, information exchange, communication networks, and storage operations—that enable seamless flows between suppliers, firms, and international markets (Grant et al., 2022).

One of the fundamental components for assessing a country's level of development is the performance of its economic indicators. Positive trends in these indicators contribute to improvements not only in economic outcomes but also in the social, cultural and institutional fabric of a nation. Logistics is among the strategic instruments that significantly influence these indicators, as it directly shapes trade efficiency, competitiveness and economic resilience (OECD, 2023). In recent years, the expansion of international

trade activities, the diversification of global markets and the increasing complexity of cross-border transactions have further elevated the critical role of logistics (World Bank, 2024). In this context, sustaining economic performance requires countries to develop robust and sustainable domestic and international trade infrastructures supported by effective logistics strategies (UNCTAD, 2023).

In today's business environment, logistics has become increasingly central due to advancements in transportation systems, digital technologies and communication networks, all of which enhance the integration and efficiency of modern supply chains (WEF, 2024).

In recent years, the conditions under which businesses operate have undergone significant transformation, driven by rapid technological advancements, shifting market expectations and increasing global uncertainties. These changes have markedly influenced the logistics activities of firms, compelling them to adapt their operations to more dynamic and digitally integrated environments (Ivanov & Dolgui, 2022). Earlier studies predicted that the future of logistics would be shaped primarily by developments in information technologies, digital commerce, integrated supply chain structures and customer-centric service models—an outlook that has been strongly reaffirmed in contemporary research (Grant et al., 2023).

3. Description and Concept of Airline Cargo

According to contemporary definitions by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA), air cargo refers to the handling, documentation, packaging, labeling and air transport of goods—excluding mail and passenger baggage—carried in compliance with international safety standards and carrier-specific operational requirements (ICAO, 2023; IATA, 2024).

Air cargo transportation has become a central component of the global transport system due to its speed, reliability and high security levels compared with other modes. Moreover, air freight services generate substantial direct and indirect economic value by supporting global supply chains, enabling high-value trade flows and contributing to the growth of numerous interconnected sectors within the world economy (ATAG, 2024; World Bank, 2024).

Shippers typically select from air, road or maritime transport modes, and their preferences are shaped primarily by factors such as transportation cost, delivery speed, service frequency, security and overall service quality (World Bank, 2024).

There is a strong and mutually reinforcing relationship between air cargo operations, international trade activity and national economic output, as air freight enables rapid, reliable and efficient access to distant markets and global supply chains (ICAO, 2023). With the accelerating effects of globalization and the expansion of digital trade networks, logistics strategies have evolved significantly, leading many firms to reassess the strategic value of air cargo and prompting airlines to increase cargo capacity in response to rising demand (OECD, 2023).

Although maritime shipping continues to dominate global trade in terms of total volume and tonnage, air cargo maintains a crucial role in supporting high-value and time-sensitive shipments, making it a key driver of economic growth and global connectivity (ATAG, 2024). Given that air freight accounts for roughly 1% of total trade volume but more than one-third of global trade value, even marginal fluctuations in market conditions can generate substantial impacts on air cargo operations (IATA, 2024).

4. Description and Concept of Unmanned Aerial Vehicle

Unmanned Aerial Vehicles (UAVs)—also commonly referred to as drones — are aircraft systems capable of being operated remotely by a human pilot or autonomously without any human on board, offering significant operational and cost-efficiencies due to the absence of an onboard pilot. (Ahmed et al., 2022).

As technology has advanced, the operational domains for UAV systems have expanded rapidly. Initially, by the late 2000s, UAV development was largely concentrated in military applications—but by the 2010s and beyond, commercial, civilian and logistics uses have surged (Obaid et al., 2025).

Today, UAVs are increasingly adopted across a wide range of sectors including agriculture, energy, construction, inspection, public safety, delivery logistics, and emergency response, reflecting their versatility and growing importance in both production and service environments (Kim et al., 2024).

- In accordance with Article 5 of the Regulations of the General Directorate of Civil Aviation (SHT-IHA), the classification of Unmanned Aerial Vehicles is made according to the maximum take-off weights of the UAV (Tunalı, 2017: 30);
- UAV0: UAVs with a maximum take-off mass of 500 g (including) – 4 kg
- UAV1: UAVs with a maximum take-off mass of 4 kg (including) - 25 kg

- UAV2: UAVs with a maximum take-off mass of 25 kg (including) – 150 kg
- UAV3: UAVs with a maximum take-off mass of 150 kg (including) and more;

The use of UAVs has expanded rapidly in recent years, evolving into a technology adopted across nearly all major sectors. Recent market analyses indicate that the global UAV industry continues its strong growth trajectory, with the drone market projected to reach approximately USD 90–100 billion by 2030, driven by both commercial and governmental demand (Allied Market Research, 2024).

With annual market revenues surpassing USD 20 billion and increasing each year, UAVs have become one of the fastest-growing segments within the broader aerospace and automation industries. However, despite this rapid market expansion, regulatory frameworks in many countries remain incomplete, and harmonized legal standards for UAV operations are still developing (OECD, 2023).

Although UAVs were initially used predominantly for military purposes, their integration into civilian life accelerated significantly within the last decade. Since the early 2010s, UAVs have gained widespread attention across public, recreational and commercial domains, and after 2019, their use has become heavily concentrated in private-sector activities. Today, drones are extensively employed across filmmaking, photography, public safety, infrastructure inspection, construction, energy, mining, agriculture, telecommunications, insurance and logistics operations (Kim et al., 2024; Obaid et al., 2025).

UAVs contribute to logistical efficiency by reducing delivery lead times, enabling point-to-point transport, and minimizing the constraints of ground-based congestion—mechanisms widely recognized as core drivers of logistics performance (Christopher, 2020). UAVs further enhance logistical operations by improving delivery precision and accessibility to remote or infrastructure-limited locations, aligning with the digitalization trends that emphasize speed, responsiveness, and end-to-end visibility in supply chains (Ivanov & Dolgui, 2022). Additionally, their autonomous capabilities support higher process standardization and lower human error, thereby improving service reliability and operational stability, which are key determinants of logistics efficiency (Kim et al., 2024). Collectively, these mechanisms illustrate how UAV adoption strengthens the logistical system through improved speed, reliability, flexibility, and real-time data integration—dimensions consistently highlighted in contemporary logistics efficiency models (World Bank, 2024).

The sector in which unmanned aerial vehicles are expected to develop the most is the logistics sector.

From small businesses to large businesses, everyone uses logistics processes. However, although it is expected to provide so much benefit, the sector in which UAVs show the slowest development is the logistics sector. The logistics sector has a developed and effective infrastructure that has completed itself especially in sea, air and road transport. It may sound nice for Amazon to deliver packages with drones for advertising purposes, but considering how many transport vehicles operate simultaneously, especially in high-population areas, it is unrealistic to claim that this distribution network will be taken over by UAVs in a short time. Expectation is not. Although unmanned aerial vehicles are at the very beginning of the road, it is expected that they will play an important role in the logistics sector in the coming years.

5. Research Methodology

Before this study, in which quantitative research design was used, a pilot study was conducted on the validity of the questionnaire and opinions were received about the applicability of the questionnaire. The research data were sent to the UAV pilots approved by the General Directorate of Civil Aviation via a multi-scale survey (survey) application via e-mail (Google survey). While direct face-to-face survey application will be preferred, the surveys were collected electronically with Google Survey due to the Covid-19 epidemic surrounding our world. A total of 1700 UAV pilots with licenses approved by the General Directorate of Civil Aviation were sent questionnaires, and 301 UAV pilots were returned. Questionnaire statements for the dimensions of Unmanned Aerial Vehicles, Design, Perceived Benefit, Perceived Ease of Use, Job Relevance, Performance Expectation, Security, which are the independent variables of the empirical research Kamali (2018) and used in the survey of this study. Among the dimensions of the questionnaire, the 5th questionnaire of the Design dimension, the 6th questionnaire of the Perceived Benefit dimension, and the Perceived Benefit dimension. The 5th and 6th questionnaire of the Ease-of-Use dimension, the 4th questionnaire of the Business Relevance dimension, the 4th and 5th questionnaire of the Performance Expectation dimension, and the 6th questionnaire of the Security dimension were developed by me for the purpose of the research. Applied survey results evaluated with statistical analysis, the findings were listed and classified. According to the results of the research, it was determined that there is a positive relationship between Unmanned Aerial Vehicle Usage and Logistics Activity.

6. Findings / Results

6.1. Factor Analysis

It is the method used to transform interrelated data structures into independent and less number of new data structures, to reveal common factors by grouping the variables that are supposed to explain an occurrence or event, and to group variables that affect a formation (Özdamar 2002:235). In other words, it is a type of multivariate analysis that provides a more meaningful and concise presentation of data based on the relationships among many variables (Kurtuluş 1985: 482).

Rennie (1997), on the other hand, defines Factor Analysis as an analytical technique that aims at a small amount of explanatory concept that gives the maximum variance result and deals with the relationships between the observed variables themselves.

Having a certain level of relationship between the variables is important for compliance with factor analysis. The Bartlett Test examines the previous correlation matrix in general terms and pays attention to the statistical significance of this correlation matrix. The desired situation is that this test is meaningful (Yaslioglu, 2017). The significance level (p value) of the test should be less than 0.05 (Kalaycı, 2008).

The Kaiser-Meyer-Olkin (KMO) test is a test that measures correlations between variables and the suitability of factor analysis. Between 0.9 and 1, the KMO criterion is excellent, between 0.8 and

0.89 very good, between 0.7 and 0.79 good, between 0.6 and 0.69 fair, between 0.5 and 0.59 weak, and when it is below 0.5, it shows that the data set is not suitable for factor analysis (Aydın, B., 2007).

Table 1. KMO value and interpretation.

KMO Size	Recommended Level
0.90+	Excellent
0.80+	Very good
0.70+	Good
0.60+	Medium
0.50+	Bad
0.50-	Unacceptable

Source: (İlhan, 2007).

In factor analysis, the factor load values should determine the relationship between the expressions and the factor, and the resulting values should be high. It also shows to what extent the factor load values represent the dimension under which the group size is located. This value is expected to be greater than 0.45, and for a small number of expressions, this limit can go down to 0.30 (Büyüköztürk, 2002:118).

6.1.1. Factor Analysis Results of Unmanned Aerial Vehicles Independent Variable

Table 2 shows the factor analysis results of the dimensions of the Unmanned Aerial Vehicles, which is the independent variable of the research. When the table is examined, it is seen that Unmanned Aerial Vehicles factor in 5 dimensions as performance expectation, perceived Benefit, safety, perceived ease of use and design. Because the expressions related to the job relevance dimension factored under the design dimension, they were excluded from the study.

1 from the design dimension, 2 from the perceived ease of use dimension, and all expressions of the job relevance dimension were excluded from the analysis. The extracted expressions are as follows;

- I have no difficulty using any UAV technology if the UAV design fits the business requirements. (DES2)
- UAV usage and features make things I want to do easier. (PERCEAS1)
- My individual learning (Uncertified) makes the use of UAV easier. (PERCEAS6)
- My job is convenient to use UAVs. (JOBREL1)
- I use drones quite well on my own. (JOBREL2)
- UAV use is one of the best options in the logistics business environment. (JOBREL3)
- UAV usage can be adapted to current and future Logistics business processes. (JOBREL4)

A Barlett significance level (p value) of 0.000 means that there is sufficient correlation between the scales for factor analysis. The KMO value is 0.903. This means that the relationship between the scales is highly suitable for factor analysis. The cumulative variance of the 5 factors in the scale is 57.887%. This result indicates that all factors explain the total variance to a large extent. Statement 6 of the safety dimension (GUV6), that is, has medium load values (between 0.45 and 0.30), and factor load values of all other statements are higher than 0.45.

Table 2. Independent variable factor analysis results.

	Factors	1	2	3	4	5
Performance Expectation						
PERFEXP2	I think the UAV can meet its business goals	,771				
PERFEXP3	I think UAV can improve my working performance	,746				
PERFEXP4	UAVs can be one of the priority elements in doing my job efficiently and effectively.	,705				
PERFEXP1	UAVs reliably meet the requirements of the business	,682				
PERFEXP5	The use of UAVs increases the efficiency of my work.	,567				
Perceived Benefit						
PERCBEN4	Using UAVs saves me time		,763			
PERCBEN2	UAV technology has a performance-enhancing and saving effect.		,670			
PERCBEN6	UAV technology makes it easier for me to gain superiority over my competitors by bringing innovation and creativity to my work.		,652			
PERCBEN3	UAV helps to increase the effectiveness of users		,639			
PERCBEN5	UAV technology benefits my daily life.		,599			
PERCBEN1	The UAV helps me to do my job faster compared to traditional services.		,560			
Safety						
SAF5	I feel that the use of UAVs is safe in my country			,770		
SAF4	It is not easy to hack or steal and use UAVs			,728		
SAF3	Easy to carry out regulated legal procedures for the use of UAVs			,646		
SAF2	I rely on UAV technology to protect my information			,618		
SAF1	I feel safe using UAV technology			,557		
SAF6	I believe that UAVs can be used in the business environment by providing air and ground safety.			,321		
Perceived Ease of Use						
PERCEAS4	Learning to use a UAV is quite easy				,684	
PERCEAS2	Using UAV systems is clear and understandable				,656	
PERCEAS5	Certified UAV Trainings facilitate the use of UAVs.				,574	
PERCEAS3	UAV systems facilitate interactions with stakeholders				,485	
Design						
DES3	My business life allows me to learn about UAV design					,789
DES5	My level of emphasis on UAV design is affected by the aesthetic and visual elements of the UAV					,599
DES1	UAV design has the effect of accelerating delivery processes.					,533
DES4	I like to work with new technologies in my area of expertise					,474
Eigenvalue		3,805	3,489	2,822	2,334	2,022
Variance (%)		15,222	13,954	11,287	9,337	8,087
Cumulative Variance (%)		15,222	29,176	40,463	49,800	57,887
KMO Test				0,903		
Bartlet Test			$\chi^2 = 3152,230$		$p=0,000$	

6.1.2. Factor Analysis Results of Logistic Dependent Variable

Table 3 shows the factor analysis results of the logistic variable, which is the dependent variable of the research. When the table is examined, it is seen that the dependent variable logistics factored under 1 dimension as logistics effectiveness.

A Barlett significance level (p value) of 0.000 means that there is sufficient correlation between the scales for factor analysis. The KMO value is 0.823. This means that the relationship between the scales is highly suitable for factor analysis. The cumulative variance of 1 factor in the scale is 68,550%. This result indicates that all factors explain the total variance to a large extent.

6.2. Normality Test

Kolmogorov-Smirnov and Shapiro-Wilk tests are used to get an idea about the distribution of research data. In addition, to understand whether the data are normally distributed or not, skewness and kurtosis values are examined, especially in studies conducted in social sciences (Yücenur et al., 2011: 162). According to Tabachnick and Fidell (2013), if the skewness and kurtosis values are between -1.5 and +1.5, it means that the data are normally distributed. According to George and Mallery (2010), this range is between -2.0 and +2.0. When the table is examined, it is seen that the data are normally distributed.

Table 3. Factor analysis results of the dependent variable.

Factors		
Logistics Effectiveness		
The technologies we have and try to achieve are effective in achieving the goals and objectives of the company I work for.		,874
In the logistics activities carried out in our company, it is aimed to provide the highest benefit with the least effort and optimization (optimization) studies are carried out for this.		,854
The services and products produced in our company and the business methods are compared with competitors and other companies in the sector		,841
The company I am in produces the necessary solutions to carry out logistics activities at the lowest cost.		,797
The vision and goals of the company I work for and my individual goals are compatible with each other. I see myself as part of the company vision		,769
Eigenvalue		3,428
Variance (%)		68,550
Cumulative Variance (%)		68,550
KMO Test		0,823
Barlett Test		X ² =863,685 p=0,000

Table 4. Normality analysis results.

Variables	Dimensions	Kolmogorov			Shapiro-Wilk			Skewness	Kurtosis
		Statistics	df	Sig.	Statistics	df	α		
Unmanned Aerial Vehicles	Performance Expectation	,143	301	,000	,896	301	,000	0,161	0,350
	Perceived Benefit	,203	301	,000	,806	301	,000	0,086	0,090
	Safety	,052	301	,044	,982	301	,001	1,5	0,61
	Perceived Ease of Use	,129	301	,000	,922	301	,000	0,163	0,446
	Design	,116	301	,000	,917	301	,000	0,15	0,183
Logistics	Logistics Effectiveness	,078	301	,000	,953	301	,000	0,287	1,522

When the table is examined, the results of the analysis performed for the independent variable of the research, UAV, and the dependent variable, Logistics, are included. Since the alpha values of Kolmogorov-Smirnov and Shapiro-Wilk tests are all less than 0.05, the normality assumption is rejected. However, since this research is carried out in the field of social sciences, it is normal for the participants in the research to respond with their emotions. For this reason, kurtosis and skewness values should be checked. When the table is examined, the skewness and kurtosis values of all dimensions of both variables are in the range of ± 1.96 . However, we see that the skewness and kurtosis values of some dimensions are close to ± 1.96 . The reason is that UAV pilots have different approaches because they use UAVs in different areas.

6.3. Reliability Analysis

Alpha (α) model (Cronbach Alpha Coefficient) was used in the reliability analysis. The alpha model is the weighted standard mean of change and is obtained by dividing the sum of the variances of the problem on a scale to the overall variance. This coefficient, which takes a value between 0 and 1, is called the alpha coefficient.

Depending on the alpha coefficient, the reliability of the scale is interpreted as follows (Kayış, 2010:405);

- If $0.00 \leq \alpha < 0.40$, the scale is unreliable,
- If $0.40 \leq \alpha < 0.60$, the reliability of the scale is low,
- If $0.60 \leq \alpha < 0.80$, the scale is quite reliable and
- If $0.80 \leq \alpha < 1.00$, the scale is highly reliable.

Table 5. Reliability analysis results.

Variables	Dimensions	Total Number of Expressions	Cronbach Alpha Coefficient
Unmanned Aerial Vehicles	Performance Expectation	5	0,870
	Perceived Benefit	6	0,828
	Safety	6	0,805
	Perceived Ease of Use	4	0,702
	Design	4	0,601
Unmanned Aerial Vehicles		25	0,910
Logistics	Logistics Effectiveness	5	0,882
Overall Reliability		30	0,920

As a result of Cronbach's alpha analysis, when the table is examined, it shows that unmanned aerial vehicles are highly reliable with an alpha value of 0.910. When the dimensions of the unmanned aerial vehicles variable are examined, the performance expectation dimension is 0.870, the perceived benefit dimension is 0.828, the security dimension is 0.805, the perceived ease of use dimension is 0.702, and the design dimension yields the reliability analysis results with an alpha value of 0.601. Performance expectation, perceived usefulness and security dimensions have high reliability, while perceived ease of use and design dimensions have normal reliability.

The logistic effectiveness alpha value, which is the dimension of the logistic variable, is 0.882. This value shows us that there is a high reliability. The general reliability alpha value of the study, on the other hand, has a high reliability of 0.920

6.4. The Relationship Between Unmanned Aerial Vehicles and Logistics

The model is the most important stage that determines the whole skeleton of the research. Research models differ according to the type of research. But there must be a model of the research (Kurtulmuş, 2010: 12).

The model of the research can be determined verbally, numerically, symbolically and geometrically. Along with the research model, it is to specify the interaction between the variables in the research and to plan the research stages (Kurtulmuş, 2010: 13).

In this case, the model we established to measure the relationship between Unmanned Aerial Vehicles and Logistics Variable is shown in Figure 3.1 below.

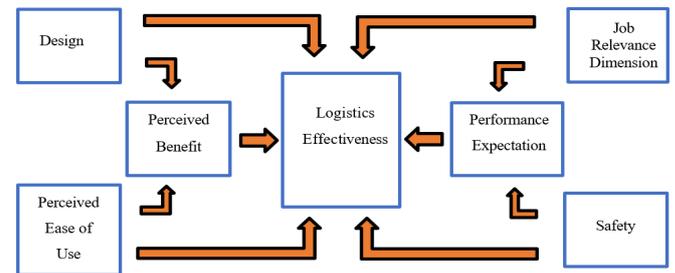


Figure 1 Model for measuring the relationship between unmanned aerial vehicles and logistics.

"It causes a difference in the professional perceptions of drone pilots regarding the use of Unmanned Aerial Vehicles in the Logistics sector." hypothesis is the main hypothesis of this study. Based on the model established above, the following hypotheses have been determined and the direction and level of the relevant hypotheses will be determined and interpreted in the correlation analysis to be carried out.

6.5. Hypotheses

H (a1): There is a positive relationship between design and perceived benefit.

H (b1): There is a positive relationship between design and logistics effectiveness.

H (a2): There is a positive relationship between perceived benefit and logistic effectiveness. H (a3): There is a positive relationship between perceived ease of use and perceived benefit.

H (b3): There is a positive relationship between perceived ease of use and logistic effectiveness. H (a4): There is a positive relationship between job interest level and performance expectation. H (b4): There is a positive relationship between job relevance and logistics effectiveness.

H (a5): There is a positive relationship between performance expectation and logistic effectiveness. H (a6): There is a positive relationship between security and performance expectation.

H (b6): There is a positive relationship between safety and logistic effectiveness.

Correlation analysis is a statistical method that aims to test the linear relationship between two variables and to measure the degree of this relationship, if any. The purpose of this analysis; when the independent variable changes, it is to see how the dependent variable will change (Sungur, 2005:115). In correlation analysis, if one variable has a high value and another variable has high values, it can be said that there is a positive interaction between the two variables. On the contrary, if one variable gets high values and the other gets low values, there is a negative correlation between the two variables. The correlation coefficient is represented by r and means $r = +1$ perfect positive correlation, $r = -1$ perfect negative correlation (Kaplan, 2011). If the correlation coefficient values are between 0.70-1.00 in the absolute value, there is a high directional difference between the variables, if it has a value between 0.70-0.30, it is moderate among the variables, and if it has a value between 0.30-0.00, there is a low directional difference between the variables. shows that there is a relationship (Büyüköztürk, 2002).

Table 6. The relationship between unmanned aerial vehicles and logistics sub-dimension.

Dimensions		Performance Expectation	Perceived Benefit	Safety	Perceived Ease of Use	Design	Logistics Effectiveness
Performance Expectation	r	1	,655	,569	,553	,501	,435
	P		,000	,000	,000	,000	,000
	N	301	301	301	301	301	301
Perceived Benefit	r	,655	1	,448	,541	,504	,309
	P	,000		,000	,000	,000	,000
	N	301	301	301	301	301	301
Safety	r	,569	,448	1	,482	,279	,443
	P	,000	,000		,000	,000	,000
	N	301	301	301	301	301	301
Perceived Ease of Use	r	,553	,541	,482	1	,452	,340
	P	,000	,000	,000		,000	,000
	N	301	301	301	301	301	301
Design	r	,501	,504	,279	,452	,1	,366
	P	,000	,000	,000	,000		,000
	N	301	301	301	301	301	301
Logistics Effectiveness	r	,435	,309	,443	,340	,366	1
	P	,000	,000	,000	,000	,000	
	N	301	301	301	301	301	301

When the table is examined, the results of the correlation analysis showing the relationship between the independent variable of the research, unmanned aerial vehicles and the dimensions of logistics, which is the dependent variable, are shown. The results of the research hypotheses are as follows.

Ha1: In the data obtained as a result of the research, it is seen that there is a 50.4% moderate positive relationship between the design dimension of the Unmanned Aerial Vehicles variable and the perceived benefit dimension. As a result, the h1a hypothesis, which was put forward that there is a positive and

significant relationship between design and perceived usefulness, was accepted.

Hb1: In the data obtained as a result of the research, it is seen that there is a moderate positive correlation of 36.6% between the design dimension of the Unmanned Aerial Vehicles variable and the logistics effectiveness dimension of the logistics variable. As a result, the h1b hypothesis, which was put forward that there is a positive and significant relationship between design and logistics effectiveness, was accepted.

Ha2: In the data obtained as a result of the research, it is seen that there is a moderate positive correlation of

30.9% between the perceived benefit dimension of the Unmanned Aerial Vehicles variable and the logistics effectiveness dimension of the logistics variable. As a result, the h2a hypothesis, which was put forward that there is a positive and significant relationship between perceived benefit and logistics effectiveness, was accepted.

Hb3: In the data obtained as a result of the research, it is seen that there is a moderate positive relationship of 54.1% between the perceived ease of use dimension of the Unmanned Aerial Vehicles variable and the perceived benefit dimension. As a result, the h3a hypothesis, which was put forward that there is a positive and significant relationship between perceived ease of use and perceived benefit, was accepted.

Hb3: In the data obtained as a result of the research, it is seen that there is a moderate positive correlation of 34.0% between the perceived ease of use dimension of the Unmanned Aerial Vehicles variable and the logistics effectiveness dimension of the logistics variable. As a result, the h3b hypothesis, which was put forward that there is a positive and significant relationship between perceived ease of use and logistics effectiveness, was accepted.

Ha5: In the data obtained as a result of the research, it is seen that there is a moderate positive relationship of 43.5% between the performance expectation dimension of the Unmanned Aerial Vehicles variable and the logistics effectiveness dimension of the logistics variable. As a result, the h5a hypothesis, which was put forward that there is a positive and significant relationship between performance expectation and logistics effectiveness, was accepted.

Ha6: In the data obtained as a result of the research, it is seen that there is a moderate positive correlation of 56.9% between the security dimension of the Unmanned Aerial Vehicles variable and the performance expectation dimension. As a result, the h6a hypothesis, which was put forward that there is a positive and significant relationship between security and performance expectation, was accepted.

Hb6: In the data obtained as a result of the research, it is seen that there is a moderate positive relationship of 44.3% between the security dimension of the Unmanned Aerial Vehicles variable and the logistics effectiveness dimension of the logistics variable. As a result, the h6b hypothesis, which was put forward that there is a positive and significant relationship between safety and logistics effectiveness, was accepted.

7. Discussions and Conclusions

Unmanned Aerial Vehicles is a technology that has entered our lives rapidly, especially in recent years,

and has found a place in many sectors. The designation of the 21st century as the "Drone Age" by the authorities has clearly shown the importance of this technology to people. The development of automation systems has played an important role in making this technology even more important, as people move forward with firm steps towards becoming a goal rather than a tool. In today's world, the use of UAVs is increasing day by day at the point that the concepts of speed and time are gaining importance, and companies want to reduce cost items in the same direction in the same direction.

In this scientific research, a study was conducted to determine the professional perceptions of the use of Unmanned Aerial Vehicles in the Logistics sector under the dimensions of Design, Performance Expectation, Perceived Benefit, Perceived Ease of Use and Security.

As a result of the statistical analyzes carried out in parallel with the main objective of the scientific research, it was determined that the use of Unmanned Aerial Vehicles in the Logistics sector caused a difference in the professional perceptions of drone pilots and the research hypothesis was accepted.

It has been observed that the relationship between the security dimension of Unmanned Aerial Vehicles and the logistic effectiveness, which is the dimension of the logistics variable, is at the highest rate. Again, it was determined that the performance expectation dimension of the UAV variable was highly correlated with the logistics effectiveness point. It has been concluded that the use of Unmanned Aerial Vehicles in the logistics sector is safe and the procedures are sufficient throughout the country. However, developing UAV technology day by day brings with it new security measures. In particular, it can be expected that security measures will be increased to prevent malicious use. Providing information to the central authorities in unauthorized and forbidden zone flights with satellite tracking can be a solution. It should be noted that the US Federal Aviation Administration (FAA) has taken a step towards an "unmanned air traffic management ecosystem" that will organize "drones" that will perform multiple flights in the national airspace.

The results of the research show that there is a high correlation between the security dimension of the Unmanned Aerial Vehicles variable and the performance expectation dimension. It has been concluded that UAVs can carry out business processes in a safe environment quickly and efficiently. UAVs appear as a solution for companies in terms of efficiency. Especially at the point of delivery, it is expected that UAVs will deliver some of the problems experienced today in a safer way. The use of UAVs in

warehouse management, which accounts for nearly 30% of the logistics costs of companies, will make a significant difference. UAVs will be in a very important position in terms of fast and reliable data stocktaking, their ability to fly safely in narrow corridors, and to prevent accidents in warehouses by reducing manpower.

UAV technology and its components, which are developing day by day, are very effective in the work to be done. In logistics business processes, design plays an active role in business processes. It is important in making current work fast. In the analyzes made, it has been determined that the design has a positive effect on the delivery processes. The desired efficiency can be achieved with a UAV capable of flying at a longer range. Especially during the Covid-19 epidemic, delivery by drone has gained importance. Many companies have taken initiatives in this regard. Finally, a company in Singapore is working on a drone that it will design towards the end of 2021, and a drone with a carrying capacity of 100 kilograms at a distance of 100 km. This is also very important in terms of making sea-to-land deliveries more efficient. However, it should be said that there are deficiencies in infrastructure and legal procedures in front of all these issues. If the necessary infrastructure and legal processes are completed, it is possible to see a much more effective process.

Although UAV systems consist of very complex components, it is quite easy to learn this system with the theoretical and practical training received from training institutions authorized by DGCA. The results of the analysis show that this certified training facilitates UAV learning. In the training modules, especially the theoretical training is important in understanding the UAV system components and the legal aspects. A UAV pilot is responsible for each parameter of the drone he uses. For this reason, they should improve their flight abilities not only by theoretical training but also by practical training. Thus, you can become a more skilled drone pilot in the field. In warehouse management, it is necessary to use a drone in narrow corridors and to be a professional drone pilot for expensive deliveries. The need for drone pilots is increasing for the developing drone technology day by day. Although it is defined as an Unmanned Aerial Vehicle, the UAV pilot is responsible for everything in this technology. Therefore, human is the center of this technology. According to the results of the analysis, we see that the number of UAV pilots has increased in the last 1 year. In addition, we can conclude that the pilots invested in the sector by obtaining the UAV1 license.

The significant relationship between perceived ease of use and logistics effectiveness shows that the

industry needs drones and this adaptation process can be easily overcome. Because the logistics sector in Turkey has been developing with an increasing momentum, especially in the last 10 years. The integration of drone technology into the sector will carry this sector even higher. Drones are expected to play a key role in the efficiency of the work to be done. It is expected that companies will create units of this technology by having UAV pilots within their own structure.

There are not many studies on the use of UAVs in the logistics sector in Turkey. In 2018, in Bahrain, Dr. Ali Kamali has made an article about the use of drones in the logistics sector for 50 professionals working in the logistics sector. It has been discussed that drones can be a solution in the logistics sector, especially with the increasing oil prices in Bahrain. In this study, a questionnaire was applied to 301 UAV pilots who received a certificate from a training institution authorized by the General Directorate of Civil Aviation, by developing the scale used by Kamali in his research. Thus, by reaching more people, the reliability of the results of the study was supported.

McCoy (2003) also emphasized that we can see the activities related to transportation, especially in the logistics sector of UAVs, by shedding light on today. He stated that there are obstacles such as design, route tracking and UAV coordination. However, in today's technology, these problems are now overcome and it is expected that UAVs will be used especially in the field of air cargo in the near future.

In Cage (2016), the food transported to the Maersk Group tanker by drone is discussed. The results of the research mentioned that delivery by drone is safer day by day. In our research, the results of the security dimension show us that the UAV is reliable. Similar results were obtained with Cage (2016).

Haidari (2016) emphasized that vaccine transfers can be carried out with UAV systems and are more cost-effective. UAV technologies, which are developing day by day, will contribute to human health in a very serious way, especially in places where urgent intervention is required. The results of the perceived benefit dimension in our research show that the use of UAV technology is preferable in terms of speed, performance and efficiency.

8. Limitations and Direction for Future Research

Since this scientific research has certain limitations, it is necessary to make some suggestions for future studies in this field. Due to the Covid-19 pandemic epidemic during the survey study of the research, the study was conducted with a sample of 5 times the survey question. The number of samples can be

increased. The analyzes made in this study can be compared by using logistics or an inclusive scale for the dimensions of logistics performance as the dependent variable of the research. In future studies, many different areas of the UAV and logistics sector can be studied, and at the point where UAV technology is developing day by day, this study can be compared with future studies. In future studies, by performing regression analysis, the levels of explanation among the dimensions can be revealed, and a ranking can be made among the dimensions according to their importance. Comparative studies can be conducted with other countries regarding the use of UAV technology in the logistics sector. The findings obtained as a result of the studies carried out can be compared or expanded with the results of this study.

Contributions by Authors

The contributions of the authors in the study are equal.

Conflict of Interest

There is no conflict of interest among the authors.

Research and Publication Ethics Statement

The study was conducted in accordance with research and publication ethics.

References

- Ahmed, F., Paul, A., & Rathore, M. M. (2022). Recent advances in unmanned aerial vehicles: A comprehensive review. *Arabian Journal for Science and Engineering*, 47(12), 15123–15147.
- Air Transport Action Group. (2024). *Aviation benefits report 2024*. ATAG Publishing.
- Akar, H. (2025). Global trends in air cargo logistics and e-commerce integration. *Journal of Air Transport Studies*, 18(1), 45–62.
- Allied Market Research. (2024). *Drone market by type, application and industry vertical: Global opportunity analysis and industry forecast, 2024–2030*. Allied Analytics LLP.
- Aydın, B. Z. (2007). Revealing the dimensions of performance measures with the help of factor analysis. In *Proceedings of the 8th Turkish Econometrics and Statistics Congress*. İnönü University, Malatya.
- Büyüköztürk, Ş. (2002). Factor analysis: Basic concepts and its use in scale development. *Educational Administration in Theory and Practice*, 32, 470–483.
- Büyüköztürk, Ş. (2002). Factor analysis: Basic concepts and its use in scale development. *Ankara University Journal of Faculty of Educational Sciences*, 32, 470–480.

- Christopher, M. (2020). *Logistics & supply chain management* (6th ed.). Pearson Education.
- Council of Supply Chain Management Professionals. (2022). *CSCMP supply chain management definitions and frameworks*. CSCMP.
- Çancı, M., & Erdal, M. (2013). *International transport management* (4th ed.). UTIKAD Publications.
- Deloitte. (2023). *Global smart last-mile logistics outlook 2023*. Deloitte Insights.
- George, D., & Mallery, P. (2010). *SPSS for Windows step by step: A simple guide and reference* (17.0 update). Pearson Education.
- Grant, D. B., Wong, C. Y., & Trautrim, A. (2022). *Sustainable logistics and supply chain management* (3rd ed.). Kogan Page.
- Grant, D. B., Trautrim, A., & Wong, C. Y. (2023). *Fundamentals of logistics management* (Updated ed.). Kogan Page.
- Gürkan, Ö., Ali, Ö., & Oğuzhan, K. (2013). Technology use in logistics. *Anadolu University*, 2155(1183), 10.
- FlyPortts. (2025). *Air cargo industry market outlook 2025*. FlyPortts Aviation Analytics.
- Future Market Insights. (2025). *Drone logistics and transportation market report 2025–2035*. FMI Research.
- Haidari, L., Brown, A., Ferguson, M., Bancroft, E., Spiker, M., Wilcox, A., Ambikapathi, R., Sampath, V., Connor, D. L., & Lee, B. Y. (2016). The economic and operational value of using drones to transport vaccines. *Vaccine*, 34, 4062–4067. <https://doi.org/10.1016/j.vaccine.2016.06.022>
- Jazairy, A., Hulthén, H., & Pedersen, A.-C. (2024). Drones in last-mile delivery: A logistics management perspective. *The International Journal of Logistics Management*, 35(2), 214–239.
- International Air Transport Association. (2004). *International Air Transport Annual Report*. <https://www.iata.org/>
- IMARC Group. (2025). *Global drone market: Industry trends, share, size, growth and forecast 2025–2030*. IMARC Publications.
- International Civil Aviation Organization. (2011). *ICAO publications*. <https://www.icao.int/>
- International Civil Aviation Organization. (2023). *Technical instructions for the safe transport of dangerous goods by air*. ICAO Publishing.
- International Air Transport Association. (2024). *Air cargo annual review 2024*. IATA.
- International Civil Aviation Organization. (2024). *Air cargo and global trade statistical yearbook 2024*. ICAO.
- Ivanov, D., & Dolgui, A. (2022). Digital supply chain management: Concepts and perspectives. *Transportation Research Part E: Logistics and Transportation Review*, 163, 102729.

- İlhan, F. (2007). *A study on factor analysis and its application to data obtained in agricultural research* (Master's thesis). Selçuk University, Graduate School of Natural and Applied Sciences.
- Kalaycı, Ş. (2008). *SPSS applied multivariate statistics techniques*. Asil Publishing.
- Kamali, A. (2018). Investigating the usability of UAV (drone) technology in the logistics industry in Bahrain. *Ciit Journal*, 9.
- Kaplan, İ. (2011). *The relationship between organizational citizenship behavior and job satisfaction: An application on Konya law enforcement organization* (Doctoral dissertation). Selçuk University, Institute of Social Sciences.
- Kayış, A. (2010). SPSS applied multivariate statistical techniques. In Ş. Kalaycı (Ed.), *Multivariate statistics*. Nobel Publishing.
- Kim, K., Kim, S., & Jung, H. (2024). Drone-assisted multimodal logistics: Trends and research issues. *Drones*, 8(9), 468. <https://doi.org/10.3390/drones8090468>
- Kurtulmuş, K. (2010). *Research methods*. Türkmen Bookstore.
- Kurtuluş, K. (1985). *Marketing research*. Istanbul University Press.
- McCoy, J. V. (2003). *Unmanned aerial logistics vehicles: A concept worth pursuing*. Bibloscholar.
- Nagy, G., Bányainé Tóth, Á., Illés, B., & Varga, A. K. (2023). The impact of increasing digitalization on the logistics sector and logistics service providers. *Multidisciplinary Sciences*, 13(4), 19–29.
- Obaid, L. A., Abdalla, A., & Al-Turjman, F. (2025). State-of-the-art review of unmanned aerial vehicles (UAVs): Applications, challenges, and opportunities. *Results in Engineering*, 23, 102145.
- Organization for Economic Co-operation and Development. (2023). *Logistics performance and economic competitiveness report 2023*. OECD Publishing.
- Organization for Economic Co-operation and Development. (2023). *Regulatory frameworks for emerging aviation technologies*. OECD Publishing.
- Organization for Economic Co-operation and Development. (2023). *Global trade and logistics transformation study*. OECD Publishing.
- Özdamar, K. (2002). *Statistical data analysis with package programs*. Kaan Kitabevi.
- Rennie, K. M. (1997). Exploratory and confirmatory rotation strategies in exploratory factor analysis. <https://eric.ed.gov/>.
- Rushton, A., Croucher, P., & Baker, P. (2022). *The handbook of logistics and distribution management* (7th ed.). Kogan Page.
- Rodrigue, J.-P., Slack, B., & Comtois, C. (2013). Liner shipping connectivity index and container port throughput. Retrieved from http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/liner_shipping_connectivity_index.html
- Sungur, O. (2010). SPSS applied multivariate statistical techniques. In Ş. Kalaycı (Ed.), Asil Publishing.
- Stattimes. (2024). *Air cargo market dynamics and competitive landscape 2024*. STAT Media Group.
- Tunali, S. (2017). Drone technology. *Journal of Safety Management*, 30.
- Turienzo, J., López, P., & Medina, J. (2024). Logistics business model evolution under digital transformation forces. *Journal of Business Economics*, 104(3), 511–528.
- United Nations Conference on Trade and Development. (2023). *Review of maritime transport 2023*. UNCTAD Publishing.
- World Bank. (2024). *Global logistics performance and trade facilitation report 2024*. World Bank Publications.
- World Economic Forum. (2024). *The future of global supply chains: 2024 outlook report*. World Economic Forum.
- World Bank. (2024). *Global air transport and logistics overview 2024*. World Bank Publications.
- Yaşlıoğlu, M. M. (2017). Factor analysis and validity in social sciences: Using exploratory and confirmatory factor analysis. *Istanbul University Journal of Business School*, 46, 75.



© Author(s) 2025.

This work is distributed under <https://creativecommons.org/licenses/by-sa/4.0/>