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The Use of New Technologies in Logistics: Drone (UAV) Use in Last Mile Delivery

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Lojistikte Yeni Teknoloji Kullanımı: Son Kilometre (Adım) Teslimatta Drone (İHA) Kullanımı

Abstract

The increasing volume of e-commerce has complicated delivery operations, making it imperative to diversify the processes. Industry leaders have attempted to use drones, autonomous vehicles, electric vehicles, etc., in delivery processes. The research examined the adoption of consumer drone usage in delivery. The Technology Acceptance Model (TAM) was used in the study. In the analysis method, Partial Least Squares-Structural Equation Modelling (PLS-SEM), which is commonly used in the literature for multiple relationships due to the presence of multiple dependent and mediating variables, was used with the Smart PLS software package. Only the H5 hypothesis was rejected in the research, and the other hypotheses were accepted. When examining the hypothesis results, it was concluded that people are open to technological innovations and have a positive outlook on using drones in future product delivery processes.

Keywords : Logistics, Last Mile Delivery, E-Commerce, Technology Acceptance Model (TAM), Supply Chain Management.

JEL Classification Codes : N7, L81, L87, L90.

Öz

Artan e-ticaret hacmi teslimat operasyonlarını zorlaştırmış olup süreçlerin çeşitlendirilmesini zorunluluk haline getirmiştir. Sektörün önde gelenleri teslimat süreçlerinde drone, otonom araç, elektrikli araç vb. kullanmayı denemiştir. Araştırmada İHA'ların teslimatta kullanımının benimsenmesi tüketiciler özelinde incelenmiştir. Araştırmada Teknoloji Kabul Modeli (TKM) kullanılmıştır. Analiz yönteminde ise birden fazla bağımlı ve aracı değişken bulunmasında dolayı literatürde çoklu ilişkilerde sıklıkla kullanılan Kısmi En Küçük Kareler-Yapısal Eşitlik Modellemesi (EKK-YEM) Smart PLS paket programıyla kullanılmıştır. Araştırmada sadece H5 hipotezi reddedilmiş olup diğer hipotezler kabul edilmiştir. Hipotez sonuçları incelendiğinde insanların teknolojik yeniliklere açık olduğu ve gelecekte ürün teslimat süreçlerinde dron kullanımına olumlu baktığını sonucuna ulaşılmıştır.

Anahtar Sözcükler : Lojistik, Son Kilometre (Adım) Teslimat, E-Ticaret, Teknoloji Kabul Modeli (TKM), Tedarik Zinciri Yönetimi.

1. Introduction

Technological innovations benefit many sectors in many ways. Technological tools and devices are used in almost every field as they facilitate processes. Therefore, digitalisation has become an inevitable reality. Since the technological innovations that businesses use positively contribute to human life, people often accept these innovations. Technological developments in the logistics sector have been examined due to the scope of the research. These technologies are lockers, autonomous vehicles, electric vehicles, and drones. The current study examined the use of drones within the scope of last-mile delivery. Drones and new technologies have been used in delivery processes due to increasing e-commerce activities in recent years. Global e-commerce volume in 2021 was around 4.9 trillion dollars. International trade is expected to be about 5.5 trillion dollars in 2022. In Türkiye, in the first six months of 2022, the e-commerce volume has reached 348 billion Turkish liras with an increase of approximately 120% (<eticaret.gov.tr>). The continuation of the e-commerce volume by increasing its speed every year has made it necessary to diversify the delivery processes today and in the future.

In Türkiye, delivery is actively carried out by cargo vending machines, autonomous vehicles, electric vehicles, and mobile branches. The inadequacy of drone technology to be used in delivery processes and the regulations published by the Directorate General of Civil Aviation (DGCA) for the use of drones limit the use of drones in delivery processes (Joerss et al., 2016: 5-17). In the future, with the construction of drone landing strips for high-rise buildings, the increase in the number of pilots using drones, and the making of drones more suitable for transportation, it will be a technology that people can benefit more from in daily life.

Individuals' perceptions and attitudes towards delivery processes will be the most critical determinants of technology usage and adaptation processes (Singireddy & Daim 2018). In this context, within the scope of the research, the growing last-mile delivery processes, parallel to the increase in e-commerce activities, have been examined with a focus on drones. This study, conducted to understand people's resistance to innovations, will provide foresight for the future use of drones in the logistics sector for last-mile delivery. The advancement of technology has not only transformed the trading environment but has also impacted the delivery processes at the end of trade. These issues have also been explored in the current research. In the subsequent sections of the study, the utilisation of drones in the last-mile delivery process has been examined, and existing examples have been considered. Following this, the methodology section provides information about the research model, analysis method, software used in the analysis process, data collection methods for surveys used in the research, and the data collection process. Subsequently, the study's conceptual model and hypotheses are explained and presented. Then, the research data analysis is carried out and presented in tables. Finally, the research is concluded with the discussion and conclusions section.

2. Drone Use in Last Mile Delivery

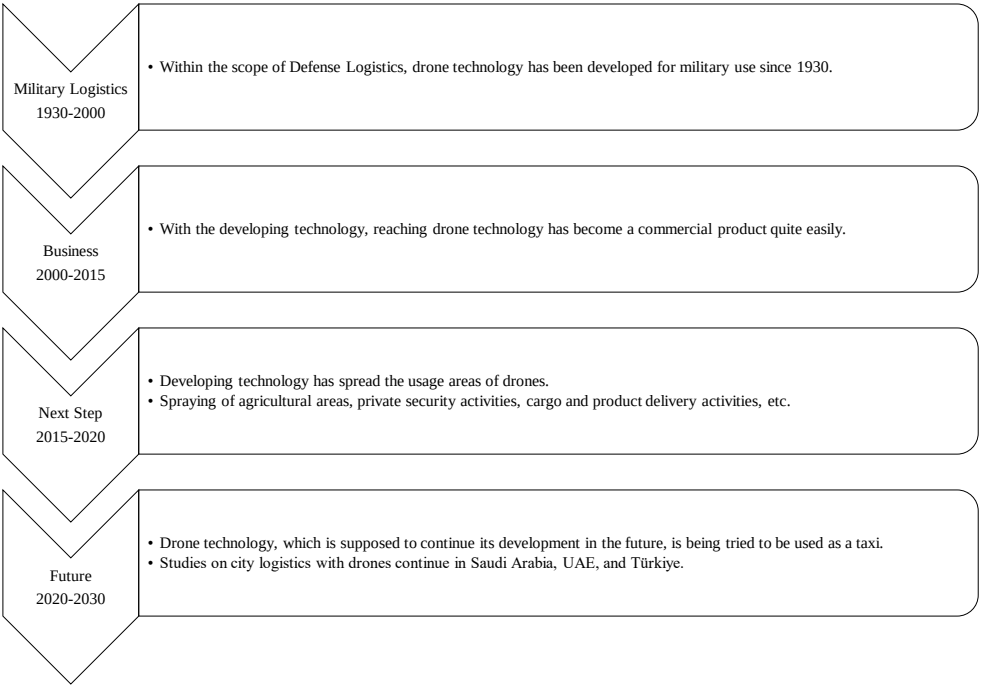
Generally, drones are unmanned aerial vehicles known as Unmanned Aerial Vehicles (UAVs) or Remotely Piloted Aircraft. Drones can be produced in different sizes and shapes in terms of the size commanded by the remote control. Although drones were used in military activities for the first time, as shown in Figure 1, they started to be used in commercial activities afterwards. It began to be used in the commercial field, especially in the last mile delivery part of the logistics processes with the consumer, with its first trial in 2013. However, it cannot be said that the development of drone technology has yet to be completed and will eventually provide the wide distribution of drone infrastructure (Rabta et al., 2019: 109-112).

Last-mile delivery refers to delivering a product to its ultimate consumption point or end user. Last-mile delivery has gained increasing importance with the rise of e-commerce. Making purchased products available to end users, such as homes, offices, or workplaces, constitutes the focal point of last-mile delivery. Last-mile delivery activities will become even more crucial, especially with the increase in e-commerce and pandemics. In this context, studies conducted within the scope of last-mile delivery will benefit both the literature and the logistics sector (Mangiaracina et al., 2019: 904; Eskandaripour & Boldsaikhan, 2023: 2-4).

In the studies on last-mile delivery, the share of the last-mile delivery in the total transportation cost was around 30%. Another study found that last-mile delivery accounts for 40% of the total cost of the supply chain (Goodman, 2005: 1-4). For this reason, the last mile delivery is seen as a complex area in the supply chain and solution proposals should be presented. In this context, lockers, autonomous vehicles, mobile delivery vehicles, and electric vehicles can be listed as the methods developed in last-mile delivery with the technology developed in the last period. Drone technology, also the research subject, will play an important role in delivering the last mile in the future (Jacobs et al., 2019: 5-14). With the development of technology, it has started to be used in delivery processes with the decrease in the production cost of aircraft, their ability to perform long-distance flights, and the completion of their integration into the logistics system (Balcik et al., 2008: 53-57).

As shown in Figure 1, although the drone was first used in the military field, it started to be used in commercial activities as the process progressed. This shows that the said technology has spread to the base. In this context, it is important to examine the use of drone technology. In particular, contactless delivery systems developed to avoid infectious diseases after COVID-19 have differentiated the last-mile delivery processes. In addition, with the increasing trend towards e-commerce after COVID-19, the importance of last-mile delivery processes has been well understood (Moshref-Javadi et al., 2020: 292-298; Nakıboğlu, 2020: 287-293).

Figure: 1
Drones' Historical and Future Timeline



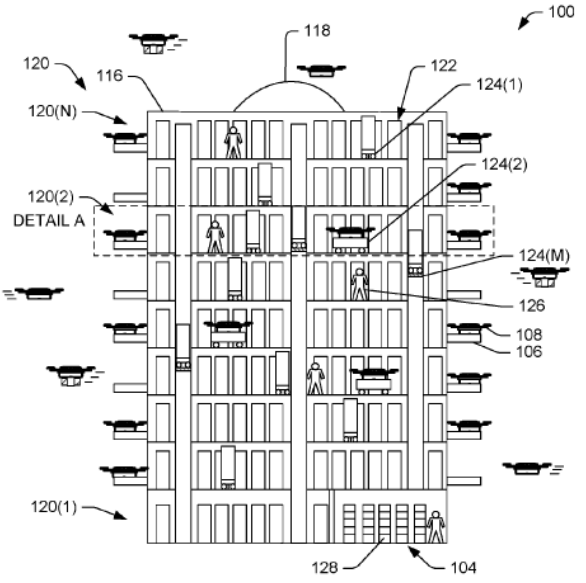
Source: Garcia & Santoso, 2019.

In parallel with the increase in the volume of e-commerce, another system that is desired to be integrated into the delivery processes is the UAV technology. It is focused on effectively using all delivery vehicles to create a sustainable logistics ecosystem. UAVs are becoming more and more popular in the last-mile delivery process. In this area, Amazon patented many drone supply centre projects in 2017. DHL made the first drone delivery within the scope of last-mile delivery by delivering medical drugs in 2013 (Aurambout et al., 2019: 1-5; Garcia & Santoso, 2019: 10-19). Figure 2 shows the image of the supply centre patent that Amazon has received in this context.

Amazon's use of drones for last-mile delivery has been covered by multiple patents, with one of them being the 'multi-level fulfilment centre for UAVs shown in Figure 2. Fulfilment Centres are large storage facilities typically located outside the city. However, these structures outside the city make it challenging for drones to make deliveries in the town. To address this issue, experts have supported the establishment of high-rise drone delivery fulfilment centres. The multi-level fulfilment centre for UAVs, developed and patented within this context, is to facilitate the delivery of shipments to recipient points using drones. These centres will allow multiple drones to take off and land simultaneously. In

addition to fixed centres, Amazon has also made efforts to let drones take off and land from moving vehicles (Michel, 2017: 7-8; Garcia & Santoso, 2019: 10-19).

Figure: 2
Multi-Level Fulfilment Centre for UAVs

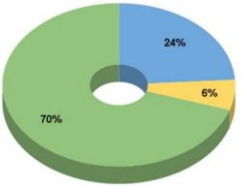


Source: Curlander, J.C. et al., 2017; Michel, 2017.

In Türkiye, the use of drones in commercial activities is becoming widespread. The drone market is increasing its volume day by day. Private and commercial drones in Türkiye are subject to certain conditions. All of the drone processes, information, documents, and records are kept at the Directorate General of Civil Aviation (DGCA). Use a license, DGCA carries out drone registration, etc. transactions. The use of drone technology will inevitably become widespread in the future. Increasing e-commerce volume daily is one of the most important signs of this. This situation can be explained with the visual and Ministry of Trade data in Figure 3 (<eticaret.gov.tr>; <web.shgm.gov.tr>).

As shown in Figure 3, the distribution of e-commerce by platforms is Web: 24% Web Mobile: 6% Mobile Application: 70%. In addition, when we look at the sectoral distribution of e-commerce, the volume of clothing, shoes, accessories, electronic goods, food, supermarket, and catering sectors is around 70%. In this case, the size of the activities that can be done within the scope of last-mile delivery is seen more clearly. The increase in the volume of e-commerce makes it necessary to diversify the delivery processes in the part where the supply chain activities meet the consumer (<eticaret.gov.tr>).

Figure: 3
Distribution of Shopping by Platforms



Web: %24 Web Mobile: %6 Mobile Application: %70
Source: <eticaret.gov.tr>, 29.12.2022.

Parallel to the expansion of e-commerce volume in Türkiye, motor couriers, lockers, mobile delivery points, autonomous vehicles, etc. It is aimed at reaching the final consumer with these methods. However, as drone technology continues to develop in the future, it is seen as an inevitable fact that its use within the scope of last-mile delivery will increase. In this context, in the current research, drone technology has been examined within the scope of last-mile delivery. While creating the research model, the Technology Acceptance Model (TAM) was frequently used to accept new technologies (Choe et al., 2021: 18-23; Waris et al., 2022: 1-6).

Table: 1
The Technology Acceptance Model Used in Drone Studies

Authors	Research Area	Hypothesis*	Result
Edwards et al. (2023)	Use of delivery drones for humanitarian operations	EF→PU	Not Supported
		S→PU	Not Supported
		PEOU→PU	Supported
		PU→AT	Supported
		PU→I	Not Supported
		AT→I	Supported
Hinzmann & Bogatzki (2020)	Autonomous delivery vehicles for last-mile delivery in Germany	PEOU→PU	Supported
		PEOU→HM	Supported
		PU→HM	Supported
		HM→I	Supported
		FC→I	Not Supported
		PS→I	Not Supported
Valencia-Arias et al. (2022)	Drones for product delivery in the context of the COVID-19 pandemic in Colombia	DR→AT	Supported
		PPR→AT	Supported
		PI→AT	Supported
		PC→AT	Supported
		C→AT	Supported
		AT→I	Supported
Koh et al. (2023)	Urban drone adoption in last-mile delivery	PEOU→PU	Supported
		PU→AT	Supported
		PPR→AT	Supported
		AT→I	Supported
Shapira & Cauchard (2021)	Drone use in public health emergencies	PEOU→AT	Supported
		PU→AT	Supported
		PU→I	Supported
		AT→I	Supported
		PPR→AT	Supported

** PU = Perceived Usefulness; PEOU = Perceived Ease of Use; EF = Efficient Operations; S = Security; HM = Hedonic Motivation; PS = Privacy Security; FC = Facilitating Conditions; I = Intention; AT = Attitude Towards; PR = Perceived Privacy Risk; DR = Delivery Risk; PI = Personal Innovativeness; PC = Compatibility; C = Complexity*

Edwards et al. (2023) examined the adoption processes of drones, which are likely to be used in last-mile delivery in the future by logistics service providers. In this context, the TAM and external variables concept was included in the model, which is commonly used in researching new technologies. The research was conducted with data obtained through surveys from 103 individuals working in leading logistics companies in China in 2016. Since drones are a new technology, the security aspect was considered important and added to the model as a variable. When the study results were examined, it was observed that ease of use and security are important factors for drones. Detailed information about the research is provided in Table 1.

Hinzmann and Bogatzki (2020) emphasised in their study that the growing volume of e-commerce has made using new technologies necessary in delivery processes. Autonomous vehicles and drones are expected to be significant alternatives in the delivery field. The research's primary focus is the impact of the expected increase in e-commerce volume on future delivery processes. In this context, the acceptance of autonomous vehicles and drones by humans has been examined. The study shows that consumers in Germany have a positive attitude towards the use of autonomous vehicles and drones in delivery processes. Additionally, hypotheses related to privacy security and facilitating conditions variables were rejected, while hypotheses related to perceived usefulness and ease of use were accepted. Detailed information about the research is provided in Table 1.

Valencia-Arias et al. (2022) focused on one of the alternatives that emerged in the logistics sector due to the increased need for contactless operations during the COVID-19 pandemic. In this context, the researchers examined the factors influencing user acceptance of drone delivery in Colombia using the TAM and Diffusion of Innovations (DIT) frameworks. The study included 121 participants from Colombia. The research results showed that all the hypotheses formulated in the conceptual model were accepted. People in Colombia have a positive perception, attitude, and intention towards using drones in last-mile delivery processes. Detailed information about the research is provided in Table 1.

In their study by Koh et al. (2023), COVID-19 has significantly shaped commercial activities. In this study, the focus was on contactless technologies during the COVID-19 pandemic, with particular emphasis on the role of drones in last-mile delivery. Therefore, the research examined drones as a technological solution to the challenges posed by high urbanisation and increased delivery traffic. Since measuring individuals' perceptions, attitudes, and behaviour towards using drones in last-mile delivery is crucial, it formed the main starting point of the research. In the current study, the acceptance process of the new technology was conducted using the TAM (Technology Acceptance Model) and external variables. A total of 450 individuals participated in the research survey. Structural equation modelling was employed in the analysis process. The analysis results indicated that perceived privacy risk, attitude, ease of use, and usefulness significantly influenced individuals' intention to use drones in last-mile delivery. Detailed information about the research is provided in Table 1.

Shapira and Cauchard (2021) examined the intention to use drones in public health emergencies (PHEs). The fact that drones can find applications in diverse areas indicates their potential versatility as a technology in the future. The investigation into drones' usage in the context of PHEs was conducted through a survey with the participation of 568 individuals. Structural equation modelling was employed in the research. The main problem of the study was to explore the factors influencing the acceptance of drone use in PHEs. The utilisation of drones in PHEs was examined within TAM and task-technology fit (TTF) frameworks. When the results were discussed, it was found that all hypotheses in the proposed research model were accepted. Perceived privacy risk, attitude, ease of use, and usefulness influenced individuals' intention to use drones in PHEs. The acceptance process of using drones in PHEs was observed positively. Detailed information about the research is provided in Table 1.

As seen in Table 1, drones have various applications in delivery processes. Although experimental, drones will likely be actively used in last-mile operations and individual transportation.

3. Methodology

Individuals receiving their products using drone technology must use their phones or devices. For this reason, individuals over +18 who can use technological devices were included in the scope of the study. The individuals in the research were reached by convenience sampling method. Since it is impossible to get everyone included in the scope of the study due to convenience sampling, research population structure, high cost, time constraints, COVID-19, and data collection difficulties, it aims to reach the accessible ones. The study's sample is convenience sampling, one of the non-random sampling methods. However, convenience sampling has some disadvantages. These include the problem of representing the population by the sample and, consequently, the limited generalizability of the analysis. The fact that participants are present in a specific environment during sample selection can lead to biased preferences. Additionally, sampling bias is introduced (Kurtuluş, 2010: 112-119; Özdamar, 2004: 80-85). The study was limited to the province of Istanbul, as it was impossible to reach everyone included due to high costs, time constraints, COVID-19, and data collection difficulties. A 5-point Likert scale ranging from 1 = 'Strongly Disagree' to 5 = 'Strongly Agree' was used for responses. The survey questions were developed in line with the items used in TAM studies. In the research, the survey form consisting of 3 parts was collected online between 05.07.2022 and 09.06.2022 via Google Form. The research was sent to 480 people online, and 267 participated in the survey. When the data was organised, analyses were carried out with 219 people (İslamoğlu & Alnıaçık, 2014: 50-60; Toraman & Geçit, 2023).

3.1. Research Methods Structural Equation Modelling (SEM)

SEM is a method used in models that examine the relationships between multiple variables. Partial Least Squares Structural Equation Modelling (PLS-SEM), frequently used

in social sciences, is an analysis method employed in studies with a more limited sample size. Multiple independent and mediator variables affect the dependent variable. In addition, the demographic characteristics of participants can also be the subject of research investigations. Complex models are frequently studied in contemporary research. In this context, using the SEM method has become necessary for completing the analysis process in models with multiple independent, mediator, and control variables. The current study used the SEM model, considering its suitability (Garcia, 2023: 3; Hair et al., 2017: 189-190).

When the research model is examined, it is seen that there is more than one independent and mediator variable, and there is more than one relationship between the variables. The literature shows that the structural equation model is generally used in research models with more than one relationship. The current study used SEM because of the similarity in question. When the literature is examined, it is known that the Smart PLS program is used in many exploratory studies using SEM. In the current study, analyses were carried out using the Smart PLS 3 program (Hair et al., 2010: 150-175; Hair et al., 2011: 186; Hair et al., 2016: 174-179; Hair et al., 2017: 189-193).

3.2. Research Model and Hypotheses

Users' acceptance of new technologies has been the subject of research by experts. These studies examined the effective factors in accepting users' technological products or services with different methods. In this context, the Technology Acceptance Model (TAM) has been used in the usage processes of new technologies in the literature. Besides, the Theory of Planned Behaviour (TPB), DIT, TAM-2, TAM-3, etc. models have also been used frequently in the literature (Davis, 1989: 323-334; Davis et al., 1989: 986-993; Venkatesh & Davis, 1996: 453: 460; Venkatesh & Morris, 2000: 116-123).

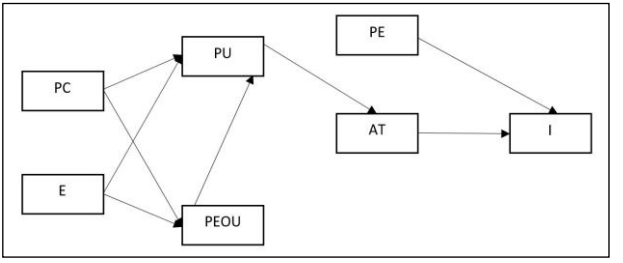
One commonly used model in the literature is the TPB, which examines how individuals carry out their behaviours and the factors influencing these processes. The theory's main premise argues that the three most important factors influence human behaviour (Shaw et al., 2022: 2; Kaminski, 2011: 2). These factors are subjective norms, perceived behavioural control, and attitude. Another critical theory is Roger's DIT, where factors influencing the diffusion process of innovations are identified as relative advantage, compatibility, complexity, trialability, and observability (Kamalanon et al., 2022: 3; Tian et al., 2023; Rogers et al., 2014: 435-440).

On the other hand, the research's conceptual model is based on TAM, TAM-2, and TAM-3, which have become widely used theories in studying new technologies since Davis proposed them in his 1986 doctoral thesis. TAM argues that the key factors influencing the acceptance of new technology are perceived ease of use and usefulness. It suggests that the technology's adoption process will be positively supported if users believe it requires less effort and that their performance will improve when they use it. Different researchers have added to the core model following TAM, developing it further. TAM-2 and TAM-3 are revised and enhanced versions of the original model (Venkatesh & Davis, 1996: 453:460;

Venkatesh & Bala, 2008: 275-280; Chocarro et al., 2023: 297; Barrett et al., 2023: 1668-1670).

TAM has been modified and used in Figure 4. The main variables of TAM are perceived usefulness, perceived ease of use, and intent. However, due to the research's scope, purpose, and predicted outputs, different mediators or independent variables can be added to the concept model. The concept model in Figure 4 was used to examine drones within the scope of last-mile delivery (Venkatesh et al., 2007: 269-275; Davis & Venkatesh, 1996: 22-30).

Figure: 4
Research Model



I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

TAM is essential in examining the factors that affect the adoption of new technologies and receiving feedback for necessary improvements due to the analysis. As independent variables to the concept model of the study, which is specific to deliveries using drones, perceived compatibility, enjoyment, and performance expectancy, mediator as variables; Intention was used as dependent variable of perceived usefulness, perceived ease of use, and attitude towards use (Venkatesh & Bala, 2008: 277-286; Venkatesh & Morris, 2000: 116-123; Venkatesh et al., 2003: 427-433).

Perceived Compatibility (PC) refers to users reconciling innovations with existing values and habits. Innovations can be adopted if they are compatible with the existing values and practices of the users. New technologies will be used when compatible with the users' past behaviours. The current research is based on the adoption of drones in the delivery process. TAM literature was used in this context while forming the H1 and H2 hypotheses (Sugandini et al., 2018: 660-669; Prakarsa et al., 2020: 63-67).

H1: Perceived Compatibility (PC) is positively related to Perceived Usefulness (PU)

H2: Perceived Compatibility (PC) is positively related to Perceived Ease of Use (PEOU)

Enjoyment (E) refers to the degree to which users perceive new technologies as valuable and efficient in their workflow and enjoyable in the use process. It refers to the perception that the use of related technology is fun. Studies have shown that enjoyment has

a positive effect on intention. TAM literature was used in this context while forming the H3 and H4 hypotheses (Choe et al., 2021: 20-29; Venkatesh et al., 2003: 427-433; Lee et al., 2019: 41).

H3: Enjoyment (E) is positively related to Perceived Usefulness (PU)

H4: Enjoyment (E) is positively related to Perceived Ease of Use (PEOU)

Perceived Ease of Use (PEOU): It is the degree to which a person believes that using a particular system will relieve the physical and mental workload. One of the critical factors for the widespread use of new technology is the perceived ease of use factor. Technologies with ease of use have an indirect positive effect on intent during the adoption process. In the delivery process, the users' convenience when receiving is emphasised. TAM literature was used in this context while forming the H5 hypothesis (Davis & Venkatesh, 1996: 22-30; Davis, 1989: 323-334; Venkatesh & Bala, 2008: 277-286).

H5: Perceived Ease of Use (PEOU) is positively related to Perceived Usefulness (PU)

Perceived Usefulness (PU) indicates the degree to which people believe their job performance will increase when they use a new technology. Usefulness by users of the system is affected by some external factors. In this context, per the research content, three independent variables were added to understand better the factors affecting the intention to use drone technology. TAM literature was used in this context while forming the H6 hypothesis (Venkatesh & Davis, 1996: 453, 460; Venkatesh & Morris, 2000: 116-123; Venkatesh & Bala, 2008: 277-286).

H6: Perceived Usefulness (PU) is positively related to Attitude Towards Use (AT)

Performance Expectancy (PE): It is the degree to which users believe they will gain performance in the system's process. For example, if cargo delivery is faster and easier with the drones examined within the scope of the research, the person will save time in terms of time. This indicates the performance obtained from the process. Studies have shown a significant and positive relationship between the intentions of people with high-performance expectations. TAM literature was used in this context while forming the H7 hypothesis (Li, 2010: 8-9; Arias-Oliva et al., 2019: 3-4; Venkatesh & Davis, 1996: 453: 460).

H7: Performance Expectancy (PE) positively relates to Intention (I)

Intention (I) consists of people's positive or negative thoughts toward active use. Since social psychologists see intention as the antecedent of behaviour, it is the most critical variable affecting active use.

Attitude Towards Use (AT): It is the positive or negative evaluation of a technology acceptance process by people. It can be defined as the evaluation of the user in accepting the innovation in question. In the studies conducted, attitude positively affects intention. In this

context, TAM literature was used while forming the H8 hypothesis (Venkatesh & Morris, 2000: 116-123; Venkatesh & Bala, 2008: 277-286; Venkatesh et al., 2003: 427-433).

H8: Attitude Towards Use (AT) positively relates to Intention (I)

The model of the research was created to analyse the factors affecting the use of drones. In the next part, the data obtained in the study will be examined in the Smart PLS 3 program. In line with the results obtained, inferences will be made for the future use of drones.

4. Results

The research used Structural Equation Modelling (SEM) with the Smart PLS 3 program. Before starting the analysis process, the research data were separated and organised. In the following stages, reliability and validity analyses, discriminant validity analysis, hypothesis tests, hypotheses results, and R^2 and R^2 adjusted results were performed, respectively.

The sample of the research is presented in Table 2. It was observed that 87% of the participants in the study, which investigates a new technology in the logistics field, are between the ages of 18-30. On the other hand, when examined by gender, an almost equal distribution was observed. Finally, when the research participants' education levels were examined, a high concentration was observed in high school and bachelor's degree levels. In this context, the participants in the research consist of young individuals with a certain level of education.

Table: 2
Descriptive Statistics of the Sample

		%
Age	18-20	59.5
	21-29	27.9
	30-39	9.0
	40-49	3.6
	50-59	-
	60 +	-
Gender	Female	45.9
	Male	54.1
Education	High School	45.0
	Vocational School	14.4
	Bachelor's Degree	36.9
	Master's Degree	3.7

The results obtained after the reliability and validity analyses were completed are shown in Table 3. Reliability and validity analyses are important for conducting hypothesis testing in the research. However, some tests need to be conducted before path analysis. These are known as reliability and validity tests, which include Factor Loading, Cronbach's Alpha values, Composite Reliability, and AVE analyses. Factor Loading examines the relationship between variables and facilitates grouping specific factors. In statistical analysis, Factor Loading should be above 0.70. Cronbach's Alpha values are another measure examined for

reliability and validity. Cronbach's Alpha values should be above 0.70. However, this value alone is insufficient (Simsek, 2007: 470-475). Composite Reliability, values above 0.70, like Factor Loading and Cronbach's Alpha values, are considered valid. Finally, the AVE value is also important for reliability and validity. The minimum value for AVE should be 0.50. When the reliability and validity analyses of the research are examined, it has been determined that it is consistent and meets the high-reliability level (Hair et al., 2010: 150-175; Hair et al., 2011: 186; Hair et al., 2016: 174-179; Hair et al., 2017: 189-193).

Table: 3
Results of the Measurement Model

Items	Factor Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
AT1	0.941	0.940	0.961	0.892
AT2	0.949			
AT3	0.943			
E1	0.683	0.889	0.925	0.759
E2	0.924			
E3	0.921			
E4	0.932			
I1	0.946	0.915	0.947	0.855
I2	0.956			
I3	0.870			
PEOU1	0.871	0.928	0.949	0.823
PEOU2	0.918			
PEOU3	0.948			
PEOU4	0.891			
PU1	0.903	0.922	0.945	0.811
PU2	0.927			
PU3	0.920			
PU4	0.852			
PE1	0.932	0.928	0.949	0.822
PE2	0.912			
PE3	0.873			
PE4	0.908			
PC1	0.948	0.902	0.939	0.838
PC2	0.917			
PC3	0.879			

I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

Table: 4
Discriminant Validity Analysis based on the Fornell-Larcker Criterion

	AT	E	I	PC	PE	PEOU	PU
AT	0.944						
E	0.752	0.871					
I	0.815	0.820	0.925				
PC	0.797	0.681	0.766	0.915			
PE	0.822	0.784	0.838	0.860	0.906		
PEOU	0.889	0.772	0.872	0.835	0.872	0.907	
PU	0.786	0.779	0.812	0.778	0.901	0.847	0.901

I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

The correlation analysis is referred to as the Fornell-Lacker Criterion in the Smart PLS package program in Table 4. Correlation analysis, also known as the Fornell-Lacker Criteria Table, is obtained by taking the square root of the AVE values. When the correlation between the variables of the created model was examined, the literature found no variable that would pose a problem. The results of the correlation analysis are shown in Table 4 (Hair

et al., 2010:150-175; Hair et al., 2011:186; Hair et al., 2016:174-179; Hair et al., 2017:189-193).

Table: 5
Hypotheses Results

Hypotheses	Path	Original Sample	T Statistics	P Values	p<0,05 Hypothesis supported?
H1	AT→I	0.387	2.237	0.026	Supported
H2	E→PEOU	0.379	4.645	0.000	Supported
H3	E→PU	0.291	3.047	0.002	Supported
H4	PC→PEOU	0.577	7.265	0.000	Supported
H5	PC→PU	0.197	1.883	0.060	Not Supported
H6	PE→I	0.520	3.040	0.002	Supported
H7	PEOU→PU	0.458	4.216	0.000	Supported
H8	PU→AT	0.786	11.489	0.000	Supported

Significant in the p<0.05 value range, I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

As a result of the analysis of the hypotheses in the research model, the H5 hypothesis was rejected, while the other hypotheses were accepted. Results are shown in Table 5. For a hypothesis to be rejected, the p-value should be above 0.05. In this context, it has been observed that only the p-value of H5 is 0.060. Therefore, the hypothesis is not supported. While the Perceived Compatibility variable in the rejected H5 hypothesis does not directly affect the perceived usefulness, it is seen that it indirectly affects the PU through the PEOU. The mediating effect of PEOU can be mentioned here (Hair et al., 2010: 150-175; Hair et al., 2011: 186; Hair et al., 2016: 174-179; Hair et al., 2017: 189-193).

Table: 6
Results of R^2 and R^2 Adjusted

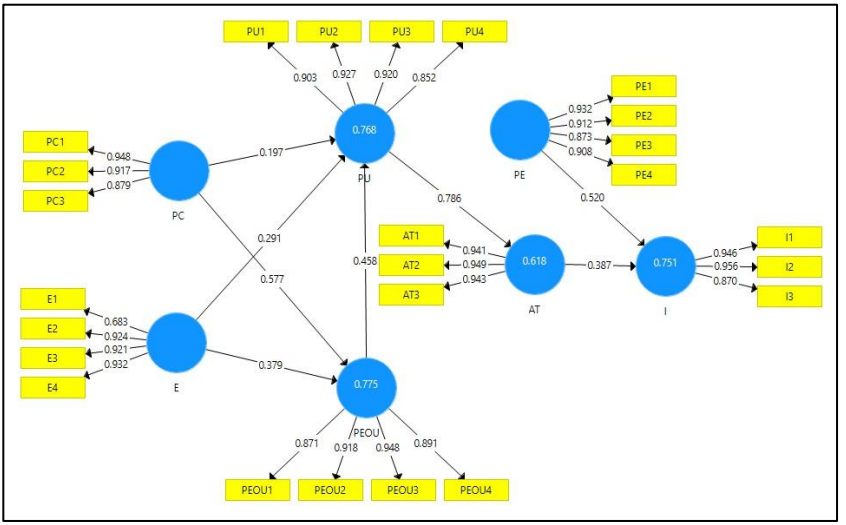
Items	R^2	$Radj^2$
AT	0.618	0.614
I	0.751	0.746
PEOU	0.775	0.770
PU	0.768	0.761

I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

The results of R^2 and R^2 Adjusted are shown in Table 6. R^2 and $Radj^2$ values above 0.70 are considered strong explanation percentages, so they are important in many respects. When the model variables R^2 and $Radj^2$ are examined, the research results must find I as 0.746. The variables included in the research model effectively explained the intention (Agustina, 2019: 281-283; Hair et al., 2010: 150-175; Hair et al., 2011: 186).

The path analysis of the research model, the path coefficients of the hypotheses, the R^2 values of the variables, and the factor loads of the variables are shown in Figure 5. The image was obtained from the Smart PLS 3 program. (Hair et al., 2011: 186; Hair et al., 2017: 189-193).

Figure: 5
Path Analysis of Research



I: Intention, AT: Attitude Towards Use, E: Enjoyment, PE: Performance Expectancy, PC: Perceived Compatibility, PEOU: Perceived Ease of Use, PU: Perceived Usefulness

5. Discussion and Conclusions

The current research has examined people's thoughts, perceptions, attitudes, and intentions against using drones, one of the technological innovations within the scope of last-mile delivery. Technology Acceptance Model (TAM), Planned Behaviour Theory (PBT), and Diffusion of Innovations Theory (DIT), etc. models are used frequently. In this context, the variables of TAM and DIT were used in the current study to show parallelism with the literature. Examining delivery processes with drones forms the basis of the research. However, since drone delivery is not actively used in Türkiye, the active use variable is not included in the model. According to the researchers, focusing on the intention variable is advocated if the relevant technology is limited, which is accepted as an antecedent of active use. Determining the factors affecting user intention specific to the relevant technology will provide the opportunity to make the necessary optimisation in the operational use process in the future (Venkatesh, et al., 2007:269-275; Davis & Venkatesh, 1996:22-30; Davis, 1989:323-334; Garcia & Santoso 2019:42: Aurambout, et al., 2019: 2-5).

When the hypotheses in the research model are examined, it is seen that only the H5 hypothesis is rejected. Other hypotheses H1, H2, H3, H4, H6, H7 and H8 were accepted. H1 suggests a significant and positive relationship between Attitude and intention, indicating that someone who views the use of drones in deliveries positively will not face difficulties in the adaptation process. H2 and H3, a significant and positive relationship between enjoyment, perceived ease of use and perceived usefulness indicates that users are offered a

different experience. This, in turn, positively affects attitude and intention. H4 suggests a significant and positive relationship between compatibility and perceived ease of use, indicating that participants' past experiences are compatible with using drones in last-mile delivery. Recently, various technologies have been used in last-mile delivery, so it can be said that people are prepared to use drones. H5, no significant relationship was found between compatibility and perceived usefulness. H6, the performance expectancy variable, is an improved version of perceived usefulness. It was also added to the model to gain in-depth insights into participants' perceived usefulness. A significant and positive relationship between performance expectancy and perceived usefulness indicates that performance is highly influential in using new technologies. H7 suggests a significant and positive relationship between Perceived ease of use and perceived usefulness, which is a suitable result for TAM. Finally, H8, the presence of a significant and positive relationship between perceived usefulness and intention, is one of the important results of the study. Attitude and intention are important variables in determining future active usage. Considering the positive and significant effects of the relevant variables in the research on drone technology, it is crucial for the sector. In this context, results in parallel with the literature were obtained in the study. Even if drones are not actively used within the scope of last-mile delivery in Türkiye, when the results of the hypothesis are examined, it is understood that the potential users will adapt to the delivery by drone shortly after the necessary infrastructure is provided.

After COVID-19, people rapidly adapted to contactless delivery applications. Since the onset of the COVID-19 pandemic, people's behaviour has changed. Using systems or technologies with contactless features, especially in shopping and payment processes, is given priority. Drones will inevitably be used within the scope of last-mile delivery. When the research results are examined, the use of drones in last-mile delivery will be a critical topic in the future. Businesses that make people's lives easier can quickly adopt technologies that increase cost-effectiveness and efficiency. All the technologies currently in use are making life easier for people while providing benefits to manufacturers, retailers, and other stakeholders. Additionally, the development of drone technology and its widespread adoption may take some time to reduce production costs. Before this process, research conducted within the framework of drones, like the current study and future research, will help the industry and academia examine the positive and negative aspects of the subject and come up with solutions. In this context, although drone deliveries are not widely used in our country, they can be seen as a preparation for the future. Finally, digitisation continues to advance rapidly in all areas. Introducing potential future technologies such as digital currency, blockchain, metaverse, virtual reality, artificial reality, artificial intelligence, etc., into people's lives will increase e-commerce volume. In this context, the importance of last-mile delivery will increase with the growth of e-commerce activities in the future. Within the scope of last-mile delivery, drone transportation can be more actively used than other technological deliveries after the necessary regulations are in place. It is believed that the results obtained will benefit academic and private-sector stakeholders.

The research model is composed of TAM, DIT, and independent variables. With the active use of drone technology, drone studies can be continued by differentiating the

variables on different samples and according to the conditions of the period. In this context, future research will be expanded with TAM-2 and TAM-3 models. Furthermore, drones are currently being used in a semi-autonomous manner. However, in the future, with the production and use of fully autonomous drones, the scope of the research can be expanded, and the study can be repeated.

6. Limitations

The first limitation of the research is the model and variables used. In the future, different models can be used to gain in-depth knowledge about the user experience. Another limitation is the sample size of the research. Since the convenience sampling method was used in the study, examining it with a different sample is conceivable. There is also a limitation in the number of samples due to the convenience sampling method in the research. Therefore, it makes it difficult to generalise the results of the study. The final limitation of the research is that the sample is limited to the Istanbul province.

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