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RESEARCH ARTICLE

Autonomous Delivery Vehicles: A Quantitative Study from the Perspective of Innovativeness

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ABSTRACT
E-commerce has become increasingly popular, making the effective management of timely and accurate deliveries critical to maintaining customer satisfaction. Autonomous delivery vehicles (ADVs) are recent innovations essential to the distribution sector. However, their popularity depends on how open consumers are to innovations. Therefore, this study addressed whether consumers' innovativeness affected their perceived usefulness and risks associated with ADVs. The study also investigated whether consumers who were more open to innovations were more willing to use ADVs. The sample consisted of 184 participants from different cities of Türkiye and data were collected using several analyses. The results showed that participants who believed in the usefulness of ADVs were more likely to use them whereas participants who focused more on the risks were less likely. Innovativeness did not affect how participants perceived the risks of ADVs.

Keywords: Innovativeness, Autonomous Delivery Vehicles, Structural Equation Modeling

1. Introduction

Technological advances change the way customers and retailers interact. Retailers have begun focusing on dynamic technologies to run complex business operations; companies must use advanced technologies to run their operations efficiently and smoothly to gain a competitive edge (Li et al., 2021). For example, advances in information and communication technologies and Industry 4.0 have enabled companies to design new means of transportation and encouraged them to address last-mile delivery in innovative ways (Ranieri et al., 2018).

The COVID-19 pandemic has also impacted innovations in last-mile delivery. With governments introducing preventive measures (stay-at-home orders, lockdowns, school closures, etc.) to prevent the spread of the virus, many people began ordering goods online (Kapser et al., 2021). Therefore, consumers' purchasing behavior has changed drastically since the pandemic; more and more consumers have begun shopping online in greater numbers and frequency (Rai et al., 2022). The spike in food delivery and online shopping due to COVID-19 has increased demand for fully automated vehicles, which provide an easy and trustworthy way to deliver goods and services (Townsend et al., 2021). Autonomous delivery vehicles (ADVs) are an innovative solution that helps companies deliver goods and services without spreading the coronavirus (Valencia-Arias et al., 2022).

The e-commerce industry is proliferating, therefore companies want to deliver their products in small packages, which is a serious challenge to logistics service providers. Ultimately, timely and efficient delivery is of the utmost importance for companies. However, staggering growth in the food, prescription, and grocery sectors has exacerbated logistics challenges (Srinivas et al., 2022). Additionally, consumers now demand on-time delivery. Therefore, e-commerce companies are optimizing their resources regarding cost and time and ensuring responsiveness to meet customers' expectations (Valencia-Arias et al., 2022). Furthermore, advances in software and hardware technologies have paved the way for AI-assisted logistics, which can potentially reduce human costs and improve operational efficiency. As such, investigating autonomous distribution technology's potential uses in a concrete context is crucial (Du, 2021).

Last-mile logistics is a critical link to e-commerce and innovative technologies can help retailers and logistics service providers cut costs, boost productivity, and satisfy customers. Recently, companies have explored many innovative last-mile delivery solutions (smart locker, automated delivery robots, and drones) (Cai et al., 2021).

Autonomous delivery vehicles have an important place in Artificial Intelligence (AI)-enabled logistics applications. However,

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little is known about how appealing they are to consumers (Kapser et al., 2021). Some people anticipate that autonomous vehicles (AVs) will replace human drivers entirely in the next few decades. Although tests are still underway, it is envisaged that AVs will also replace other types of vehicles. For example, automotive industry leaders have demonstrated their self-driving vehicle models in various areas of transportation, proving that they are much more efficient than conventional means of transportation (Pisarov & Mester, 2021).

The increased freight transportation in urban areas contributes to congestion, limited public space, and air and noise pollution, which reduce urban dwellers' quality of life (Patella et al., 2021). Therefore, experts think that ADVs could resolve such problems.

This paper investigated what consumers thought about ADVs and how willing they were to use them. The study adopted a technology acceptance model (TAM) and technological innovativeness perspective.

2. Autonomous Delivery Vehicles

Last-mile delivery refers to the transfer of products from a transportation hub to the final delivery destination (Huang & Feng, 2021). Nowadays, companies more frequently use ADVs, autonomous delivery robots (ADRs), or drones for last-mile deliveries. Artificial intelligence and machine learning are required to operate autonomous machines in various states of autonomy (Lawless, 2022). Through their AI-based sensors, cameras, and radars, AVs can map their environment and travel to different locations. They can also use 5G technology to communicate with other vehicles (Chan & Lee, 2021).

Autonomous vehicle safety relies on high-precision GPS (Du, 2021); they use sensors, cameras, and intelligent information systems for automated driving, real-time interactions, and information communication. Environment sensing, positioning, path planning, vehicle control, and driving are their basic modules. Autonomous delivery robots are electrically-powered motorized vehicles that can deliver goods directly to customers. There are two types of ADRs: sidewalk autonomous delivery robots (SADRs) and autonomous delivery vans and road-based autonomous lockers (RALs). As the name suggests, SADRs are pedestrian-sized robots that only use sidewalks or pedestrian paths, while RALs make use of roads (Figliozzi & Jennings, 2020). Autonomous vehicles and ADRs attract the attention of delivery companies interested in reducing costs, delivery errors, fatal accidents, delivery time, pollution, and energy consumption and improving staff safety and 24/7 delivery efficiency. Of late, ADRs have attracted much attention, especially from food delivery companies (Schnieder et al., 2022). Companies (e.g., FedEx, Amazon, etc.) are testing ADRs in many US cities. Amazon is also testing a drone prototype that can deliver to customers in less than 30 minutes. Although these are just tests, experts believe that most companies will adopt this technology to meet the dramatic increase in online orders due to COVID-19 (Figliozzi, 2020). However, ADRs require a well-designed and well-maintained off-road infrastructure because SADRs (Starship, Kiwibot, etc.) share sidewalks with pedestrians. In contrast, RALs (Nuro, Neolix, etc.) share the roads with other vehicles (Rai et al., 2022). Autonomous vehicles operate on the ground or in the air, where drones were initially introduced for military purposes. However, today, they are of interest to delivery services due to their ability to access remote locations (Rai et al., 2022).

Pretrained deep learning models allow ADVs to navigate the roads autonomously. An ADV's principal input is a real-time camera while the steering angle is provided by the system, and the car is driven accordingly. The vehicle's location is also communicated to the authority via a map. Autonomous delivery vehicles are predicted to significantly change traffic systems and public safety (Chy et al., 2022). Drones and ADVs are promising for logistics and transportation (He & Csiszár, 2021); drone delivery presents a chance for sustainable corporate growth and environmental improvement, although it requires a significant initial investment (skilled labor force, technicians, facilities) and infrastructure known as drone airports due to the reliance on machine learning and AI technology (Valencia-Arias et al., 2022).

A drone delivery system can be used in urban areas or remote locations. Drones have unique advantages, such as low overhead costs, high access points, and no traffic delays. As of yet, commercial food delivery through drones is not viable because of legal constraints in many nations. However, there is hope that this technology can fulfill customer requirements. The advent of new technologies in the retail sector has facilitated client engagement and brand loyalty. Because of this, drone technology has a significant impact on the food delivery industry. Similarly, drones offer a novel replacement for the automobiles and motorbikes currently used, which contribute significantly to gridlock and air pollution (Li et al., 2021).

The idea of drone delivery dates back to December 2013, when Amazon announced initiatives to test them as a replacement for traditional delivery methods. Since then, some large companies (Mercedes-Benz, United Parcel Service, DHL, etc.) have integrated drones into their delivery systems. As a result, delivery drones have attracted a great deal of attention. Research communities have recently focused on speed, flexibility, safety, and costs (Jasim et al., 2022). In 2013, Amazon CEO Jeff Bezos launched Prime Air, a drone expected to deliver parcels weighing up to 2.5 kilograms from warehouses to customers in 30 minutes. In 2013, Deutsche Post DHL conducted the first test flights of the Parcelcopter over the Rhine River in Bonn. In an emergency circumstance in 2014, medicine was flown from the German mainland to the island of Juist via the Parcelcopter. In 2016, the Parcelcopter was put through its paces in the Bavarian Alps, where it transported necessities like medicine and sports equipment from the valley to the peak in arduous conditions (Schaarschmidt et al., 2021).

Groupe Renault, the Transdev Group, IRT SystemX, Institut VEDECOM, and the University of Paris-Saclay launched the Paris-Saclay Autonomous Lab initiative in May 2019. Its goal is to improve the current infrastructure of the Saclay Plateau by creating new forms of autonomous mobility service that make use of both private and public roads. More than 20,000 students and 1,600 faculty and staff members at the University of Lille in Villeneuve d'Ascq use the electric driverless shuttle service that Keolis and the European Metropolis of Lille began in December 2018. The service ran for a year and featured two Navya electric autonomous shuttles making four fixed stops over a circular path of 1.4 kilometers, connecting students to two nearby metro stops. Recent years have seen the commencement of a research initiative in Lyon into the feasibility of using autonomous electric shuttles to improve urban transportation (Trotta et al., 2022).

Companies (Amazon, Google, UPS, etc.) are all experimenting with drone delivery services. UPS has stated that it has successfully tested a drone that takes off from the roof of a UPS package car to drop off an item then fly back to the car. UPS estimates that it may save up to $50 million per year by having its drivers reduce their mileage by just one mile per day (Brunner et al., 2019). To enable contactless last-mile delivery for some gated communities, JD Logistics has deployed its ADRs in the Pudong New Area of the city. TwinswHeel has tested an unmanned delivery robot capable of climbing to a certain curb height to complete last-mile deliveries (Yu et al., 2020).

2.1. Advantages of Autonomous Delivery Vehicles

Urbanization generates air, noise, climate, traffic, and accident issues such as greenhouse gas emissions, sleep difficulties, death, maiming, etc. And so, AVs and ADVs solve such issues (Ranieri et al., 2018) and companies are most pressured by stakeholders wanting sustainable products and cheaper innovative technologies. Electric vehicles are quiet enough for night delivery and electric ADVs can also reach cities since internal combustion engine cars are banned (Kassai et al., 2020).

Because their navigation and sensing functions are done by more reliable technologies than human senses, AVs are safer than conventional automobiles. As a result, AVs optimize routes and perform smoother braking and acceleration, thus saving fuel (Yuen et al., 2020). Therefore, they are more eco-friendly than conventional vehicles (Jasim et al., 2022). Furthermore, ADVs have lower costs, can provide faster and more precise delivery, and ensure higher levels of personnel security (Figliozzi & Jennings, 2020).

Drones can take the place of other modes of transportation currently used for package delivery as vehicle congestion has little effect on them and they can be run by automated computer systems, which lessen the need for human labor and are environmentally beneficial. The advantages of drones are fast delivery, reliability, efficiency, safety, stability (Valencia-Arias et al., 2022), and reduction in traffic jams, fees, carbon emissions, and accidents. They are expected to contribute significantly to food delivery services because they are time- and cost-efficient (Jasim et al., 2022). Drones can optimize origin-to-destination routing thanks to cloud computing and big data, further accelerating delivery (Zhu, 2019). Companies use drones to manage events and deliver goods. Recently, some restaurant chains have started using drones to deliver food due to their cost-effectiveness, swiftness, and range. Drones also help companies extend their delivery coverage to remote areas with limited or no ground transportation infrastructure (Khalil et al., 2022).

2.2. Disadvantages of Autonomous Delivery Vehicles

There are some disadvantages to ADVs. Tesla's self-driving car crashed in March 2018, killing its passenger while on autopilot. For this reason, experts recommend that AVs be used at slow speeds for last-mile delivery, where the risk is minimal (Masood et al., 2021), as vehicles will deliver late if they travel at low speeds on long routes. Overall, the speed of ADVs should depend on public sentiment and traffic regulations. For example, most countries require ADVs to operate at walking speed on sidewalks due to their low weight; Starship's self-driving vehicles are designed to drive on sidewalks at a maximum speed of 6 km/h. Moreover, most cities do not have roads dedicated to ADVs, which, therefore, are often subject to various limitations that make roads more complex and thus increase delivery times (Huang & Feng, 2021). However, as ADVs are only recently being tested and regulated, such problems will eventually be resolved.

Drones are useful as long as they do not adversely affect the quality of the goods they deliver, and whether the product's quality can be maintained throughout delivery remains a significant concern and challenge (Amicone et al., 2021). Furthermore, drones can be subject to remote cyber-attacks. People are also concerned about privacy due to the possibility of being recorded or attacked by drones. Therefore, the more customers are informed about drones and their functionality, the more readily they will adopt them. Consumer reactions suggest that they resist new technologies due to their belief that traditional systems are safer. However, consumers may adopt drones more quickly because they trust certain brands (Valencia-Arias et al., 2022).

High prices are another disadvantage. New technologies are more expensive than the dominant technology at the time of entry. Therefore, consumers' perceived price level is critical because it may mean a monetary loss. Perceived price may deter customers from purchasing products. The more reasonably priced a product, the more consumers want to buy it (Yen, 2022). If consumers think a technological breakthrough is too expensive, they are less likely to use it (Nikou, 2019). Regarding cost efficiency, drone delivery costs influence consumers' behavioral intentions to use drone services. If autonomous drone delivery services are prohibitively expensive, consumers will not pay for them (Tom, 2020).

Price sensitivity is the manner in which consumers respond to price fluctuations, and acts as an essential determinant of behavioral intention (Kapser et al., 2021). For example, Kapser and Abdelrahman (2020) found that price sensitivity determined German users' acceptance of ADVs. Boone and Ganeshan (2013) also detected a negative correlation between transportation costs and order frequency.

3. Literature Review and Research Hypotheses

The TAM theory is widely used to assess consumers' attitudes and behavioral intentions toward technological breakthroughs (Mathew et al., 2021). The TAM assumes that consumers who perceive a new technological product as useful and user-friendly are more likely to use it. As a result, it is the best model for gauging whether or not customers will accept deliveries made by unmanned vehicles (Waris et al., 2022).

Technology readiness is defined as consumers' tendency to adopt and use new technological products or services (Parasuraman, 2000). Consumers with a high level of technological preparedness are more likely to perceive new technologies as useful and easy-to-use. Therefore, technology readiness positively affects consumers' intentions to use technology (Choi & Yoo, 2021), which means that consumers interested in technology are likely to be more willing to use drone delivery services (Li et al., 2021).

Consumer innovativeness is consumers' tendency to buy new products or services rather than follow familiar consumption patterns. Consumers' propensity to be inventive provides a quantitative measure of an innovation's chances of being adopted in the market because it is based on observable behavior (Chen, 2014). The more innovative the consumer is, the more likely the consumer will buy a new product or service upon its launch (Mathew et al., 2021). According to Mathew et al. (2021), a positive correlation exists between consumer innovativeness and purchase intention. Specifically, this suggests that consumer innovativeness positively affects purchase intention for AVs. Kapser et al. (2021) also regard innovativeness as critical in consumers' willingness to adopt new technological products. Therefore, they argue that the more innovative the consumer is, the more likely the consumer will try ADVs as a delivery option. Valencia-Arias et al. (2022) maintain that consumers with high personal innovativeness adopt new technological products and overcome uncertainties more easily.

More innovative consumers may trust delivery drones more and readily accept their risks. They can more easily address potential concerns about the performance and features of delivery drones. Therefore, innovativeness results in a positive attitude toward new technologies. Khalil et al. (2022) argue that innovativeness shapes consumers' behavioral intentions toward new technological products or services. They state that more innovative consumers are less resistant to new technologies. Mittendorf et al. (2017) maintain that innovative consumers are more likely to participate in drone delivery services.

In this context, the following hypothesis is formulated.

H1: More innovative consumers are more likely to use ADVs.

More innovative consumers are expected to have more positive beliefs about new technological products or services and are less likely to allow risks to affect their intentions to use them (Yen, 2022).

According to Chauhan et al. (2019), innovative consumers adopt innovations much earlier because they are better at coping with risks than others. Rogers (1995) states that innovative users are more willing to cope with the uncertainties of innovative technologies (Aldas-Manzano et al., 2009). According to Zhang and Hou (2017), innovative consumers perceive risks at a low level. Bülbül and Özoğlu (2014) also maintain that there is a negative correlation between innovativeness and perceived risks. Tanakinjal et al. (2010) found that technical knowledge positively affected perceived risks. Aldas-Manzano et al. (2009) determined that innovativeness had a negative effect on perceived risks regarding online banking and e-retail. They concluded that innovative consumers had more positive attitudes toward risks.

Hence, the second hypothesis is formed.

H2: More innovative consumers are less likely to focus on the risks of ADVs.

When discussing a product's perceived usefulness, we are referring to the general consensus among consumers that its use will improve their efficiency and performance (Chan & Lee, 2021). Perceived usefulness is thought to be a key factor in determining behavioral intention and technological adoption (Waris et al., 2022). Additionally, it affects consumer attitude toward a product or service regarding the use and diffusion of the information system (Sung & Jeon, 2020).

Innovativeness determines how popular a new technological product or service will become (Kim et al., 2021a). The more innovative the consumer is, the more willing the consumer is to use technological innovations (Esen, 2020). Ullah et al. (2020) state that innovativeness positively affects perceived usefulness and ease of use. Alamsyah et al. (2022) argue that innovativeness determines how useful consumers perceive new technological products or services. According to Acikgoz et al. (2022), innovative consumers enjoy discovering new things more and perceive new technological products and services as easier to use and more useful. They , alongside Fagan et al. (2012), found that innovativeness positively affected perceived usefulness.

As such, the third hypothesis is formulated.

H3: More innovative consumers are more likely to perceive ADVs as useful.

According to Leon et al. (2021), performance expectancy, linked to perceived usefulness, is the strongest predictor of intention to use. Furthermore, according to innovation diffusion theory, innovations that are less complex and more consistent with experience have a rapid diffusion rate (Al-Rahmi et al., 2019).

The TAM theory assumes that consumers' attitudes toward using a system influence their behavioral intentions. Research also shows a significant relationship between attitudes and behavioral intentions (Tsai & Tiwasing, 2021). For example, consumers with more positive attitudes toward logistics technology are more inclined to use it (Cai et al., 2021).

With the surge in online orders, delivery providers have strengthened their logistics operations. This expansion has resulted in the emergence of alternate delivery services. Consequently, consumers are willing to pay more for faster delivery of higher-quality products (Valencia-Arias et al., 2022).

Yoo et al. (2018) and Mathew et al. (2021) argue that consumers in both developed and developing countries are more enthusiastic about using drones for delivery services because they are faster and more eco-friendly than conventional transportation; consumers accept drone delivery services because they believe that they provide a relative advantage (Valencia-Arias et al., 2022). Researchers Xiao and Goulias (2022) found that older drivers' perceptions of the usefulness and safety of automated driver assistance systems (such as adaptive cruise control) influenced their intentions to use these features, and the same was found regarding perceptions of the usefulness of fully automated driving systems. Li et al. (2021) state that food delivery drones will significantly reduce environmental pollution. Gasoline-powered vehicles pollute the environment, whereas drone-based food delivery services are environmentally friendly. Masood et al. (2021, p. 2) claim that AVs can significantly reduce accidents and vehicle uptime. Williams et al. (2020) believe that consumers will consider AVs much safer than conventional vehicles.

In this context, a fourth hypothesis is formed.

H4: Consumers who perceive ADVs as useful are more likely to use them.

Researchers often use TAM to examine the effects of perceived risk on consumers' attitudes and behaviors. For example, due to uncertainties, consumers may fear that new technological products or services pose risks (Mathew et al., 2021). According to Yen (2022), perceived risk refers to the uncertainty perceived by consumers at the time of purchase. Additionally, perceived risk explains consumers' attitudes toward new technological products or services, where the anxiety experienced is considered within the scope of perceived risk (Valencia-Arias et al., 2022).

In general, perceived risk is anxiety about possible losses or uncertainties and it prevents consumers from adopting new products or services. Consumers who believe a technological innovation poses risks are less likely to use it. Essentially, there is a negative correlation between perceived risk and technology acceptance (Sungh & Jeon, 2020). Technological uncertainties may also cause consumers to focus on the risks of new technological products or services as they are about consumers' inability to predict the outcomes of technological developments and technical environments. Consumers concentrate on costs and risks to justify rejecting a new technological product or service. Generally, the lower the risk perception, the more readily consumers accept new technological products and services (Liu et al., 2019).

According to marketing studies, consumers may be resistant to autonomous technologies for a variety of reasons, such as perceived complexity and perceived risk (de Bellis & Johar, 2020). According to Sharma et al. (2022), autonomous technologies that allow customers to delegate shopping decisions to AI-based systems are rising in number. However, trust and privacy issues prevent consumers from adopting such technologies. For example, passengers who focus on the risks of electric aircraft develop negative attitudes toward the technology and therefore use it less often (Mathew et al., 2021). Furthermore, according to Kapser et al. (2021), since ADVs pose some risks (poor technology interaction, accidents, etc.), consumers' perception of those risks may negatively affect their behavioral intention.

Privacy is a concern in drone delivery services because consumers are required to share personal data (Valencia-Arias et al., 2022). According to Tom (2020), consumers may view food delivery drones in a negative light because of drones' military history.

Moreover, consumers are concerned that their privacy may be compromised because drones are equipped with cameras and facial recognition software. Mathew et al. (2021) argue that civilian food delivery drones pose risks to privacy and security because they can be used for surveillance and cyber espionage. Finally, according to Khalil et al. (2022), some consumers are skeptical of drones due to the lack of human touch and may have negative perceptions of drone food delivery services because they perceive them as too risky.

Consumers' worries about financial losses as a result of a service's failure to perform as promised is another example of risk (Valencia-Arias et al., 2022). Khalil et al. (2022) consumers are unsure whether drones will be able to deliver their packages on time and consumers may perceive drones as too risky if they malfunction, make errors, or fail to find a suitable landing spot (Valencia-Arias et al., 2022); packages may not be delivered because drones may be crashed, damaged, or stolen (Mathew et al., 2021), or the package gets lost or delivered elsewhere (Schaarschmidt et al., 2021). According to Hwang and Choe (2019), risk perception negatively affects consumers' intentions to use drone food delivery services. Consumers avoid using a new technological product or service if they believe it is too risky (Khalil et al., 2022). Yoo et al. (2018) found that perceived risk negatively affected consumers' intention to adopt drone delivery services.

In this context, the final hypothesis is formulated.

H5: Consumers who consider ADVs too risky are less likely to use them.

4. Method and Results

The conceptual framework of this study is depicted in Figure 1.

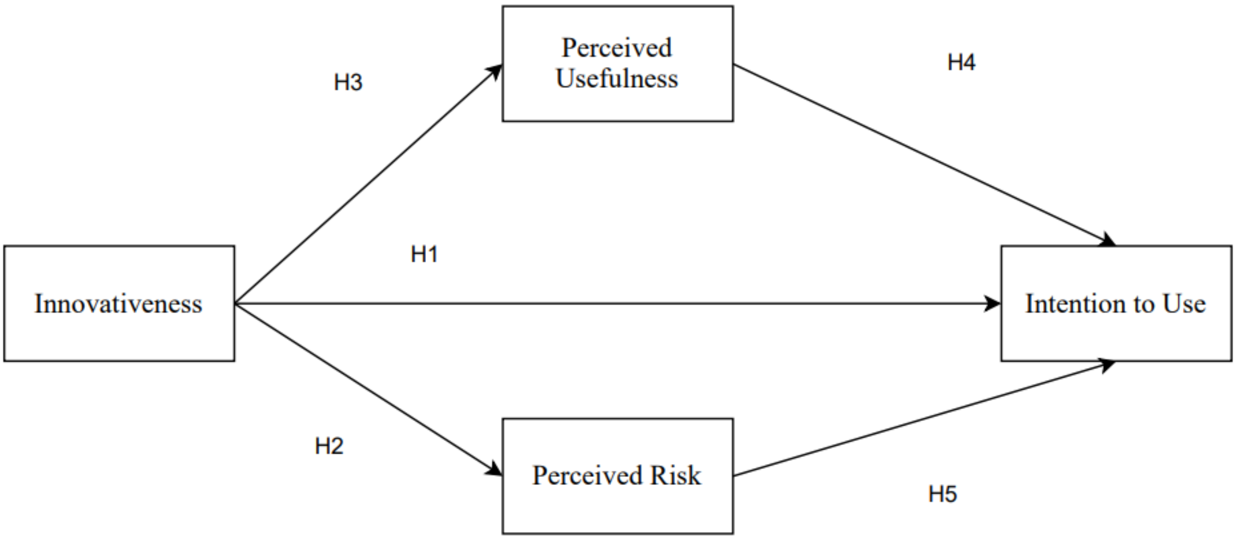

Figure 1. Conceptual Framework

The sample consisted of 184 people living in different cities of Türkiye. Research data were collected online between December 2020 and January 2023. The inclusion criterion was knowing about ADVs. Participants were recruited using convenience sampling.

Permission for the research was obtained from the Kastamonu University Social and Human Sciences Research and Publication Ethics Committee, dated 07.11.2022 and numbered 11/15.

The Innovativeness Scale (IS) was based on Kapser et al. (2021) and Manfreda et al. (2021). The Perceived Usefulness Scale (PUS) was based on Herrenkind et al. (2019) and Bogatzki and Hinzman (2020). The Perceived Risk Scale (PRS) was derived from Kapser and Abdelrahman (2020). Data were collected using a survey consisting of two parts. The first part was a personal information form on demographic characteristics (Table 1). The second part consisted of the IS, PUS, PRS, and use intention scale The scales consisted of items rated on a five-point Likert-type scale (1 = Strongly disagree to 5 = Strongly agree). Scale questions are presented in the Appendix.

Table 1. Participants' Demographic Characteristics

Gender	**Frequency**	**Percent**
Female	78	42,4
Male	106	57,6
Age	**Frequency**	**Percent**
18–25	41	22,3
26–35	44	23,9
36–45	66	35,9
46–55	27	14,7
56 +	6	3,3
Education	**Frequency**	**Percent**
Primary education	2	1,1
Secondary education	17	9,2
Associate degree	11	6,0
Bachelor's Degrees	85	46,2
Master	44	23,9
PhD	25	13,6
Profession	**Frequency**	**Percent**
Public sector employee	60	32,6
Private sector employee	47	25,5
Self-employed (lawyer, doctor, accountant, etc.)	16	8,7
Shopkeepers / Company owners	10	5,4
Retired	5	2,7
Housewife	9	4,9
Student	37	20,1

The validity and reliability of the scales were established using exploratory factor analysis (EFA), confirmatory factor analysis (CFA), reliability analysis, and normality tests.

Table 2. EFA Results

Innovativeness	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
IN1	,736	−,765	,709	3,89	,768
IN2	,870	−1,306	1,985	4,00	,923
IN3	,874	−1,099	1,383	4,04	,920
IN4	,881	−1,174	1,645	3,92	,938
KMO: , 811 Approx. Chi-Square: 356,380 df:6 sig.:,000 Total Variance Explained: % 70,972					
Perceived Usefulness	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
PU1	,873	−,740	,815	3,76	,910
PU2	,883	−,487	,232	3,89	,809
PU3	,942	−,572	,688	3,78	,809
PU4	,914	−,412	,611	3,76	,789
KMO: , 833 Approx. Chi-Square: 583,198 df:6 sig.:,000 Total Variance Explained: % 81,621					
Perceived Risk	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
PR1	,817	−,274	−,467	3,22	1,024
PR2	,826	−,339	−,082	3,13	,906
PR3	,847	−,440	−,292	3,35	,952
PR4	,843	−,372	−,370	3,28	,983
PR5	,826	,000	−,404	3,07	,893
KMO: , 837 Approx. Chi-Square: 505,822 df:10 sig.:,000 Total Variance Explained: % 69,221					
Intention to Use	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
IU1	,889	−,459	,703	3,55	,795
IU2	,908	−,481	,442	3,73	,823
IU3	,902	−,238	−,042	3,63	,859
KMO: , 744 Approx. Chi-Square: 294,954 df:3 sig.:,000 Total Variance Explained: % 80,971					

The EFA results show that all of the items had factor loadings above 0.5: the IS had 0.736–0.881; the PUS had 0.873–0.942; the PRS had 0.817–0.847; and the use intention scale had 0.889–0.908. All scales had KMO (Kaiser-Meyer-Olkin) values greater than 0.60, for which Bartlett's test of sphericity was significant. These results showed that the sample was large enough for factor analysis. All scales explained 50% of the total variance. They had kurtosis and skewness values of -2 to +2, indicating normal distribution (Lin et al., 2016).

Table 3 shows the CFA goodness of fit results.

Table 3. CFA Goodness of Fit Results.

Variable	χ^2	df	χ^2/df	GFI	CFI	NFI	RMSEA	SRMR
Criterion			***≤5***	***≥.85***	***≥.90***	***≥.90***	***≤.08***	***≤.08***
Innovativeness	2,382	2	1,191	0,994	0,999	0,993	0,032	0,0140
Perceived Usefulness	0,12	2	0,06	1	1	1	0,000	0,000
Perceived Risk	5,493	4	1,373	0,988	0,995	0,989	0,067	0,0268
Intention to Use	0	0		1	1	1	0,000	0,000

The CFA results showed that the scales had acceptable goodness of fit values (Boateng et al., 2018).

Reliability was assessed after the EFA and CFA.

Table 4 shows the Average Variance Extracted (AVE) and composite reliability (CR) values.

Table 4. Reliability Results

Variable	AVE	CR	Cronbach' Alpha
Innovativeness	0,62	0,86	0,864
Perceived Usefulness	0,75	0,93	0,923
Perceived Risk	0,59	0,88	0,888
Intention to Use	0,71	0,88	0,882

The scales had alpha coefficients greater than 0.70, indicating that the scales were reliable. Also, the scales had AVE values greater than 0.50 and CR values greater than 0.70, indicating that the scales were valid and reliable (Kautish & Sharma, 2019).

To establish the nature and extent of the association between the variables, a correlation analysis was performed before the hypotheses were tested (Table 5).

Table 5. Correlation Results

	Innovativeness	Perceived Usefulness	Perceived Risk	Intention to Use
Innovativeness	1			
Perceived Usefulness	,530**	1		
Perceived Risk	−,074	−,236**	1	
Intention to Use	,460**	,641**	−,277**	1

There was a positive correlation between: innovativeness, perceived usefulness, and intention to use ($p < 0.01$); and perceived usefulness and intention to use ($p < 0.01$). There was a negative correlation between: perceived usefulness and perceived risk ($p < 0.01$); and perceived risk and intention to use ($p < 0.01$). There was no correlation between innovativeness and perceived risk.

The hypotheses were tested using a structural equation model (Figure 2).

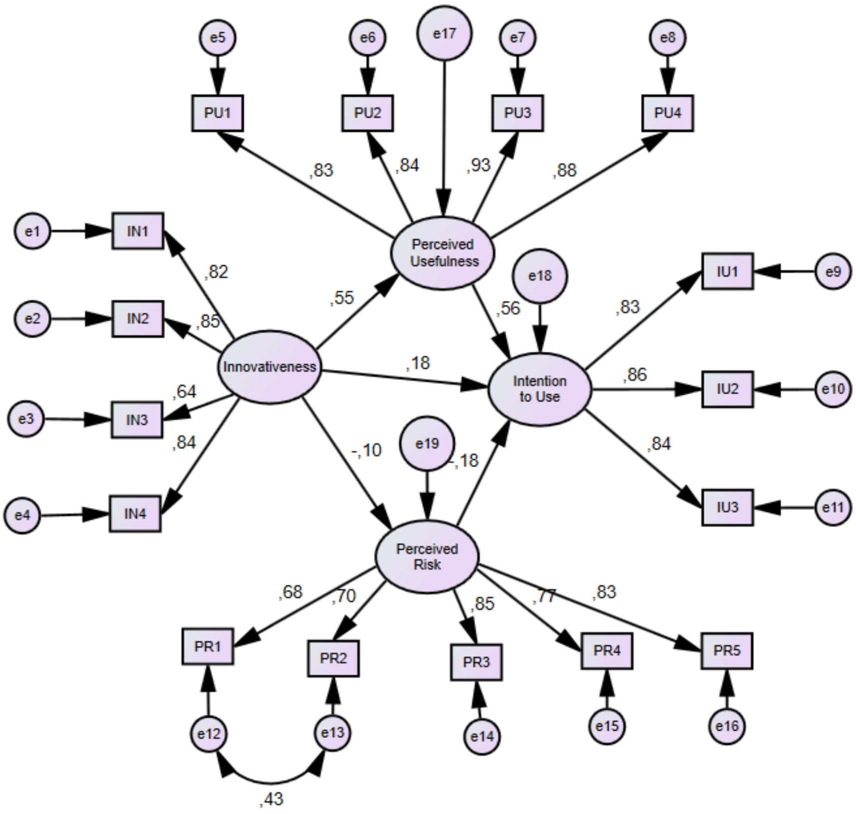

Figure 2. Structural Equation Model

Table 6 shows the goodness of fit values for the structural equation model and Table 7 provides structural equation model analysis results (Table 7).

Table 6. Goodness of Fit Values for the Structural Equation Model

Variable	χ^2	**df**	χ^2**/df**	**GFI**	**CFI**	**NFI**	**RMSEA**
Criterion			*≤5*	*≥.85*	*≥.90*	*≥.90*	*≤.08*
Model	173,923	100	1,739	0,902	0,960	0,919	0,068

Table 7. Structural Equation Model Analysis Results

	Analysis Path		**B**	**β**	**S.E.**	**CR.**	**p**
Perceived usefulness	<---	Innovativeness	0,524	0,553	0,077	6,819	***
Perceived risk	<---	Innovativeness	−0,106	−0,1	0,088	−1,193	0,233
Intention to use	<---	Innovativeness	0,15	0,183	0,067	2,239	0,025
Intention to use	<---	Perceived usefulness	0,486	0,563	0,075	6,482	***
Intention to use	<---	Perceived risk	−0,143	−0,184	0,052	−2,768	0,006

Innovativeness positively affected perceived usefulness and intention to use. Perceived usefulness had a positive effect on the intention to use. Perceived risk had a negative effect on the intention to use. Innovativeness did not significantly affect perceived risk. The results confirmed all the hypotheses barring H3

5. Conclusion

This study addressed whether consumers' innovativeness affected their perceived usefulness and risks associated with ADVs while investigating if innovativeness affected the intention to use ADVs. The results showed that innovativeness significantly affected perceived usefulness and intention to use. Chan and Lee (2021) found that innovative consumers were more likely to use AVs with 5G technology. Kim et al. (2021b) determined that innovativeness affected attitude, affecting consumers' intentions to use drone food delivery services. These results show that innovative consumers have more positive attitudes toward new technological products and services and are more willing to use them. Our results showed that innovativeness did not significantly affect perceived risk, suggesting that innovative consumers do not believe that ADVs are too risky. Şahin and Gelmez (2020) and Yapraklı and Gül (2021) reported that innovativeness positively affected perceived risk. However, our hypothesis claimed that innovativeness would negatively affect perceived risk. These results indicate that more research is warranted to better understand the impact of innovativeness on the perceived risk associated with autonomous services. Economic development and environmental sustainability can only be achieved with the help of digitalization and technological progress. Nations are embracing the latest innovations and technological advancements in order to outdo each other and act more strategically than ever before. Innovations and technological adaptations are crucial for countries and companies to sustain their businesses and achieve their goals (Ullah et al., 2020).

The results showed that perceived usefulness positively affected the intention to use and negatively affected perceived risk. This result indicates that consumers with positive attitudes toward ADVs are more likely to use them over consumers who believe ADVs are too risky. Our results complement the literature (Yoo et al., 2018; Çelik & Aydın, 2021).

Consumers do not have extensive knowledge about ADVs because they are a newly emerging service. However, e-commerce is constantly growing. Therefore, the importance of last-mile delivery in online shopping cannot be overstated (Wang et al., 2022). With more e-commerce deliveries being compact and light-weight, more light commercial vehicles than heavy vehicles are being added to city streets as e-commerce grows (Patella et al., 2021). The most expensive part of the supply chain is urban last-mile delivery. Consequently, autonomous driving technologies are anticipated to save expenses and boost productivity (Wang et al., 2022). Furthermore, companies can offer cheap, reliable, and fast delivery services using AVs that interact with customers. This can increase customer satisfaction and loyalty (Shbool et al., 2022).

Autonomous delivery vehicles are also energy- and eco-friendly. In contrast, traditional urban deliveries have been criticized for causing traffic congestion and urban pollution. Therefore, small electric vehicles are promoted for delivery services (Yu et al., 2020). Renewable energy solutions are also becoming increasingly important in developing countries. Issues with energy production and distribution are becoming increasingly pressing in the world's poorest nations; millions are affected by energy crises because they struggle to meet the energy needs of both the industrial and residential sectors. Therefore, disruptive technology for energy management in developed states is emerging as a paradigm for improving the traditional energy system in developing states (Ullah et al., 2020). Greenhouse gas emissions and energy utilization can be lowered by using ADV-based delivery systems (Zhu, 2019). Therefore, ADVs should be further integrated for sustainability.

Autonomous delivery vehicles will also be advantageous for urban traffic optimization while ADRs save more money and time than conventional transportation when customers need to be served within a specific time frame. Moreover, ADR deliveries save more time when customers are more clustered (Srinivas et al., 2022). Companies often choose heavy internal-combustion vehicles for parcel delivery services. Drivers also deliver packages to customers. This contributes to gridlock, pollution, and noise. Due to a changing culture, online ordering and on-time deliveries, consumer personalization, and increased economic pressure on logistics service providers due to space shortages and delays, logistical needs are unique in their variability (Kocsis et al., 2022). Autonomous delivery vehicles should also be used more widely to prevent or reduce the problems associated with urban traffic.

This study analyzed ADV services from the perspective of intention to use and innovativeness. Therefore, researchers should conduct further studies on ADVs from a sustainability perspective.

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REFERENCES

Acikgoz, F., Filieri, R., & Yan, M. (2022). Psychological predictors of intention to use fitness apps: the role of subjective knowledge and innovativeness. International Journal of Human–Computer Interaction, 1-13. DOI: 10.1080/10447318.2022.2074668

Aldás-Manzano, J., Lassala-Navarré, C., Ruiz-Mafé, C., & Sanz-Blas, S. (2009). The role of consumer innovativeness and perceived risk in online banking usage. International Journal of Bank Marketing, 27 (1) 53-75.

Alamsyah, D.P., Setyawati, I., & Rohaeni, H. (2022). New technology adoption of e-learning: model of perceived usefulness. 2022 3rd International Conference on Big Data Analytics and Practices (IBDAP), 79-84.

Al-Rahmi, W.M., Yahaya, N., Aldraiweesh, A.A., Alamri, M.M., Aljarboa, N.A., Alturki, U. & Aljeraiwi, A.A., (2019). Integrating technology acceptance model with innovation diffusion theory: an empirical investigation on students' intention to use E-learning systems. IEEE Access 7, 26797–26809. https://doi.org/10.1109/access.2019.2899368.

Amicone, D., Cannas, A., Marci, A. & Tortora, G. (2021). A smart capsule equipped with artificial intelligence for autonomous delivery of medical material through drones. Applied Sciences, 11, 7976, 1-13. https://doi.org/10.3390/app11177976

Boateng, G.O, Neilands, T.B., Frongillo, E.A., Melgar-Quiñonez, H.R. & Young, S.L. (2018) Best practices for developing and validating scales for health, social, and behavioral research: a primer. front. Public Health, 6, 149.

Bogatzki, K. & Hinzmann, J. (2020). Acceptance of autonomous delivery vehicles for last mile delivery in germany. extension of the technology acceptance model to an autonomous delivery vehicles acceptance model. Master Thesis in Business Administration. Jönköping University

Boone, T., & Ganeshan, R. (2013). Exploratory analysis of free shipping policies of online retailers. International Journal of Production Economics, 143 (2), 627-632.

Brunner, G., Szebedy, B., Tanner, S. & Wattenhofer, R. (2019). The urban last mile problem: autonomous drone delivery to your balcony. 2019 International Conference on Unmanned Aircraft Systems (ICUAS) Atlanta, GA, USA, June 11-14, 2019.

Bülbül, H. & Özoğlu, B. (2014). Tüketici yenilikçiliği ve algılanan riskin satın alma davranışına etkisi. Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 44, 43-58.

Cai, L., Yuen, K.F., Xie, D., Fang, M. & Wang, X. (2021). Consumer's usage of logistics technologies: Integration of habit into the unified theory of acceptance and use of technology. Technology in Society, 67, 1-11.

Chan, W.M. & Lee, J.W.C. (2021). 5G connected autonomous vehicle acceptance: the mediating effect of trust in the technology acceptance model. Asian Journal of Business Research, 11 (1), 1-22.

Chauhan, V., Yadav, R. & Choudhary, V. (2019). Analyzing the impact of consumer innovativeness and perceived risk in internet banking adoption: A study of Indian consumers. International Journal of Bank Marketing, 37 (1) 323-339.

Chen, K.K. (2014). Assessing the effects of customer innovativeness, environmental value and ecological lifestyles on residential solar power systems install intention. Energy Policy, 67, 951-961.

Choi, J. & Yoo, D. (2021). The impacts of self-construal and perceived risk on technology readiness. J. Theor. Appl. Electron. Commer. Res., 16, 1584–1597. https://doi.org/10.3390/jtaer16050089

Chy, M.K.A.; Masum, A.K.M.; Sayeed, K.A.M. & Uddin, M.Z. (2022). Delicar: a smart deep learning based self driving product delivery car in perspective of Bangladesh. Sensors, 22, 126, 1-25. https://doi.org/10.3390/s22010126

Çelik, Z., & Aydın, İ. (2021). Perakendecilikte drone ile ürün teslimatının tüketicilerin davranışsal niyetlerine etkisi, bmij, 9 (4), 1422-1436.

de Bellis E. & Johar G.V. (2020). Autonomous shopping systems: identifying and overcoming barriers to consumer adoption. Journal of Retailing 96 (1) 74–87.

Du, D. (2021). Research on the application of "last-mile" autonomous delivery vehicles in the context of epidemic prevention and control. 2021 International Symposium on Artificial Intelligence and its Application on Media (ISAIAM). 74-77 DOI 10.1109/ISAIAM53259.2021.00022

Esen, F.S. (2020). Dijital bankacılık kullanımına teknoloji kabulü temelli bir yaklaşım. Bilişim Teknolojileri Dergisi, 13 (4), 401-410

Fagan, M., Kilmon, C. & Pandey, V. (2012). Exploring the adoption of a virtual reality simulation: The role of perceived ease of use, perceived usefulness and personal innovativeness. Campus-Wide Information Systems, 29 (2) 117-127.

Figliozzi M. & Jennings D. (2020). Autonomous delivery robots and their potential impacts on urban freight energy consumption and emissions. Transportation Research Procedia 46, 21–28

Figliozzi M.A. (2020). Carbon emissions reductions in last mile and grocery deliveries utilizing air and ground autonomous vehicles. Transportation Research Part D, 85, 1-12.

Ganjipour, H. & Edrisi, A. (2022). Applying the integrated model to understanding online buyers' intention to adopt delivery drones in Iran. Transportation Letters, 1-14. DOI:10.1080/19427867.2022.2035130

He, Y. & Csiszár, C. (2021). Model for crowdsourced parcel delivery embedded into mobility as a service based on autonomous electric vehicles. Energies, 14, 3042, 1-24. https://doi.org/10.3390/en14113042

Herrenkind, B., Brendel, A. B., Nastjuk, I., Greve, M., & Kolbe, L. M. (2019). Investigating enduser acceptance of autonomous electric buses to accelerate diffusion. Transportation Research Part D: Transport and Environment, 74, 255–276.

Huang Y. & Feng X. (2021). Time and cost efficiency of autonomous vehicles in the last-mile delivery: a UK case. International Business

Research, 14 (3), 26-40.

Hwang, J. & Choe, J.Y. (2019). Exploring perceived risk in building successful drone food delivery services. Int. J. Contemp. Hosp. Manag. 31, 3249–3269.

Jasim, N.I., Kasim, H. & Mahmoud, M.A. (2022). Towards the development of smart and sustainable transportation system for foodservice industry: modelling factors influencing customer's intention to adopt drone food delivery (DFD) services. Sustainability, 14, 2852, 1-21. https://doi.org/10.3390/su14052852

Kapser, S. & Abdelrahman, M., (2020). Acceptance of autonomous delivery vehicles for last-mile delivery in Germany – Extending UTAUT2 with risk perceptions. Transp. Res. C 111, 210–225. http://dx.doi.org/10.1016/J.TRC.2019.12.016.

Kapser, S., Abdelrahman, M. & Bernecker, T. (2021). Autonomous delivery vehicles to fight the spread of Covid-19 –How do men and women differ in their acceptance? Transportation Research Part A. 148, 183-198.

Kassai, E.T., Azmat, M. & Kummer, S. (2020). Scope of using autonomous trucks and lorries for parcel deliveries in urban settings. Logistics, 4, 17, 1-24; doi:10.3390/logistics4030017

Kautish, P. & Sharma, R. (2019). Value orientation, green attitude and green behavioral intentions: an empirical investigation among young consumers. Young Consumers, 20 (4) 338-358.

Khalil, A., Shankar, A., Bıdhi, R., Behl, A. & Ferraris, A. (2022). Why do people resist drone food delivery services? an innovation resistance theory perspective. IEEE Transactions on Engineering Management, 1-11. doi: 10.1109/TEM.2022.3202485.

Kim, E.J.; Kim, J.J.; Han, S.H. (2021a). Understanding student acceptance of online learning systems in higher education: application of social psychology theories with consideration of user innovativeness. Sustainability, 13, 896, 1-14. https://doi.org/10.3390/su13020896

Kim, J.J., Kim, I & Hwang, J. (2021b). A change of perceived innovativeness for contactless food delivery services using drones after the outbreak of COVID-19. International Journal of Hospitality Management, 93, 1-11.

Kocsis, M., Zöllner, R. & Mogan, G. (2022). Interactive system for package delivery in pedestrian areas using a self-developed fleet of autonomous vehicles. Electronics, 11, 748, 1-34. https://doi.org/10.3390/electronics11050748

Lawless, W. (2022). Risk determination versus risk perception: a new model of reality for human–machine autonomy. Informatics, 9, 30, 1-20. https://doi.org/10.3390/informatics9020030

Leon, S., Chen, C. & Ratcliffe, A. (2021): Consumers' perceptions of last mile drone delivery, International Journal of Logistics Research and Applications, 1-21. DOI:10.1080/13675567.2021.1957803

Li, J., Rombaut, E. & Vanhaverbeke, L. (2021). A systematic review of agent-based models for autonomous vehicles in urban mobility and logistics: Possibilities for integrated simulation models. Computers, Environment and Urban Systems. 89, 1-20.

Li, G., Liang, Y., Wang, H., Chen, J. & Chang, X. (2022). Factors influencing users' willingness to adopt connected and autonomous vehicles: net and configurational effects analysis using PLS-SEM and FsQCA. Journal of Advanced Transportation, 1-23. https://doi.org/10.1155/2022/7489897

Lin, Y., Luo, J., Cai, S., Ma, S. & Rong, K. (2016). Exploring the service quality in the e-commerce context: a triadic view. Industrial Management & Data Systems, 116 (3) 388-415.

Liu, H., Yang, R., Wang, L. & Liu, P. (2019). Evaluating initial public acceptance of highly and fully autonomous vehicles. International Journal of Human–Computer Interaction, 35 (11), 919-931.

Manfreda, A., Ljubi, K. & Groznik, A. (2021). Autonomous vehicles in the smart city era: An empirical study of adoption factors important for millennials. International Journal of Information Management, 58, 1-12.

Mathew, A.O.; Jha, A.N.; Lingappa, A.K. & Sinha, P. (2021). Attitude towards drone food delivery services—role of innovativeness, perceived risk, and green image. Journal of Open Innovation: Technolgy Market and Complexity, 7, 144, 1-19. https://doi.org/10.3390/joitmc7020144

Masood, K.; Zoppi, M.; Fremont, V.& Molfino, R.M. (2021). From drive-by-wire to autonomous vehicle: urban freight vehicle perspectives. Sustainability, 13, 1169, 1-21. https://doi.org/10.3390/su13031169

Mittendorf, C., Franzmann, D. & Ostermann, U. (2017). Why would customers engage in drone deliveries? Twenty-third Americas Conference on Information Systems, Boston, 2017, 1-10.

Nikou, S. (2019). Factors driving the adoption of smart home technology: an empirical assessment. Telematics and Informatics, 45, 1-12.

Parasuraman, A. (2000) Technology readiness index (TRI) a multiple-item scale to measure readiness to embrace new technologies. J. Serv. Res., 2, 307–320.

Patella, S.M.; Grazieschi, G.; Gatta, V.; Marcucci, E. & Carrese, S. (2021). The adoption of green vehicles in last mile logistics: a systematic review. Sustainability, 13, 6, 1-29. http://dx.doi.org/10.3390/su13010006

Pisarov, J.L. & Mester, G. (2021). The use of autonomous vehicles in transportation. Tehnika – Mašinstvo 70 (2), 171-177. DOI: 10.5937/tehnika2102171P

Rai, H.B., Touami, S. & Dablanc, L. (2022). Autonomous e-commerce delivery in ordinary and exceptional circumstances. The French case. Research in Transportation Business & Management. 100774, 1-11. https://doi.org/10.1016/j.rtbm.2021.100774.

Ranieri, L., Digiesi, S., Silvestri, B. & Roccotelli, M. (2018). A review of last mile logistics innovations in an externalities cost reduction vision. Sustainability, 10, 782; 1-18. doi:10.3390/su10030782

Rogers, E. (1995), Diffusion of innovations. The Free Press, New York, NY

Schaarschmidt, M., Bertram, M. & Knobloch, M. (2021). Last mile drone delivery services: Adoption barriers before and during the COVID-19 pandemic. Forty-Second International Conference on Information Systems, Austin 2021

Schnieder, M.; Hinde, C. & West, A. (2022). Land efficient mobility: evaluation of autonomous last mile delivery concepts in London. Int. J. Environ. Res. Public Health, 19,10290, 1-21. https://doi.org/10.3390/ijerph191610290

Sharma, S., Singh, G., Gaur, L. & Afaq, A. (2022). Exploring customer adoption of autonomous shopping systems. Telematics and Informatics, 73, 1-12.

Shbool, M.A., Al-Bazi, A. & Al-Hadeethi, R. (2022). The effect of customer satisfaction on parcel delivery operations using autonomous vehicles: An agent-based simulation study. Heliyon, 8, 1-14.

Srinivas, S., Ramachandiran, S. & Rajendran, S. (2022). Autonomous robot-driven deliveries: A review of recent developments and future directions. Transportation Research Part E, 165, 1-26.

Sunh, H.J. & Jeon, H.M. (2020). Untact: customer's acceptance intention toward robot barista in coffee shop. Sustainability, 12, 8598, 1-16. doi:10.3390/su12208598

Şahin, E. & Gelmez, E., The effect of consumer innovativeness, perceived risk and personality traits on purchase behavior. BMIJ, 8 (2), 2289-2311.

Tanakinjal, G.H., Deans, K.R. & Gray, B.J. (2010). Innovation characteristics, perceived risk, permissibility and trustworthiness in the adoption of mobile marketing. Journal of Convergence Information Technology, 5 (2), 112-123.

Tom, N.M.F. (2020). Crashed! why drone delivery is another tech idea not ready to take off. International Business Research, 13 (7), 251-264.

Townsend, R.M., Atkinson-Palombo, C., Terbeck, F. & Garrick, N. (2021). Hopes and fears about autonomous vehicles. Case Studies on Transport Policy, 9, 1933-1942.

Trotta, M., Archetti, C., Feillet, D. & Quilliot, A. (2022). Pickup and delivery problems with autonomous vehicles on rings. European Journal of Operational Research, 300, 221-236.

Tsai, Y.T. & Tiwasing, P. (2021). Customers' intention to adopt smart lockers in last-mile delivery service: A multi-theory perspective. Journal of Retailing and Consumer Services, 61, 1-9.

Ullah, N., Alnumay, W.S., Al-Rahmi, W.M., Alzahrani, A.I. & Al-Samarraie, H. (2020). Modeling cost saving and innovativeness for blockchain technology adoption by energy management. Energies, 13, 4783, 1-22. doi:10.3390/en13184783

Valencia-Arias, A., Rodríguez-Correa, P.A., Patiño-Vanegas, J.C., Benjumea-Arias, M., De La Cruz-Vargas, J. & Moreno-López, G. (2022). Factors associated with the adoption of drones for product delivery in the context of the covid-19 pandemic in Medellín, Colombia. Drones, 6, 225, 1-19. https://doi.org/10.3390/drones6090225

Wang, H., Zhang, L., Kong, Q., Zhu, W., Zheng, J., Zhuang, L. & Xu, X. (2022). Motion planning in complex urban environments: An industrial application on autonomous last-mile delivery vehicles. J Field Robotics, 1–28. DOI: 10.1002/rob.22107

Waris, I., Ali, R., Nayyar, A., Baz, M., Liu, R. & Hameed, I. (2022). An empirical evaluation of customers' adoption of drone food delivery services: an extended technology acceptance model. Sustainability, 14, 2922, 1-18. https://doi.org/10.3390/su14052922

Williams, E., Das, V. & Fisher, A. (2020). Assessing the sustainability implications of autonomous vehicles: recommendations for research community practice. Sustainability, 12, 1902, 1-13. doi:10.3390/su12051902

Xiao, J. & Goulias, K.G. (2022). Perceived usefulness and intentions to adopt autonomous vehicles. Transportation Research Part A, 161, 170-185.

Yapraklı, T. Ş., & Gül, B. (2021). Tüketici yenilikçiliği, algılanan risk ve ürün ilgileniminin online satın alma davranışı üzerindeki etkisi. Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, 9 (5), 1507-1534

Yen, Y.S. (2022). Channel integration affects usage intention in food delivery platform services: the mediating effect of perceived value. Asia Pacific Journal of Marketing and Logistics, 1-20. https://doi.org/10.1108/APJML-05-2021-0372

Yoo, W., E. Yu, & J. Jung. (2018). Drone delivery: factors affecting the public's attitude and intention to adopt. Telematics and Informatics 35 (6), 1687–1700.

Yu, S., Puchinger, J. & Sun, S. (2020). Two-echelon urban deliveries using autonomous vehicles. Transportation Research Part E, 141, 1-29.

Yuen, K.F., Chua, G., Wang, X., Ma, F. & Li, K.X. (2020). Understanding public acceptance of autonomous vehicles using the theory of planned behaviour. Int. J. Environ. Res. Public Health, 17, 4419, 1-19. doi:10.3390/ijerph17124419

Zhang, Z. & Hou, Y. (2017). The effect of perceived risk on information search for innovative products and services: the moderating role of innate consumer innovativeness. Journal of Consumer Marketing, 34 (3) 241-254.

Zhu, X. (2019). Segmenting the public's risk beliefs about drone delivery: a belief system approach. Telematics and Informatics, 40, 27-40.

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Appendix A: Scale Items

Innovativeness
IN1: If I heard about a new technology, I would look for ways to try it out. (Kapser et al., 2021)
IN2: I like experimenting with new technologies. (Kapser et al., 2021)
IN3: I am excited by the opportunities offered by new technologies. (Manfreda et al., 2021)
IN4: I am not afraid to experiment with new technologies. (Manfreda et al., 2021)
Perceived Usefulness
PU1: Autonomous delivery vehicles will allow me to pick up packages faster. (Bogatzki & Hinzman, 2020)
PU2: Using autonomous delivery vehicles to pick up parcels increases my efficiency. (Bogatzki & Hinzman, 2020)
PU3: Autonomous delivery vehicles will deliver packages more efficiently. (Bogatzki & Hinzman, 2020)
PU4: Autonomous delivery vehicles will be useful delivery vehicles. (Bogatzki & Hinzman, 2020)
Perceived Risk
PR1: Having autonomous delivery vehicles on public roads will pose a risk. (Kapser, 2019)
PR2: Autonomous delivery vehicles will add significant uncertainty to public roads. (Kapser, 2019)
PR3: Autonomous delivery vehicles may not perform well during cargo delivery and may cause problems (e.g., locker fails to open, Bluetooth disconnection, etc.). (Kapser, 2019)
PR4: Autonomous delivery vehicles may not function correctly during parcel delivery.
PR5: Something might go wrong with the performance of autonomous delivery vehicles during parcel delivery. (Kapser, 2019)
Intention to Use
IU1: I am thinking of using autonomous delivery vehicles for delivery. (Kapser & Abdelrahman, 2020)
IU2: I will try to use autonomous delivery vehicles as a delivery option in my daily life when it becomes available. (Kapser & Abdelrahman, 2020)
IU3: I think I will use autonomous delivery vehicles frequently when they are available. (Kapser & Abdelrahman, 2020)