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ORIGINAL PAPER

ACCEPTANCE OF E-VEHICLES FOR LAST-MILE PARCEL DELIVERY FROM THE PERSPECTIVE OF DRIVERS: A STUDY IN TURKIYE

Serdar Alnıpak[1], Yavuz Toraman[2]

1) International Trade and Logistics Department, Nisantasi University, İstanbul, **Turkey**
2) Vocational School Foreign Trade Programme, Nisantasi.University, İstanbul, **Turkey**

ABSTRACT. Background: Last-mile delivery constitutes the most inefficient and costly part of logistics processes, thus increasing the importance of research in this area. Numerous alternative solutions and current technological advancements are being investigated to reduce the negative effects and make it more efficient and cost-effective. One of these alternatives is the use of electric vehicles for last-mile delivery. There is limited research on factors influencing user acceptance in the literature, and also a lack of studies on factors influencing driver acceptance. In this study, the authors aim to investigate the factors influencing drivers' acceptance of using electric vehicles for LMD of small and medium-sized parcels.

Methods: This study examines the factors influencing drivers' acceptance of e-vehicles for last-mile delivery within the framework of the Technology Acceptance Model (TAM). In addition to the basic TAM variables, the current research adds the independent variables of environmental concern and enjoyment to the conceptual model.

Results: Based on data from 180 participants in Turkiye, it was observed that environmental concern and perceived ease of use did not have an impact on perceived usefulness. Furthermore, the lack of influence of enjoyment on intentions is another important finding of the research. However, the other hypotheses were supported.

Conclusions: Based on the present research It is understood that drivers need time to fully adopt electric vehicles. The increasing integration and automation efforts among relevant parties, as well as the adaptation of vehicles for large-scale shipments, will contribute to the increased use of electric vehicles. Besides, technical issues related to electric vehicle delivery, as well as traffic regulations, should be promptly planned, and real-life tests and pilot programs should be accelerated and expanded.

Keywords: Last-mile Delivery, E-vehicles, TAM, Structural Equation Model

INTRODUCTION

Logistics processes are generally defined in three stages: first-mile logistics, middle-mile logistics, and last-mile logistics. The last stage involves multiple distribution points and accounts for more than half of transportation costs. In this regard, the use of new technologies and business models plays a facilitating role in problem-solving [Kåresdotter et al. 2022]. In recent years, last-mile logistics (LMD), which constitutes the final stage of business-to-consumer (B2C) online sales, has gained increasing significance in terms of efficient logistics management [Lim et al. 2018, Liu et al. 2019]. Due to factors such as challenging service levels, the multitude and dispersal of delivery points, LMD is considered the most inefficient and costly process for companies, and encompasses all logistics activities related to the delivery of shipments to private customer households in urban areas [Asdecker 2021, Jacobs et al. 2019, Macioszek, 2018, Moshref-Javadi et al. 2020]. According to [Boysen et al. 2021], LMD starts at an origin point (depot), where the goods to be delivered to the respective urban area arrive after long-haul transportation, and it involves the final delivery of the goods to the customer after one or more transportation and storage process steps. Last-mile deliveries are categorized based on the type of goods transported, such as grocery shopping, ready-

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made meals, courier services, large appliances, and packages [Allen et al. 2018].

Door-to-door services pose challenges for both companies and cities in various aspects. The most significant challenges include the increasing number of packages, deliveries, and vehicles due to online sales, costs, consumers' expectations for personalized and flexible services, companies' commitments to fast delivery, higher supplier costs, stricter environmental regulations, increased parking space requirements, vehicle breakdowns, greenhouse gas emissions, security risks, fuel consumption, noise, and traffic congestion [Assmann et al. 2019, Hu et al. 2019, Park et al. 2016].

When examining the academic literature, it can be observed that LMD is generally studied in three contexts: environmental sustainability, effectiveness (service level), and efficiency (costs) [Mangiaracina et al. 2019]. Both academia and the business world agree that LMD is one of the most critical logistics processes [Lim et al. 2018]. Research conducted in this context indicate that new technologies, transportation vehicles, and innovative strategies enable more effective, efficient and cost-effective LMD, particularly in urban areas [Balaska et al. 2022, Kulkarni and Barge 2020, Savelsbergh and Van Woensel 2016]. One of these innovations is the use of electric vehicles for LMD. However, such use is still in its infancy. Undoubtedly, consumer acceptance is a critical factor in the success of a technology, alongside technological maturity. In this context, identifying and understanding the factors that influence consumer acceptance is of great importance [Punakivi and Tanskanen 2002, Asdecker 2021, Osakwe et al. 2022]. Literature research indicates that the number of studies on the use of the relevant technology in last-mile parcel delivery is very limited. Furthermore, no study specifically focusing on Turkiye has been found. Additionally, no research has been encountered regarding the acceptance of this technology by vehicle drivers. In this study, the authors aim to investigate the factors influencing drivers' acceptance of using electric vehicles for LMD of small and medium-sized parcels, utilizing the Technology Acceptance Model (TAM), which is one of the most commonly used models for understanding the acceptance of a technology by individuals. The study also aims to provide a comprehensive literature review on the subject. In addition to the core TAM variables, the study incorporates the independent variables of environmental concern and enjoyment into the conceptual model. It is expected that exploring the relationships between these added variables and intentions will contribute to the existing LMD literature. This is the first attempt to investigate this topic in Turkiye. This study also represents a research agenda on this topic and offers broad research opportunities for the future. Moreover, it helps stakeholders better understand the factors that influence e-vehicle adoption for last-mile parcel delivery from the perspective of drivers and therefore encourages the development of industry use.

E-VEHICLES AND ITS USAGE IN LMD

The increase in e-commerce has led to a rise in last-mile package deliveries, primarily in urban areas, negatively impacting environmental, economic, and social sustainability. There are several innovative alternatives available to address these problems, such as reception boxes, crowdshipping, trunk delivery, cargo bikes, pick-up points, underground delivery, scooters, parcel lockers, robots (bots), e-vehicles, drones, home access systems, autonomous vehicles, combined with people transportation [Ulmer and Streng 2019, Wang et al. 2014, Carbone et al. 2017, Devari et al. 2017, Dorling et al. 2016, Murray and Chu 2015, Slabinac 2015, Reyes et al. 2017].

Although the use of fully or partially electric vehicles that produce zero emissions, have low noise levels, and operate on batteries is still in its infancy for commercial transportation and distribution, they are considered a good solution in the context of environmental sustainability [Saldaña et al. 2019, Quak et al., 2016, Nicolaides et al. 2017, Anosike et al. 2021]. [Kijewska et al. 2016] and [Bandeira et al. 2019] emphasize electric vehicles and electromobility as one of the best alternatives for addressing issues related to emissions from conventional fuels. Fully electric vehicles have great potential for reducing externalities associated with LMD in the near future [Ranieri et al. 2018]. Electric hybrid and fuel cell electric vehicles (FCEVs) are lightweight, agile, environmentally friendly, highly mobile, low-noise, and require less space for parking, making them suitable for transporting small packages. The main limitations of electric vehicles are their limited range (averaging about 150 km), the need for recharging, and long charging times. As a result, hybrid vehicles with lower investment costs and higher autonomy are currently more preferred [Ranieri et al. 2018]. Undoubtedly, the autonomy of vehicles, the location of charging points, and charging times are of great importance in using electric vehicles for LMD [Ranieri et al. 2018]. In addition to these factors, infrastructure (sufficiency of depot-based and public charging stations) and other operational barriers (driver training, fleet size decisions, topography, integration of limited range and charging station location into routing problems) can pose challenges relating to the adoption of this technology [Anosike et al. 2021, Christensen et al. 2017, Guo et al. 2018].

There are various studies in the academic literature regarding the use of electric vehicles for LMD. Oliviera et al. (2017) established that the use of zero-emission electric vehicles in last-mile distribution can reduce the negative impacts of traditional transportation and facilitate the transition to an efficient new transportation infrastructure. Bandeira et al. (2019) conducted a study focused on Brazil, indicating that the use of electric three-wheeled bicycles for LMD is a more suitable alternative in economic, environmental, and social aspects, and it does not require public incentives. Kijewska et al. (2016) highlighted electric vehicles as one of the best alternatives for addressing issues related to emissions from conventional fuels, focusing on practical applications within the EUFAL (Electric urban freight and logistics) project. Schröder (2017) mentioned that the use of electric vehicles in LMD can lead to cost savings in operations, emphasizing that the technical and economic benefits of electric vehicles in last-mile distribution will increase depending on technological, political, and market demand developments.

STUDIES ON USERS' ACCEPTANCE OF E-VEHICLES

From the Industrial Revolution to the present, many technologies have emerged that have made human life easier. However, new technologies have also brought along some environmental issues [Wu et al. 2019]. In particular, global warming and CO2 emissions have made it necessary for governments and companies to act more sensitively [Shanmugavel and Micheal 2022]. In this context, investments in renewable energy have increased to ensure sustainability and protect the future of the world, making the use of environmentally friendly electric vehicles more essential than ever [Shanmugavel et al. 2022]. In this regard, it is predicted that electric vehicles, autonomous vehicles and drone technology will advance in the future, and with the constructive policies of governments, their market share will increase [Wang et al. 2022]. Within this scope, investigating the attitudes and intentions of potential users towards electric vehicles is of great importance. Although there are limited studies in the literature regarding consumer acceptance of using electric vehicles for LMD, no studies have been found specifically addressing driver acceptance. [Wikstrom, Hansson and Alvfors 2016] emphasized that user acceptance is the most crucial factor in the successful adoption of electric vehicles. [Anosike et al. 2021] researched the challenges and evaluated the potential of adopting electric vehicles for last-mile package deliveries. It was indicated that companies using these vehicles will face difficulties related to fleet size, delivery schedules, and capacity. Shanmugavel and Micheal (2022) conducted a study with 402 participants, adding different variables to the Technology Acceptance Model (TAM) to investigate the relationships between consumers' behavior, attitude, and intentions in the context of electric vehicle usage. The findings demonstrate that all marketing activities and incentive opportunities significantly influence the intention to purchase electric vehicles. Shanmugavel et al. (2022) examined the acceptance processes and influencing factors of electric vehicle usage with the participation of 400 individuals using the TAM. Structural Equation Modeling (SEM) was used in the analysis. The findings indicated significant relationships between the included variables and intention. A mediating effect was found between Perceived Usefulness (PU) and Intention (I), and furthermore, age, income, and gender were found to have a positive moderating effect on the relationships between PU and I. In a study involving 232 participants, Dudenhöffer (2013) emphasized that inadequate information provision would lead to failure in the acceptance of electric vehicles by end users. Analysis conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) yielded different results from the TAM literature. Wu et al. (2019) investigated factors influencing the acceptance of electric and autonomous vehicles by potential users in the context of environmental benefits. The analysis in that study was conducted using TAM and SEM. The findings showed a positive relationship between PU, Perceived Ease of Use (POUE), Environmental Concern (EC), and Intention (I). Tu and Yang (2019) examined individuals' intentions to purchase electric vehicles and the influencing factors within the framework of TAM, Theory of Planned Behavior (TPB), and Innovation Diffusion Theory (IDT). The analysis in their study, conducted using SEM, indicated a positive relationship between Attitude Towards Use (AT) and Intention (I) with all variables except the Product Innovativeness (PI) variable. Ngoc et al. (2023) investigated the factors influencing the acceptance of electric vehicle usage for LMD using TAM and data obtained from individuals residing in Vietnam. The findings showed no significant relationship between I and the variables PU and Perceived Risks (PR), but the results of other hypothesis tests were consistent with the literature. Studies conducted on this subject using TAM and their findings are summarized in Table 1.

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

Davis (1986) based his work on the Theory of Reasoned Action (TRA) and proposed the Technology Acceptance Model (TAM), which incorporates the variables Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), to investigate the factors influencing the usage processes of new technologies. TAM has been widely used in the context of the acceptance of new technologies. TRA focuses on studying people's general behavior, while TAM is more concerned with individuals' attitudes and intentions towards technological products and services [Davis 1989]. According to Ajzen and Fishbein (2005), the most important factor influencing individuals' adoption of a new technology is their intention to engage in that behavior. Intention (I) is considered a prerequisite for any behavior [Venkatesh and Davis 2000]. The stronger an individual's intention, the more likely their behavior is expected to change. In this regard, active behavior increases the likelihood of using new technologies [Davis, 1989; Venkatesh and Davis 1996]. The main variables in TAM, Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Attitude Towards Use (AT), are constructed to capture individuals' perceptions of new technologies [Davis et al. 1992]. PEOU refers to the belief that using the relevant technology will reduce the physical and mental effort required [Venkatesh and Davis 2000]. PU represents the degree to which users believe that using a specific system will enhance their job performance. AT reflects users' positive or negative thoughts and feelings towards the technology in question [Davis et al. 1992, Davis 1989]. Additionally, PEOU influences intention and attitude through PU (mediating variable). Attitude is considered an important determinant of intention [Venkatesh and Davis, 2000].

Based on all this information, in the current study, in addition to the core TAM variables, the concept model has included the variables Environment Concern (EC) and Enjoyment (E). The sub-dimensions of the hypotheses and their corresponding questions have been formulated in line with the literature [Ha and Janda 2012, Wu et al. 2019]. The hypotheses formulated are as follows:

The active usage processes of any technology can be predicted by individuals' intentions. When examining the adaptation processes for technologies with limited active usage, intention is included as a dependent variable in research models. In this regard, the relevant study focuses on intention as a precursor indicator of active usage [Tu and Yang 2019, Davis 1989, Ngoc et al. 2023, Venkatesh and Bala 2008, Toraman and Geçit, 2023]. Therefore, it is important to investigate the relationship between intention, which is considered an important determinant, and AT. Hence, the positive attitudes of EVs users towards the relevant technology will serve as a significant motivational factor for intention, which is a precursor to active usage. A conceptual model that guides this research and summarizes the hypotheses is presented in Figure 1.

Table 1. TAM Studies On Users' E- Vehicles Acceptance

Reference	Related Area	Hypothesis*	Result
Shanmugavel & Micheal (2022)	Usage of Electric Vehicles in City Logistics in India	PI→PU	Supported
		RPI→PU	Supported
		RPA→PU	Supported
		RP→PU	Supported
		PI→PU	Supported
		PIC→PU	Supported
		PU→I	Supported
Shanmugavel et al. (2022)	Usage of Electric Vehicles in City Logistics in India	II→PU	Supported
		VEI→PU	Supported
		PI→PU	Supported
		II→I	Supported
		VEI→I	Supported
		PI→I	Supported
		PU→I	Supported
Dudenhöffer (2013)	Usage of plug-in Electric Vehicles in City Logistics	PU→I	Not Supported
		PEOU→I	Not Supported
		PEOU→PU	Supported
		OU→I	Not Supported
		OU→PEOU	Supported
		SN→PU	Not Supported
		SN→I	Supported
Wu et al. (2019)	Usage of Autonomous Electric Vehicles in City Logistics	EC→PU	Supported
		EC→PEOU	Supported
		EC→I	Supported
		PEOU→PU	Supported
		PEOU→I	Supported
		PU→I	Supported
Tu & Yang (2019)	Usage of Electric Vehicles in City Logistics	PI→AT	Not Supported
		PC→AT	Supported
		PU→AT	Supported
		PEOU→AT	Supported
		SN→I	Supported
		AT→I	Supported
Ngoc et al. (2023)	Usage of Electric Cargo Vehicles in LMD	AT→I	Supported
		PEOU→PU	Supported
		PEOU→I	Supported
		PU→I	Not Supported
		PU→AT	Supported
		PR→PU	Not Supported
		PR→I	Supported
		PR→AT	Supported

*PU=Perceived Usefulness; PEOU=Perceived Ease of Use; PR=Perceived Risks; SN= Subjective Norms; SI=Social Influence; EC=Environmental Concern; PC=Perceived Compatibility; OU= Objective Usability; RPI = relative product innovativeness; RPA = relative product advantage; RP = relative price advantage; PIC = perceived incentives; PI = personal innovativeness; II=Information Influence; VEI=Value-expressive Influence, PI=Product, Innovativeness; I= Intention; AT= Attitude Towards Use.

Table 2. Hypotheses and Explanations

	Explanations
H1: Environment Concern (EC) affects the Perceived Usefulness (PU) to drive Electric Vehicles in last-mile parcel delivery.	EC is defined as the attitude that people form towards environmental issues, which has increased with the rise of environmental problems [Wu et al. 2019]. In recent years, people have been inclined to choose more environmentally friendly businesses, products, and vehicles due to global environmental crises. Studies have shown that individuals who show sensitivity towards this issue exhibit environmentally friendly attitudes and behaviors. In this context, it is crucial to investigate the existence of a positive and significant relationship between EC and PU. [Minton and Rose 1997]. It is expected that individuals who prioritize environmental issues will be more willing to use EVs within the scope of LMD. This suggests that there may be a positive relationship between EC and PU.

H2: Environment Concern (EC) affects the Perceived Ease of Use (PEOU) to drive electric vehicles in last-mile parcel delivery.	EC is defined as the attitude that people form towards environmental issues, which has increased with the rise of environmental problems [Wu et al. 2019]. In recent years, people have been inclined to choose more environmentally friendly businesses, products, and vehicles due to global environmental crises. Studies have shown that individuals who show sensitivity towards this issue exhibit environmentally friendly attitudes and behaviors. In this context, it is crucial to investigate the existence of a positive and significant relationship between EC and PU. [Minton and Rose 1997]. It is expected that individuals who prioritize environmental issues will be more willing to use EVs within the scope of LMD. This suggests that there may be a positive relationship between EC and PU.
H3: Environment Concern (EC) affects the Intention (I) to drive Electric Vehicles in last-mile parcel delivery.	Individuals with a high level of awareness not only participate in environmental conservation activities but also prefer environmentally friendly alternatives in their product and service purchases [Kim and Choi 2005]. As mentioned in the previous paragraphs, PEOU represents the degree to which an individual believes that using new technologies in a specific domain requires less effort [Venkatesh and Morris 2000]. The positive attitudes of environmentally conscious drivers towards electric vehicles support the existence of a positive and significant relationship between EC and PEOU.
H4: Enjoyment (E) affects the Perceived Usefulness (PU) to drive Electric Vehicles in last-mile parcel delivery.	Considering those electric vehicles, which are the subject of the current study, have environmentally friendly technology, it is likely that their use in LMD services will be positively perceived by consumers. Additionally, drivers who have environmental concerns are expected to have a positive view towards using both an economical and environmentally friendly delivery vehicle. Taking into account the potential impact of drivers' environmental sensitivities on their perceptions, attitudes, and intentions, EC has been included in the conceptual model. In this context, it can be argued that there is a positive relationship between EC and I [Venkatesh and Morris 2000].
H5: Enjoyment (E) affects the Perceived Ease of Use (PEOU) to drive Electric Vehicles in last-mile parcel delivery.	Enjoyment refers to the degree to which individuals perceive the use of technology as enjoyable. In recent years, the notion of deriving pleasure from the use of emerging technologies has been recognized as an important factor [Lee et al. 2019]. Previous studies have shown mixed findings regarding the relationship between E and PU [Mun and Hwang 2003]. In this context, the current study has included the relationship between E and PU in the conceptual model to examine the association between these variables.
H6: Enjoyment (E) affects the Intention (I) to drive Electric Vehicles in last-mile parcel delivery.	It is known that individuals' beliefs about the enjoyment of new technologies influence PU through PEOU [Venkatesh 2000]. Therefore, in line with this understanding, Enjoyment (E) has been included in the conceptual model, assuming that it will have a direct and indirect relationship with PEOU [Mun and Hwang 2003, Lee et al. 2019]. In this context, the current study focuses on the relationship between PU and PEOU through the variable of Enjoyment in the context of electric vehicle (EV) drivers.
H7: Perceived Ease of Use (PEOU) affects the Perceived Usefulness (PU) to drive Electric Vehicles in last-mile parcel delivery.	In studies conducted within the TAM framework, the existence of a relationship between enjoyment and intention has been observed [Lee et al. 2019]. It is stated that Enjoyment positively influences individuals' intention to use technology [Davis et al. 1992, Venkatesh 2000]. In the current study, Enjoyment has been included in the conceptual model, considering its potential impact on drivers' intentions to use EVs.
H8: Perceived Ease of Use (PEOU) affects Attitude Towards Use (AT) to drive Electric Vehicles in last-mile parcel delivery. *H9: Perceived Usefulness (PU) affects Attitude Towards Use (AT) to drive Electric Vehicles in last-mile parcel delivery.*	As mentioned in the previous paragraph, PEOU represents the degree to which an individual believes that using a particular technology will require less effort. In this context, it is assumed that the belief in less effort will also influence PU. Previous studies have provided evidence for the existence of this relationship [Davis 1989, Wu et al. 2019].
H10: Attitude Towards Use (AT) affects Intention (I) to drive Electric Vehicles in last-mile parcel delivery.	Attitude Towards Use (AT) is related to individuals' positive or negative perceptions of new technologies. The most important determinants of AT towards technology usage are PU and PEOU. Previous studies have explained individuals' attitudes towards technological innovations through the variables of perceived usefulness and perceived ease of use [Cai et al., 2021]. In this context, it is expected that drivers' beliefs that using EVs in LMD processes will enhance their performance and will positively influence their attitude towards use. Additionally, drivers' beliefs that they will exert less effort in urban traffic are expected to positively impact their attitude [Wu et al. 2019]. Based on this information, hypotheses H8 and H9 have been formulated.

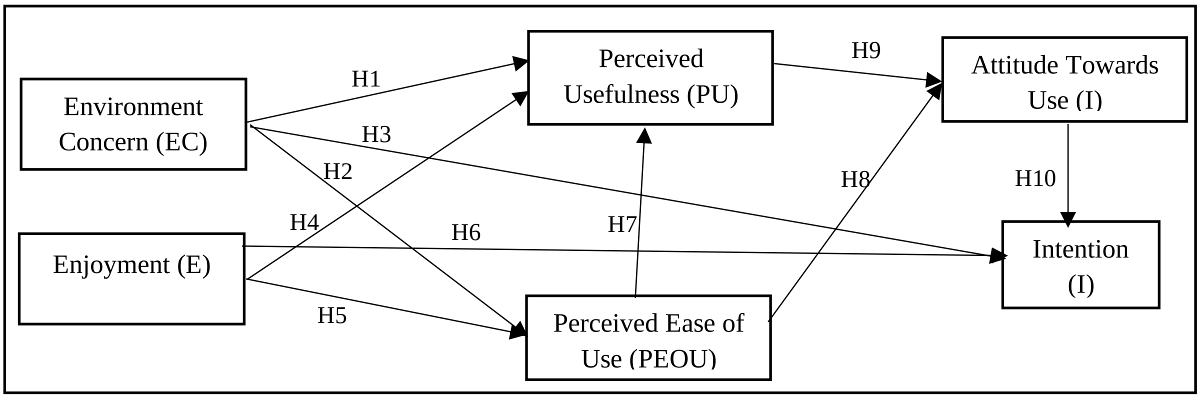

Fig. 1. Proposed Research Model.

RESEARCH METHODOLOGY AND DATA ANALYSIS

The authors created an online survey to collect data in order to empirically test the theoretical model and hypotheses. PLS-SEM was used to evaluate the measurement and structural models and test the assumed relationships between constructs. A 5-point Likert scale was used for responses, ranging from 1 = 'Strongly Disagree' to 5 = 'Strongly Agree'. The survey questions were developed in accordance with the items used in TAM studies. Sample data was collected in 2022 via online and face-to-face interviews. This study targeted drivers residing in Turkiye and working in different carrier firms who were involved in the LMD processes by driving vehicles. There are no formal statistics about the total number of drivers involved in the relevant processes. For this reason, the authors built samples using the most known 6 carrier firms working for B2C deliveries and a total of 180 responses were obtained. The findings obtained from the relevant participants are stated below.

Table 3. Descriptive Statistics of Respondents

Age	**No**	**%**
Under 21	30	16.7
21-29	105	58.3
30-39	25	13.9
40-49	15	8.3
50-59	-	-
60 and over	5	2.8
Total	**180**	**100**
Gender	**No**	**%**
Male	165	91.7
Female	15	8.3
Total	**180**	**100**
Income	**No**	**%**
5500 ₺ and under	40	22.2
5500 ₺ -7500 ₺	45	25
7501 ₺-9500 ₺	20	11.1
9501 ₺-11500₺	35	19.4
11501 ₺ and over	40	22.2
Total	**180**	**100**
Education	**No**	**%**
Middle school	20	11.1
High school	80	44.4
Vocational school	30	16.7
4-year College Degree	30	16.7
Master's degree	20	11.1
Total	**180**	**100**

Table 3 presents the demographic characteristics of the participants in the study. The fact that only 8.3% of the participants were female can be explained by the predominance of male drivers in the industry. It can be inferred that young carriers are preferred in activities such as last-mile logistics, as 75% of the participants were below the age of 30. When examining the educational degrees of the participants, it can be observed that individuals with a high school diploma constitute the majority, accounting for 44%.

Table 4. Convergent validity, construct and indicator reliabilities

Items	Source adapted	Factor Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
EC1 I think that drivers are responsible for the use of e-vehicles (EVs) in parcel delivery processes for environmental sustainability.	Wu *et al.*, 2019; Müller, 2019; Wang *et al.*, 2020	0.853	0.755	0.859	0.670
EC2 I think that environmental problems have become more serious due to the use of internal combustion engines.	Wu *et al.*, 2019; Müller, 2019; Wang *et al.*, 2020	0.815			
EC3 I consider the environmental consequences when choosing the delivery vehicle type in parcel delivery processes.	Wu *et al.*, 2019; Müller, 2019; Wang *et al.*, 2020	0.328			
EC4 I think we should live in harmony with the environment by using EVs in last-mile parcel delivery processes to ensure sustainability.	Wu *et al.*, 2019; Müller, 2019; Wang *et al.*, 2020	0.785			
E1 Driving the EVs to be enjoyable in last-mile parcel delivery.	Lee *et al.*, 2019; Mun & Hwang 2003; Venkatesh, 2000	0.804	0.756	0.862	0.678
E2 Driving the EVs is pleasant in last-mile parcel delivery.	Lee *et al.*, 2019; Mun & Hwang 2003; Venkatesh, 2000	0.934			
E3 I have a fun driving the EVs in last-mile parcel delivery.	Lee *et al.*, 2019; Mun & Hwang 2003; Venkatesh, 2000	0.719			
PU1 Driving the EVs improves my performance in last-mile parcel delivery.	Venkatesh, 2000; Michels *et al.*, 2021	0.783	0.869	0.910	0.718
PU2 Driving the EVs.increases my productivity in last-mile parcel delivery.	Venkatesh, 2000; Michels *et al.*, 2021	0.923			
PU3 Driving the EVs enhances my effectiveness in last-mile parcel delivery.	Venkatesh, 2000; Michels *et al.*, 2021	0.769			
PU4 I find the EVs to be useful in last mile parcel delivery.	Venkatesh, 2000; Michels *et al.*, 2021	0.903			
PEOU1 My interaction with the EVs is clear and understandable.	Venkatesh, 2000; Michels *et al.*, 2021; Davis *et al.*, 1989	0.898	0.865	0.908	0.714
PEOU2 Interacting with the EVs does not require a lot of my mental effort.	Venkatesh, 2000; Michels *et al.*, 2021; Davis *et al.*, 1989	0.804			
PEOU3 I find the EVs to be easy to drive in last-mile parcel delivery.	Venkatesh, 2000; Michels *et al.*, 2021; Davis *et al.*, 1989	0.892			
PEOU4 I find it easy to drive the EVs to do what I want it to do.	Venkatesh, 2000; Michels *et al.*, 2021; Davis *et al.*, 1989	0.779			
AT1 I like driving EVs in last-mile parcel delivery.	Cai et al., 2021; Davis *et al.*, 1989	0.905	0.869	0.920	0.793
AT2 I prefer driving EVs in last-mile parcel delivery.	Cai et al., 2021; Davis *et al.*, 1989	0.826			
AT3 I am glad that I have the option of driving the EVs in last-mile parcel delivery.	Cai et al., 2021; Davis *et al.*, 1989	0.937			
I1 I intend to drive EVs in last-mile parcel delivery.	Venkatesh, 2000; Davis *et al.*, 1989; Lee et al., 2019	0.942	0.898	0.937	0.831
I2 I predict that I would drive EVs in last-mile parcel delivery.	Venkatesh, 2000; Davis *et al.*, 1989; Lee et al., 2019	0.867			
I3 I will drive EVs for last-mile parcel delivery in future	Venkatesh, 2000; Davis *et al.*, 1989; Lee et al., 2019	0.925			

The measurement model was tested for internal consistency and for convergent and discriminant validity. The measurement items have demonstrated high levels of internal consistency reliability. These values are shown in Table 4. The Cronbach's Alpha values, which are recommended to be above 0.70, range from 0.755 to 0.898. The composite reliability values, also recommended to be above 0.70, range from 0.859 to 0.937. The factor loadings values, recommended to be above 0.70, range from 0.719 to 0.942. The AVE (Average Variance Extracted) values, recommended to be above 0.50, range from 0.670 to 0.831. In conclusion, all variables in the proposed research model are reliable and valid in terms of reliability and validity [Hair et al. 2011, Fornell and Larcker 1981, Hair et al. 2020, Sarstedt et al. 2022].

Table 5: Discriminant Validity Analysis based on Fornell-Larcker Criterion

Items	**AT**	**E**	**EC**	**I**	**PEOU**	**PU**
AT	0.890					
E	0.716	0.842				
EC	0.667	0.610	0.884			
I	0.875	0.725	0.738	0.912		
PEOU	0.826	0.613	0.591	0.772	0.845	
PU	0.722	0.729	0.577	0.637	0.550	0.848

After conducting reliability and validity analysis of the research, a correlation analysis was performed using the Fornell-Larcker criteria. Correlation analysis provides information about the strength and direction of relationships between variables. The Fornell-Larcker criteria table is constructed by taking the square root of the AVE values. The results are shown in Table 5. As can be seen, the variables meet the requirement of having the highest correlation with themselves. The values in the Fornell-Larcker criteria table are consistent with the literature [Hair et al. 2020, Hair et al. 2011, Fornell and Larcker 1981, Hair et al. 2019].

Table 6. Outputs of Structural Model

Hypothesis	**Relation**	**Path Coefficient**	**t value**	**p value**	**<0.05 Hypothesis supported?**
H1	EC→PU*	0.045	0.384	0.701	Not Supported
H2	EC→PEOU***	0.447	3.719	0.000	Supported
H3	EC→I**	0.296	3.434	0.001	Supported
H4	E→PU***	0.594	6.434	0.000	Supported
H5	E→PEOU**	0.304	2.650	0.008	Supported
H6	E→I*	0.084	1.232	0.218	Not Supported
H7	PEOU→PU*	0.161	1.733	0.083	Not Supported
H8	PEOU→AT***	0.612	7.230	0.000	Supported
H9	PU→AT***	0.387	4.202	0.000	Supported
H10	AT→I***	0.621	8.283	0.000	Supported

Note: *p < .10; **p < .01; *** p < .001.

The research results are shown in Table 6. The hypothesized model was estimated based on bootstrapping. Of the 10 relationships tested, 7 were found to be significant at $p <0.5$. EC had no influence on PU ($\beta = 0.045$, $p > 0.5$). EC had a positive effect on PEOU ($\beta = 0.447$, $p < 0.5$). EC had a positive effect on I ($\beta = 0.296$, $p < 0.5$). In addition, E had a positive effect on PU ($\beta = 0.594$, $p < 0.5$). E had a positive effect on PEOU ($\beta = 0.304$, $p < 0.5$). E had no influence on I ($\beta = 0.084$, $p > 0.5$). PEOU had no influence on PU ($\beta = 0.161$, $p > 0.5$). PEOU had a positive effect on AT ($\beta = 0.612$, $p <0.5$). Finally, PU had a positive effect on AT ($\beta = 0.387$, $p <0.5$). AT had a positive effect on I ($\beta = 0.621$, $p <0.5$). The analyses indicate that parallel results were obtained with the PU and PEOU literature (Davis et al., 1992: Davis, 1989). The H1, H6 and H7 hypotheses were not supported. However, as can be seen in Table 7, AT fully mediated between PEOU and I. In this context, an indirect effect is observed between PEOU and I. In addition, an indirect effect is observed between EC and AT. However, as can be seen in Table 7, and PEOU was fully mediated between EC and AT.

Table 7. Indirect Effects

Relation	Path Coefficient	t value	p value
PEOU→AT→I***	0.380	5.812	0.000
EC→ PEOU→AT**	0.274	3.130	0.002

Note: *p <.10; **p <.01; *** p <.001.

The R^2 and $Radj^2$ values are presented in Table 8. Since the active use of electric vehicle technology in logistics processes is not widespread, the analysis of factors influencing drivers' usage intention was the focus of the research. Therefore, the R^2 and $Radj^2$ values related to intention were examined. The R^2 value for intention was found to be 0.856, and the $Radj^2$ value was 0.851.

Table 8: R^2 Values of Variables

Items	**R^2**	**$Radj^2$**
PU	0.542	0.526
PEOU	0.477	0.465
AT	0.787	0.782
I	0.856	0.851

Based on the R^2 value, it can be inferred that a significant portion of the factors influencing drivers' intention to use electric vehicles in the LMD process has been included in the research, considering the absence of active use. The analysis of the research model is shown in Figure 2 as the output of Smart PLS 4. Factor loadings and T statistics are important factors in reliability and validity analysis. Figure 2 illustrates the sub-dimensions of the variables and their corresponding factor loadings. Additionally, it presents the path coefficient (β) values and p-values indicating the acceptance of the research hypotheses. Finally, the summary includes the explanation percentages for the mediating and dependent variables, along with the R^2 values. A significant relationship was not found between EC and PU, E and I, and PEOU and PU, while all other hypotheses were accepted ($p < .05$).

CONCLUSIONS

Research shows that approximately 95% of parcel deliveries cover distances below 100 miles, which can be served effectively by zero-emission electric vehicles. The use of electric vehicles in the LMD, which presents various challenges in terms of energy efficiency and reducing environmental impact, is expected to have a revolutionary impact on reducing carbon footprints. In this context, identifying and understanding the factors that influence consumer acceptance, which is a determinant of market success, is of great importance for this technology. There are limited studies on factors influencing user acceptance in the literature, as well as a lack of research specifically focusing on factors influencing driver acceptance. This study examines the factors influencing driver acceptance of electric vehicles for LMD within the framework of the TAM. In addition to the core TAM variables, this study incorporates the independent variables of environmental concern and enjoyment. This research is the first to investigate the factors influencing driver acceptance of electric vehicle technology in parcel delivery specifically in Turkiye using the TAM framework.

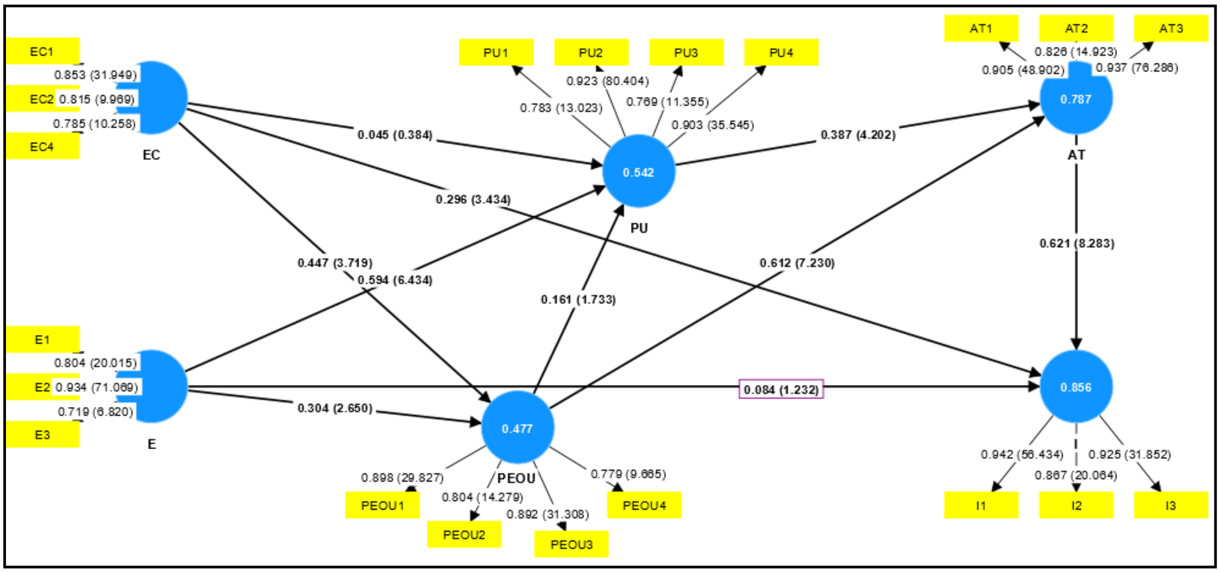

Fig. 2. PLS analysis results.

The findings of this study show that there is no direct significant and positive relationship between environmental concern and perceived usefulness. Similarly, there is no significant relationship between perceived ease of use and perceived usefulness of electric vehicle drivers. Additionally, the lack of a significant relationship between enjoyment and intention indicates that drivers may have different motivations in the delivery process rather than hedonic pleasures. The other hypotheses of the study have positive and significant relationships. When examining the indirect effects of environmental concern and perceived ease of use, it suggests that drivers may need time to fully embrace electric vehicles. As previously stated, due to the low rate of active usage, the focus of the current research is on drivers' intention to use electric vehicles. The relationships between the key factors influencing drivers' active usage (AT and I), parallel results with the literature are obtained. Therefore, identifying the factors influencing the use of electric vehicles will provide insights to future private institutions, organizations, and policymakers operating in this field.

Undoubtedly, the increasing integration and automation efforts among relevant parties, as well as the adaptation of vehicles for large-scale shipments, will contribute to the increased use of electric vehicles. In this context, technical issues related to electric vehicle delivery, as well as traffic regulations, should be planned soon, and real-life tests and pilot programs should be accelerated and expanded. Future studies can analyze urban logistics structures in different cities, evaluate the rationality of using relevant vehicles, assess the location selection for charging stations, and identify factors influencing user acceptance of this technology in different countries to make comparisons. Additionally, it should be noted that this study was limited to Turkiye, thus conditions in other countries may yield different findings. It should be acknowledged that the use of electric vehicles in the last-mile delivery process is still in the testing phase. As electric vehicles become more widely utilized in relevant processes, different factors can be added to the model or research can be expanded using different models.

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REFERENCES

Ajzen, I. 1991, The theory of planned behavior. Organizational behavior and human decision processes, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T.

Allen, J., Piecyk, M., Piotrowska, M., McLeod, F., Cherrett, T., Ghali, K., ... & Austwick, M. 2018, Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London. Transportation Research Part D: Transport and Environment, 61, 325-338. https://doi.org/10.1016/j.trd.2017.07.020.

Anosike, A., Loomes, H., Udokporo, C. K., & Garza-Reyes, J. A. 2021, Exploring the challenges of electric vehicle adoption in final mile parcel delivery. International Journal of Logistics Research and Applications, 1-25. https://doi.org/10.1080/13675567.2021.1978409.

Asdecker, B. 2021, Building the E-commerce supply chain of the future: what influences consumer acceptance of alternative places of delivery on the last-mile. Logistics, 5(4), 90. https://doi.org/10.3390/logistics5040090.

Assmann, T., Bobeth, S., & Fischer, E. 2019, A conceptual framework for planning transhipment facilities for cargo bikes in last mile logistics. In Data Analytics: Paving the Way to Sustainable Urban Mobility: Proceedings of 4th Conference on Sustainable Urban Mobility (CSUM2018), 24-25 May, Skiathos Island, Greece (575-582). Springer International Publishing. https://doi.org/10.1007/978-3-030-02305-8_69

Balaska, V., Tsiakas, K., Giakoumis, D., Kostavelis, I., Folinas, D., Gasteratos, A., & Tzovaras, D. 2022, A Viewpoint on the Challenges and Solutions for Driverless Last-Mile Delivery. Machines, 10(11), 1059. https://doi.org/10.3390/machines10111059.

Boysen, N., Fedtke, S., & Schwerdfeger, S. 2021, Last-mile delivery concepts: a survey from an operational research perspective. Or Spectrum, 43, 1-58. https://doi.org/10.1007/s00291-020-00607-8.

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, 101789. https://doi.org/10.1016/j.techsoc.2021.101789

Carbone, V., Rouquet, A., & Roussat, C. 2017, The rise of crowd logistics: a new way to co-create logistics value. Journal of Business Logistics, 38(4), 238-252. https://doi.org/10.1111/jbl.12164.

Christensen, L., Klauenberg, J., Kveiborg, O., & Rudolph, C. 2017, Suitability of commercial transport for a shift to electric mobility with Denmark and Germany as use cases. Research in Transportation Economics, 64, 48-60. https://doi.org/10.1016/j.retrec.2017.08.004.

Davis, F. D. 1989, Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 13(3), 319-340. https://doi.org/10.2307/249008.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. 1992, Extrinsic and intrinsic motivation to use computers in the workplace 1. Journal of applied social psychology, 22(14), 1111-1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. 1989, User acceptance of computer technology: A comparison of two theoretical models. Management science, Vol. 35, No. 8, 982-1003. https://www.jstor.org/stable/2632151.

De Mello Bandeira, R. A., Goes, G. V., Gonçalves, D. N. S., Márcio de Almeida, D. A., & de Oliveira, C. M. 2019, Electric vehicles in the last mile of urban freight transportation: A sustainability assessment of postal deliveries in Rio de Janeiro-Brazil. Transportation Research Part D: Transport and Environment, 67, 491-502. https://doi.org/10.1016/j.trd.2018.12.017.

Devari, A., Nikolaev, A. G., & He, Q. 2017, Crowdsourcing the last mile delivery of online orders by exploiting the social networks of retail store customers. Transportation Research Part E: Logistics and Transportation Review, 105, 105-122. https://doi.org/10.1016/j.tre.2017.06.011.

Dorling, K., Heinrichs, J., Messier, G. G., & Magierowski, S. 2016, Vehicle routing problems for drone delivery. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 47(1), 70-85. https://doi.org/10.1109/TSMC.2016.2582745

Dudenhöffer, K. 2013, Why electric vehicles failed: An experimental study with PLS approach based on the Technology Acceptance Model. Journal of Management Control, 24(2), 95-124. https://doi.org/10.1007/s00187-013-0174-2

Guo, F., Yang, J., & Lu, J. 2018, The battery charging station location problem: Impact of users' range anxiety and distance convenience. Transportation Research Part E: Logistics and Transportation Review, 114, 1-18. https://doi.org/10.1016/j.tre.2018.03.014.

Ha, H. Y., & Janda, S. 2012, Predicting consumer intentions to purchase energy-efficient products. Journal of Consumer Marketing, 29(7), 461-469. https://doi.org/10.1108/07363761211274974

Hair Jr, J. F., Howard, M. C., & Nitzl, C. 2020, Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. Journal of Business Research, 109, 101-110. https://doi.org/10.1016/j.jbusres.2019.11.069.

Hair, J. F., Ringle, C. M., & Sarstedt, M. 2011, PLS-SEM: Indeed a silver bullet. Journal of Marketing theory and Practice, 19(2), 139-152. https://doi.org/10.2753/MTP1069-6679190202.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. 2019, When to use and how to report the results of PLS-SEM. European business review, 31(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

Hu, W., Dong, J., Hwang, B. G., Ren, R., & Chen, Z. 2019, A scientometrics review on city logistics literature: Research trends, advanced theory and practice. Sustainability, 11(10 2724. https://doi.org/10.3390/su11102724

Jacobs, K., Warner, S., Rietra, M., Mazza, L., Buvat, J., Khadikar, A., S. Cherian & Khemka, Y. 2019, The last-mile delivery challenge. Capgemini Research Institute, 1-40.

Kåresdotter, E., Page, J., Mörtberg, U., Näsström, H., & Kalantari, Z. 2022, First mile/last mile problems in smart and sustainable cities: A case study in Stockholm County. Journal of Urban Technology, 29(2), 115-137. https://doi.org/10.1080/10630732.2022.2033949

Kijewska, K., Konicki, W., & Iwan, S. 2016, Freight transport pollution propagation at urban areas based on Szczecin example. Transportation Research Procedia, 14, 1543-1552. https://doi.org/10.1016/j.trpro.2016.05.119

Kim, Y., & Choi, S. M. 2005, "Antecedents of Green Purchase Behavior: an Examination of Collectivism, Environmental Concern, and Pce", in NA- Advances in Consumer Research Volume 32, eds. Geeta Menon and Akshay R. Rao, Duluth, MN: Association for Consumer Research, Pages: 592-599.

Kulkarni, S. R., & Barge, P. 2020, Effect of COVID-19 on the shift in consumer preferences with respect to shopping modes (Offline/Online) for groceries: an exploratory study. International Journal of Management, 11(10), 581-590. https://doi.org/10.34218/IJM.11.10.2020.055

Lee, J., Kim, J., & Choi, J. Y. 2019, The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. Telematics and Informatics, 39, 37-48. https://doi.org/10.1016/j.tele.2018.12.006

Lim, S. F. W., Jin, X., & Srai, J. S. 2018, Consumer-driven e-commerce: A literature review, design framework, and research agenda on last-mile logistics models. International Journal of Physical Distribution & Logistics Management, 48(3), 308-332. https://doi.org/10.1108/IJPDLM-02-2017-0081

Liu, C., Wang, Q., & Susilo, Y. O. 2019, Assessing the impacts of collection-delivery points to individual's activity-travel patterns: A greener last mile alternative?. Transportation Research Part E: Logistics and Transportation Review, 121 84-99. http://dx.doi.org/10.1016/j.tre.2017.08.007

Macioszek, E. 2018, First and last mile delivery–problems and issues. In Advanced Solutions of Transport Systems for Growing Mobility: 14th Scientific and Technical Conference" Transport Systems. Theory & Practice 2017" Selected Papers (147-154). Springer International Publishing.

Mangiaracina, R., Perego, A., Seghezzi, A., & Tumino, A. 2019, Innovative solutions to increase last-mile delivery efficiency in B2C e-commerce: a literature review. International Journal of Physical Distribution & Logistics Management. 49(9), 901-920. https://doi.org/10.1108/IJPDLM-02-2019-0048

Michels, M., von Hobe, C. F., von Ahlefeld, P. W., & Musshoff, O. 2021, An extended technology acceptance model for the adoption of drones in German agriculture. In Precision agriculture'21, 206-216. Wageningen Academic Publishers. https://doi.org/10.3920/978-90-8686-916-9

Minton, A. P., & Rose, R. L. 1997, The effects of environmental concern on environmentally friendly consumer behavior: An exploratory study. Journal of Business research, 40(1), 37-48. https://doi.org/10.1016/S0148-2963(96)00209-3

Moshref-Javadi, M., Hemmati, A., & Winkenbach, M. 2020, A truck and drones model for last-mile delivery: A mathematical model and heuristic approach. Applied Mathematical Modelling, 80, 290-318. https://doi.org/10.1016/j.apm.2019.11.020

Mun, Y. Y., & Hwang, Y. 2003, Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. International Journal of Human-Computer Studies, 59(4), 431-449. https://doi.org/10.1016/S1071-5819(03)00114-9

Müller, J. M. 2019, Comparing technology acceptance for autonomous vehicles, battery electric vehicles, and car sharing—A study across Europe, China, and North America. Sustainability, 11(16), 4333. https://doi.org/10.3390/su11164333

Murray, C. C., & Chu, A. G. 2015, The flying sidekick traveling salesman problem: Optimization of drone-assisted parcel delivery. Transportation Research Part C: Emerging Technologies, 54, 86-109. https://doi.org/10.1016/j.trc.2015.03.005

Ngoc, A. M., Nishiuchi, H., & Nhu, N. T. 2023, Determinants of carriers' intentions to use electric cargo vehicles in last-mile delivery by extending the technology acceptance model: a case study of Vietnam. The International Journal of Logistics Management, 34(1), 210-235. https://doi.org/10.1108/IJLM-12-2021-0566

Nicolaides, D., Cebon, D., & Miles, J. 2017, Prospects for electrification of road freight. IEEE Systems Journal, 12(2), 1838-1849. https://doi.org/10.1109/JSYST.2017.2691408

Oliveira, C., Bandeira, R., Goes G., Gonçalves D., and D'Agosto, M. 2017, "Sustainable Vehicles-based Alternatives in Last Mile Distribution of Urban Freight Transport: A Systematic Literature Review". Sustainability, 9, 1324. https://doi.org/10.3390/su9081324

Osakwe, C. N., Hudik, M., Říha, D., Stros, M., & Ramayah, T. 2022, Critical factors characterizing consumers' intentions to use drones for last-mile delivery: Does delivery risk matter?. Journal of Retailing and Consumer Services, 65, 102865. https://doi.org/10.1016/j.jretconser.2021.102865

Park, H., Park, D., & Jeong, I. J. 2016, An effects analysis of logistics collaboration in last-mile networks for CEP delivery services. Transport Policy, 50, 115-125. https://doi.org/10.1016/j.tranpol.2016.05.009

Punakivi, M., & Tanskanen, K. 2002, Increasing the cost efficiency of e-fulfilment using shared reception boxes. International Journal of Retail & Distribution Management, 30(10), 498-507. https://doi.org/10.1108/09590550210445362

Quak, H., Nesterova, N., & Van Rooijen, T. 2016, Possibilities and barriers for using electric-powered vehicles in city logistics practice. Transportation Research Procedia, 12, 157-169. https://doi.org/10.1016/j.trpro.2016.02.055

Ranieri, L., Digiesi, S., Silvestri, B., & Roccotelli, M. 2018, A review of last mile logistics innovations in an externalities cost reduction vision. Sustainability, 10(3), 782. https://doi.org/10.3390/su10030782

Reyes, D., Savelsbergh, M., & Toriello, A. 2017, Vehicle routing with roaming delivery locations. Transportation Research Part C: Emerging Technologies, 80, 71-91. https://doi.org/10.1016/j.trc.2017.04.003

Saldaña, G., San Martín, J. I., Zamora, I., Asensio, F. J., & Oñederra, O. 2019, Analysis of the current electric battery models for electric vehicle simulation. Energies, 12(14), 2750. https://doi.org/10.3390/en12142750

Sarstedt, M., Hair, J. F., Pick, M., Liengaard, B. D., Radomir, L., & Ringle, C. M. 2022, Progress in partial least squares structural equation modeling use in marketing research in the last decade. Psychology & Marketing, 39(5), 1035-1064. https://doi.org/10.1002/mar.21640

Savelsbergh, M., & Van Woensel, T. 2016, 50th anniversary invited article—city logistics: Challenges and opportunities. Transportation Science, 50(2), 579-590. http://dx.doi.org/10.1287/trsc.2016.0675

Schröder, D. 2017, Utility evaluation of battery electric vehicles in urban distribution, In: Jahn, Carlos Kersten, Wolfgang Ringle, Christian M. (Ed.): Digitalization in Maritime and Sustainable Logistics: City Logistics, Port Logistics and Sustainable Supply Chain Management in the Digital Age. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 24, 215-228. https://doi.org/10.15480/882.1485

Shanmugavel, N., & Micheal, M. 2022, Exploring the marketing related stimuli and personal innovativeness on the purchase intention of electric vehicles through Technology Acceptance Model. Cleaner Logistics and Supply Chain, 3, 100029. https://doi.org/10.1016/j.clscn.2022.100029

Shanmugavel, N., Alagappan, C., & Balakrishnan, J. 2022, Acceptance of electric vehicles: A dual-factor approach using social comparison theory and technology acceptance model. Research in Transportation Business & Management, 45, 100842. https://doi.org/10.1016/j.rtbm.2022.100842

Slabinac, M. 2015, Innovative solutions for a "Last-Mile" delivery–a European experience. 15th international scientific conference Business Logistics in Modern Management, 111-129.

Toraman, Y., & Geçit, B. B. 2023, User Acceptance of Metaverse: An Analysis for e-Commerce in the Framework of Technology Acceptance Model (TAM). Sosyoekonomi, 31(55), 85-104. https://doi.org/10.17233/sosyoekonomi.2023.01.05

Tu, J. C., & Yang, C. 2019, Key factors influencing consumers' purchase of electric vehicles. Sustainability, 11(14), 3863. https://doi.org/10.3390/su11143863

Ulmer, M. W., & Streng, S. 2019, Same-day delivery with pickup stations and autonomous vehicles. Computers & Operations Research, 108, 1-19. https://doi.org/10.1016/j.cor.2019.03.017

Venkatesh, V., & Bala, H. 2008, Technology acceptance model 3 and a research agenda on interventions. Decision sciences, 39(2), 273-315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. 1996, A model of the antecedents of perceived ease of use: Development and test. Decision sciences, 27(3), 451-481. https://doi.org/10.1111/j.1540-5915.1996.tb00860.x

Venkatesh, V., & Davis, F. D. 2000 A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management science, 46(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., & Morris, M. G. 2000, Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. MIS quarterly, 115-139. https://doi.org/10.2307/3250981

Venkatesh, V. 2000, Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. Information systems research, 11(4), 342-365. https://doi.org/10.1287/isre.11.4.342.11872

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. 2003, User acceptance of information technology: Toward a unified view. MIS Quarterly, 2(3), 425-478. https://doi.org/10.2307/30036540

Wang, N., Tian, H., Zhu, S., & Li, Y. (2022). Analysis of public acceptance of electric vehicle charging scheduling based on the technology acceptance model. Energy, 258, 124804. https://doi.org/10.1016/j.energy.2022.124804

Wang, Y., Wang, S., Wang, J., Wei, J., & Wang, C. 2020, An empirical study of consumers' intention to use ride-sharing services: using an extended technology acceptance model. Transportation, Vol. 47, 397-415. https://doi.org/10.1007/s11116-018-9893-4

Wang, X., Zhan, L., Ruan, J., & Zhang, J. 2014, How to choose "last mile" delivery modes for e-fulfillment. Mathematical Problems in Engineering, 2014, 417129. https://doi.org/10.1155/2014/417129

Wikström, M., Hansson, L., & Alvfors, P. 2015, An end has a start–investigating the usage of electric vehicles in commercial fleets. Energy Procedia, 75, 1932-1937. https://doi.org/10.1016/j.egypro.2015.07.223

Wu, J., Liao, H., Wang, J. W., & Chen, T. 2019, The role of environmental concern in the public acceptance of autonomous electric vehicles: A survey from China. Transportation Research Part F: Traffic Psychology and Behaviour, 60, 37-46. https://doi.org/10.1016/j.trf.2018.09.029

Serdar Alnipak ORCID ID: https://orcid.org/0000-0002-5722-9960
International Trade and Logistics Department,
Nisantasi University, İstanbul, **Turkey**
e-mail: serdar.alnipak@nisantasi.edu.tr

Yavuz Toraman   ORCİD ID: https://orcid.org/0000-0002-5196-1499
Vocational School Foreign Trade Programme,
Nisantasi.University, İstanbul, **Turkey**
e-mail: yavuz.toraman@nisantasi.edu.tr