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# PARCEL LOCKERS: A NOVEL APPROACH TO DELIVERY IN THE TURKISH POSTAL SECTOR

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## *Özet*

Günümüzde posta sektörü, haberleşme gönderileri tabanlı bir anlayıştan posta kolisi/kargosu merkezli bir anlayışa doğru evrilmiştir. Dinamik teknoloji sürecinin posta sektörüne sirayet etmesi ile birlikte yeni teknoloji odaklı teslimat hizmetleri ortaya çıkmıştır. Bu makale posta hizmetlerine ilişkin yeni iş modellerinin ortaya çıkmasının yanı sıra alternatif teslimat modellerinde teknolojik gelişim sürecinin posta sektörüne etkisini göstermeyi amaçlamaktadır. Ayrıca dijitalleşme ve teknoloji ile birlikte farklı teslimat modellerinin birbiriyle etkileşimi sonucu söz konusu bu yeni teknolojik teslimat modellerinin tüketiciye ve çevreye yansıması değerlendirilecektir. Bu çalışma, teknoloji odaklı teslimat hizmetlerinin sınıflandırılması ve yakın dönemde yaygınlık kazanması muhtemel alternatif teslimat hizmetleri hakkında bilgi vermeyi amaçlamaktadır. Son olarak söz konusu çalışmada, yeni teknolojilerin posta gönderileri teslimatına entegre edilmesi ile birlikte teslimat sürelerinin kısalması, posta gönderilerinin geniş çaplı bir bölgede son kullanıcıya ulaşımının sağlanması, ekolojik dengenin korunması vb. amaçların neler olduğuna ilişkin genel bir değerlendirme yapılacaktır.

**Anahtar Kelimeler:** *Posta Sektörü, Haberleşme, Dijitalleşme, Teknoloji*

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## *Abstract*

In today's world, the postal sector has transitioned from a letter posts-based understanding to a parcel/cargo-centric approach. The advent of dynamic technological processes has led to the emergence of new technology-focused delivery services in the postal sector. This article aims to demonstrate the impact of technological advancements in alternative delivery models in the postal sector, alongside the emergence of new business models for postal services. Furthermore, the interaction of different delivery models with digitization and technology will be evaluated in terms of their implications for consumers and the environment. This study aims to provide insights into the classification of technology-focused delivery services and potential alternative delivery services likely to gain prevalence in the near future. Lastly, a general assessment will be made regarding the integration of new technologies into postal deliveries, aiming at shorter delivery times, widespread access to postal deliveries in a large area, ecological balance maintenance, etc.

**Keywords:** *Postal Sector, Communication, Digitalization, Technology*

## INTRODUCTION

This study offers a general overview of current developments in delivery services in the postal sector and research on technological business models affecting consumers, the main actors in delivery services. The article highlights the importance of technological advancements in the evolution and development of the postal sector, and presents some examples of new technology-based delivery models. It is considered highly important in assessing the impact of digitalization and the technology process on the postal market and the strategic position of the postal sector.

The primary objective of writing this article is to evaluate how future technological developments will affect the postal sector and changes in delivery services in the short and long term, impacting consumers and ecological balance. The study aims to reveal the motives of stakeholders in the postal sector, the common benefits for all stakeholders, the advantages and disadvantages of technology-based new delivery services for both postal service providers and end-users, and how legal regulations and necessary conditions will be provided.

In this context, it would be highly beneficial to determine the motives behind postal service providers' delivery services, common benefits for all stakeholders in the sector, and the advantages and disadvantages of technology-based new delivery services for both postal service providers and end-users.

This study aims to examine the significant transformation of delivery services in the postal sector alongside the growing prominence of e-commerce. The evaluation of the current landscape of alternative delivery services initiated by postal service providers due to the growth of e-commerce will be conducted. Research will be conducted on what technology-based alternative delivery services are, how necessary conditions will be provided, and what challenges are encountered. Subsequently, a brief overview will be provided of the process regarding alternative delivery services that have started to be used in the Turkish postal sector and the legal regulations. Finally, the study will be concluded with a general assessment of the use of new technologies in delivery services in the postal sector.

## THE NEW DELIVERY SERVICE TECHNOLOGIES IN THE POSTAL SECTOR

Technology and digitization have instigated profound transformations in the postal sector, akin to numerous other industries. In tandem with advancing technology, companies operating within the postal sector have pursued digitization in delivery services to curtail costs and adapt to the evolving world. The technology employed in final-stage delivery services has not only mitigated labor costs for firms but has also facilitated swifter and more adaptable deliveries. One of the pivotal aspects of integrating new technologies into the postal sector for companies has been ensuring consumer satisfaction in delivery services. Companies engaged in the postal sector have embarked on a quest for technology-based novel alternative models to enhance service quality, consumer satisfaction, and cost reduction. The application of new technologies in the postal sector has materialized in two critical domains: logistics activities for companies and delivery services. To scrutinize the impact of alternative delivery models on consumer satisfaction in final-stage delivery services, it would be highly advantageous to initially delve into delivery services in the postal sector.

## DELIVERY SERVICES IN POSTAL SECTOR

The postal sector encompasses one of the oldest and most widespread means of communication, forming the main framework of postal services. The main stages of postal services include collection, sorting, transportation, and delivery services. This study will focus on delivery services, the final stage of the provision of postal services. Traditional delivery methods used in delivery services, the most important aspect of the provision of postal services, have undergone significant changes due to technological advancements and the increasing volume of e-commerce shipments.

The key factors influencing this change include a decrease in letter posts and an increase in demand for parcel mail, technological advancements, changes in organizational forms, and the increased use of electronic devices in delivery services in line with technology.

Postal services play a fundamental role in every country due to the social and

economic impact they generate. Delivery services in the postal sector emerge as a vital component of countries economic and communication infrastructure, serving as an indispensable element for communication and trade. In recent years, there has been increasing interest in how technology and digitalization can affect the development of postal services. The development of the internet, mobile phones, and communication technology has provided a new dimension to the postal sector. Regarding delivery services in the postal sector, new technologies have played a significant role in making postal services customer-centric. With new technology-based delivery models, consumers are not only better informed about the status of their deliveries through tracking but also have the option to redirect a postal shipment to a different delivery point or postpone delivery if they are not at home (Otsetova, 2018).

Although there are various classifications of postal shipments, we can generally divide postal shipments into two main groups: letter posts and cargo or parcels. The development process of parcel mail delivery within the postal service definition is much more dynamic than letter posts due to the highly competitive market and the rapid growth of e-commerce. Operational efficiency in parcels, considering the use of technology, plays a significant role. However, the demand for new and improved services is also an essential driving force for postal service providers to modernize and upgrade their technologies, including information technology (Hillebrand, 2016). From this perspective, a significant consideration in integrating new technologies into the postal sector is the delivery services of parcels.

Looking at the European perspective, the traditional postal supply chain consists of an end-to-end system. According to 97/67/EC under the European Postal Services Directive, we can say that the postal supply chain consists of four stages: customs clearance, sorting, inter-city transportation, and delivery services. Customs clearance involves collecting postal shipments through various methods for distribution. Shipments are sorted at the distribution center based on homogeneous groups (product, form, and destination). Then the shipments are transported to the distribution center in the destination area. As shipments approach the target center, they are sorted again and directed to the relevant location. In the final stage, postal shipments are delivered to customers through various methods (Zurel & Scorca, 2020).

Delivery services are one of the most crucial activities in delivering postal shipments to recipients. Modernizing delivery systems is essential for effectively responding to unforeseen adverse situations according to user preferences. The application of new technologies for this purpose is a suitable solution due to the numerous possibilities it offers. The integration of these technology-based models into the system will be highly beneficial for the postal sector (Lazarević & Dobrodolac, 2020).

Time is a critical factor in the development of postal services. Technology now has a significant impact on various stages of the postal process, such as sorting and distribution operations. For example, barcodes facilitate the expedited sorting of postal products as they can be automatically categorized. Similarly, the use of information and communication technologies in the provision of postal services is a potential source of productivity. Digital tools, although not replacing traditional delivery services in the postal sector, can enhance process efficiency and flexibility while reducing operational costs. This is possible with the entry of alternative delivery models into the sector through new technology (Perekhozhikh, 2022).

Last-mile delivery services constitute the most costly part of the postal supply chain. The growth of online shopping via the internet and the consequent shift from delivery to retail stores to home delivery for customers have increased the number of delivery vehicles in residential areas. This has led to increased congestion in residential areas and emissions. Hence, researchers worldwide have embarked on researching alternative delivery methods to reduce the costs and external effects of last-mile delivery services (Schnieder & Hinde, 2021).

By 1950, about one-third of the world's population (less than 1 billion people) lived in urban areas, and by 2050, it is expected that this ratio will increase to two-thirds (more than 6 billion people) (United Nations, 2014). This increased population density has become a significant problem for last-mile delivery services. In terms of consumer preferences, the increasing preference for home delivery by consumers poses a significant concern for postal service providers. The growth in e-commerce and the increasing preference for home delivery have led to the differentiation of last-mile delivery services (Zurel & Scorca, 2020).

The transformation of traditional delivery services in the postal sector is also influenced by concerns about maintaining ecological balance. The pursuit of

more environmentally friendly alternative delivery services in order to ensure a sustainable clean environment has gained momentum.

The Universal Postal Union (UPU) plays a key role in regulating postal service providers globally by issuing strategic regulations in the operation of postal activities. UPU initiated an "Environmental Protection Program" in 1994 by establishing a Working Group to find solutions to environmental issues. Simultaneously, it established a "Sustainable Development Project Group" to implement sustainable development initiatives (UPU, 2023).

In light of the strategies implemented by UPU and previous steps taken, many postal service providers have begun to implement the global mission of sustainable development through proactive sustainable development strategies focusing on environmental, social, and economic activities at all levels of postal operations. At the 26th UPU Congress held in İstanbul in 2016, the topic of sustainable development was also discussed. Member countries and some postal service providers committed to adopting and implementing a proactive sustainable development strategy that focuses on environmental, social, and economic activities at all levels of postal operations and promotes awareness of sustainable development. National postal service providers selected within this scope are expected to make their products and services more environmentally friendly as much as technology and resources allow. In this context, selected postal service providers should encourage the recycling of paper and other materials in production and the use of recycled materials. Various criteria like these have contributed to the idea of developing environmentally friendly new technology-focused alternative delivery models (UPU, 2016).

Additionally, it is crucial for communication technology developments to feed postal sector resources and systems to ensure a greener environment. Integrating new technologies such as hardware and software virtualization into the postal sector is essential. Therefore, taking these technological steps will also allow the configuration of powerful yet outdated and energy-inefficient computers currently in use. Moreover, increasing energy efficiency, acquiring new efficient machines to reduce noise, and launching more sophisticated new electronic devices are of great importance to the postal sector. In this context, postal service providers have accelerated their efforts to respond more quickly to customer expectations and integrate their environmentally friendly technologies into the sector.

## NEW DELIVERY SERVICES TECHNOLOGIES

The use of different technologies is not merely an innovation in the postal sector but stands out as factors that enable innovation. Today, in the postal sector, innovative technologies such as lockers, autonomous vehicles, robots, and drones are expected to play more significant roles in the future. The integration of new technologies into delivery services heralds a structural change in the postal sector.

The postal market supply chains are facing disruptive new technological innovations such as enhanced connectivity (geolocation and real-time tracking information), blockchain (verified digital labeling), and artificial intelligence (high-accuracy demand forecasting and smart interfaces). These innovations not only offer efficiency improvements in providing postal services but also provide increased operational model reliability (Zurel & Scorca, 2020).

Considering all these developments, the implementation of new business models in delivery services with the involvement of technology is crucial both in terms of performance metrics and their contributions to the environment. Therefore, it would be highly beneficial to classify new technology-based delivery services to enhance efficiency in the postal sector and examine the components of alternative delivery services and the vehicles used in providing delivery services.

## PARCEL LOCKERS IN LAST-MILE DELIVERY SERVICES: A COMPREHENSIVE REVIEW

The COVID-19 pandemic has accelerated the use of e-commerce due to changes in shopping preferences. The number of e-commerce users in Europe has been increasing rapidly in recent years, and this trend is likely to continue in the near future. Consequently, new delivery models such as lockers installed in public or private areas are emerging (Ambrosini, Bermont-Vialatte, & Lefort, 2023).

While the use of lockers has been prevalent in many parts of the world and Europe for an extended period, they are continuously being revised and improved with the integration of new technologies.

With the widespread adoption of e-commerce, there has been a significant increase in the number of B2C deliveries. Challenges such as difficulty in finding addresses, incomplete and incorrect deliveries, traffic congestion during last-mile

delivery, and environmental pollution have triggered the emergence of alternative delivery models (Lagorio & Pinto, 2020). Solutions such as supervised delivery and delivery to automated points are becoming increasingly common to overcome these challenges.

Parcel lockers can generally be classified into three main categories: public, semi-private, and private. Public lockers include smart lockers located along the street in public areas. Semi-private lockers include smart lockers found at train or metro stations, supermarkets, schools, universities, shopping malls, parking lots, and gas stations. Private lockers are those belonging to private properties such as apartment buildings or complexes, and large companies or office buildings (Senay & Dijk, 2023).

Although technology-based smart lockers are primarily used for parcel or package deliveries, they can also be used for food and medicine deliveries with appropriate equipment such as climate control devices (Buzzega & Novellani, 2021). Lockers, being accessible 24/7, reduce the need to synchronize the delivery times between the customers and the distributors and decrease the rate of failed deliveries (Akdoğan & Özceylan, 2023).

As mentioned above, lockers provide consumers with more flexibility in receiving their packages or shipments due to their accessibility at all times of the day. The use of lockers by courier companies for postal deliveries has allowed multiple parcels to be left at a single stop, enhancing the efficiency of delivery services. Additionally, lockers enable postal service providers to address the issue of lost or stolen deliveries, thus providing a secure and easily accessible solution for both recipients and delivery personnel (Hillebrand, Thiele, & Junk, 2016).

Using lockers for parcel collection and delivery points is seen as a better option compared to home delivery services, especially when demand for such services is not homogeneous. However, if demand for this service is not uniform, the use of lockers, or the service level (number of parcels that can be delivered), may be low (Schnieder & Hinde, 2021). Therefore, it is important for lockers used as delivery points to have a homogeneous structure in terms of weight, volume, and address-specific discrimination.

Furthermore, delivery points and locked delivery cabinet networks are not seen as separate markets in the postal sector. These two alternative delivery meth-

ods are considered substitutes for home delivery services. The proliferation of these points and locked delivery cabinet networks is driven not by demand but by supply. Therefore, future developments in the postal sector largely depend on the investment decisions of the parties involved.

Parcel lockers not only expand the range of applications and functions but also their accessibility to all postal service providers is crucial. In many countries, postal service providers have begun to rely more on lockers and other collection points to deliver mail. In addition to providing greater convenience for consumers, parcel lockers potentially reduce transportation costs and the risk of failed deliveries for postal service providers. Many locked delivery cabinet operators already allow access for relatively third-party postal service providers to deliver parcels. Moreover, in Italy, the Netherlands, the UK, and Türkiye, postal regulatory authorities are reviewing or in the process of reviewing the presence and accessibility of Lockers (Cullen International, 2023).

According to a report published by ERGP in 2023, based on research conducted in ERGP member countries, delivery services through address delivery and smart lockers were reported to be the most preferred delivery methods by consumers. This preference was attributed to the high efficiency of both delivery methods for users. Additionally, it was noted that in cases where address delivery was not possible, consumers preferred to collect their mail from the nearest post office or from smart lockers serving as branch offices (ERGP, 2023).

Several companies providing postal services on a global scale, such as Deutsche Post, PostNord, or the Polish postal service provider InPost, have announced efforts to expand locked delivery cabinet networks. In addition to smart lockers located in public areas in Europe, the development of smart lockers near residential or business addresses is clearly evident (Ambrosini, Bermont-Vialatte, & Lefort, 2023).

In addition to all these assessments; the economic implications of using parcel lockers for both consumers and businesses in Europe and Türkiye remain largely unexplored. Limited data on the cost advantages of parcel lockers for postal service providers, the difficulty in accurately determining the technology's cost, varying levels of technological advancement across countries, and the unquantified benefits for consumers have hindered a comprehensive economic assessment in this article.

After discussing the general functions and uses of lockers, it is worth examining the number of lockers in Europe. The table below provides information on postal service providers using lockers and the number of lockers in European countries published by Cullen International (Cullen International, 2023)

**Table 1.**

**Information on Parcel Lockers Used in Selected European Countries**

| Country | Ownership | Number of Parcel Lockers | Access by Third Parties |
|---|---|---|---|
| **Austria** | Austrian Post | 524 | Yes |
| | A1 | 90 | Yes |
| | MyFlexBox | 360 | Yes |
| **Belgium** | Bpost | 375 | Yes |
| **Czech Republic** | Česká pošta | 9.000 (ParcelShop &Lockers). | No |
| | OX Point | 150 | Yes |
| | Alza | 2.600 | Yes |
| | Zásilkovna | 3.650 | No |
| | PPL | 4.000 (ParcelShop &Lockers). | No |
| | DPD Pickup | 3.000 (ParcelShop &Lockers). | No |
| **Denmark** | Post Danmark | 1.740 | No |
| | Naerboks | 3.194 | No |
| **Finland** | Posti (EHS) | 1.902 | No |
| | Pakettipiste | 600 | Yes |
| **France** | La Poste | 500 | No |
| | Amazon | - | No |
| **Germany** | Deutsche Post DHL | 11.500 | No |
| **Ireland** | An Post | 170 | No |
| **Italy** | Poste Italiane | 350 | No |

| | | | |
|---|---|---|---|
| **Luxembourg** | Post Luxembourg | 133 | No |
| **Netherlands** | PostNL | 500 | Yes |
| | DHL (De Buren) | 109 | Yes |
| **Norway** | Posten Norge | 1.688 | No |
| | PostNord | 1.500 | No |
| | Instabox | 41 | No |
| **Poland** | Poczta Polska | 182 | No |
| | InPost | 20.228 | Yes |
| | DHL | 1.200 | Yes |
| | Allegro | 2.700 | Yes |
| | PKN Orlen | 2.000 | No |
| **Portugal** | CTT | 508 | No |
| **Spain** | Correos | 2.852 | No |
| | Citibox | 22.500 | No |
| | Amazon | 120 | No |
| | SEUR | 500 | No |
| | Cainiao (AliExpress) | 200 | No |
| **Sweden** | PostNord | 1.800 | No |
| | Budbee | 1.628 | No |
| **United Kingdom** | Royal Mail | - | No |
| | Amazon | 5.000 | No |
| | InPost | 4.800 | Yes |

*Source: CULLEN, 2023.*

A review of European examples regarding the use of lockers; Germany's Deutsche Post DHL (DPDHL) pioneered the first parcel lockers in Europe in 2003. Since then, it has grown significantly. DPDHL's lockers is exclusive to its operations, serving as a competitive advantage. By expanding its delivery capacity through lockers, DPDHL aims to lower delivery costs and provide more flexible

delivery options to online shoppers, ultimately enhancing customer satisfaction. By the end of 2023, DPDHL aimed to reach a network of over 12,000 parcel lockers. Additionally, DPDHL is piloting a screenless, app-controlled locker system, projected to constitute approximately one-third of its locker network in 2023.

By way of another example; Belgium boasts between 5,000 and 6,000 delivery points, distributed relatively evenly across the country. These points encompass post offices, cargo stores, in-store pickup locations, and parcel locker stations. Bpost leads the market with 1,855 delivery access points. GLS, Mondial Relay, and PostNL each operate over 1,000 delivery points, while UPS, DPD, DHL Express, and DHL Parcel have hundreds in Belgium (Niederprüm et al., 2023, p. 28).

Spain also has specialized lockers for parcels outside the universal service, including those developed by USP. Citibox has recently joined the market with its own locker network. Moreover, there are collaborations between Citibox and Correos Citypaq, and between SEUR and PUDO, as well as lockers manufactured by Amazon.(Niederprüm et al., 2023, p. 28).

Poland, with its highly competitive B2C postal delivery market, serves as another notable example in Europe. InPost, a Polish company established in 2006, was the first to introduce parcel lockers in the country. Currently, InPost is the largest PHS in Europe with over 16,000 smart lockers in Poland. The company operates in 20 countries globally, including the UK, France, and the UAE, offering smart and refrigerated lockers (Pruchnicka, 2021).

In the UK, lockers provide a widespread network of smart cabinets for convenient parcel pickup and drop-off. Commonly found in public spaces, particularly near retail stores, petrol stations, and supermarket car parks, these lockers have been adopted by numerous supermarkets, shops, and retail chains. Many of these businesses have partnered with locker manufacturers to offer customers the option of collecting parcels during their shopping trips. Royal Mail, in collaboration with ByBox, piloted a locker service in 2011 but ceased operations following ByBox's withdrawal. While Royal Mail continues to offer delivery and collection points, it no longer provides locker services. Despite the absence of domestic locker manufacturers, Amazon has made approximately 5,000 lockers accessible to consumers after restricting third-party PHS access. However, InPost, in partnership with Parcel2Go, operates 4,800 lockers in the UK. These lockers remain

accessible to third-party PHS, enabling consumers to utilize them for parcel delivery services (Cullen, 2023).

When we look at the process of using smart parcel lockers in the delivery services of the postal sector in Türkiye, it can be observed that postal service providers in Türkiye have accelerated the use of parcel lockers. Within this context, both the Universal Postal Service Provider, PTT, and many other postal service providers in Türkiye have started delivery services through parcel lockers in addition to traditional home delivery services. Especially in cities like İstanbul and Ankara, customers can choose delivery services via parcel lockers for purchases made through e-commerce. The functionality of using parcel lockers currently focuses on delivery and return services for postal items. This application, which provides access to postal items 24/7, operates as follows: after the postal item is deposited in the parcel locker, the recipient receives a one-time delivery code and address information via SMS. The process is completed when the customer enters their Turkish Republic Identity Number and the one-time code on the parcel locker screen to collect their item. This delivery method, which is currently offered as an alternative option in e-commerce applications and is carried out through informing the customer via SMS, is expected to increase and diversify in the future (BTK, 2023).

Moreover, parcel lockers started to be used in delivery services by postal service providers in Türkiye for the first time in 2021, and the number of parcel lockers and the number of shipments made through these smart lockers increased significantly by 2023. The table below provides information on parcel lockers and the number of shipments made through these lockers by the leading postal service providers, including the Universal Postal Service Provider PTT Inc., with the highest market share in the postal sector in Türkiye since 2021 (BTK, 2024).

**Table 2.**

**Numeric Information on Parcel Lockers of Postal Service Providers in Türkiye**

| | Services Providers | Lockers | Number of Parcel | Number of Parcel per Locker |
|---|---|---|---|---|
| 2021 | Aras Kargo | - | - | - |
| | PTT | 352 | 198.359 | 564 |
| | Trendyol Express | 180 | 9.422 | 52 |
| | Yurtiçi Kargo | 20 | 1.176 | 59 |
| | All Services Providers | 552 | 208.957 | 379 |
| 2022 | Aras Kargo | 124 | 95.971 | 774 |
| | MNG Kargo | - | - | - |
| | PTT | 405 | 193.213 | 477 |
| | Trendyol Express | 629 | 1.400.494 | 2.227 |
| | Yurtiçi Kargo | 186 | 80.647 | 434 |
| | All Services Providers | 1.344 | 1.770.325 | 1.317 |
| 2023 | Aras Kargo | 1.142 | 271.261 | 238 |
| | PTT | 405 | 61.950 | 153 |
| | Trendyol Express | 1.243 | 3.708.781 | 2.984 |
| | Yurtiçi Kargo | 1.078 | 74.467 | 69 |
| | All Services Providers | 3.868 | 4.116.459 | 1.064 |

*Source: BTK 2024.*

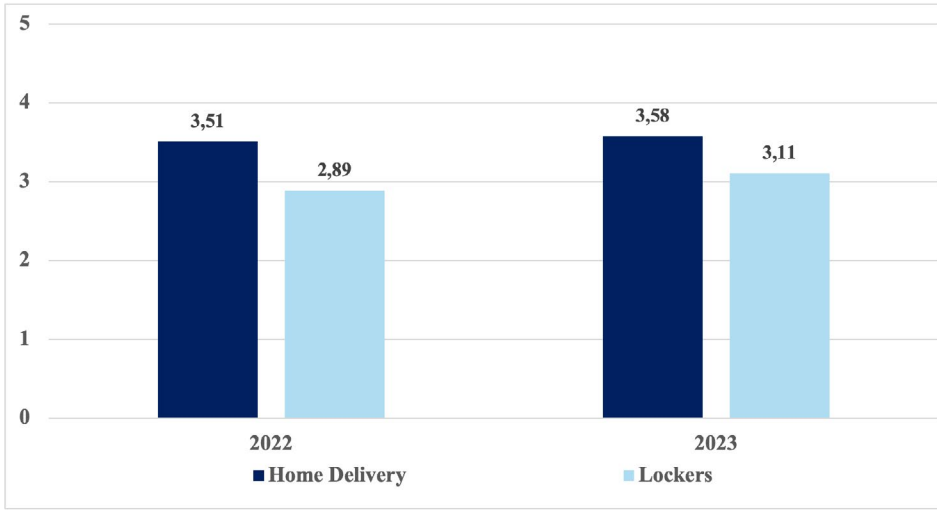
On the other hand, it is possible to say that PTT, as the universal service provider in our country, currently utilizes only parcel lockers among alternative delivery methods, without using delivery points. Considering the importance of delivery times in terms of consumer satisfaction and service quality, and taking

into account that PTT only has parcel lockers in metropolitan cities, the average delivery times of shipments delivered to addresses are higher compared to the average delivery times of shipments delivered through parcel lockers.

The graph below depicts the average delivery times for address delivery and delivery via parcel lockers by PTT Cargo, the universal service provider, over the years.

**Table 3.**

**Average Delivery Times of Parcels Delivered by PTT to Home Delivery and via Parcel Lockers**




*Source: BTK 2023.*

To provide a few examples of locker manufacturers; Rovenma, a Turkish company founded in 2016, is a leading manufacturer of parcel lockers. The company offers modular designs that can be adapted to various locations and customer needs. Rovenma's lockers are used by major e-commerce platforms such as PTT Kargomat, Trendyol 7/24, and Pudo. With a focus on innovation and customization, Rovenma's lockers feature Bluetooth connectivity, offline usage, and a high level of security.

PUDO, another Turkish company established in 2020, offers a network of

independent, flexible pickup and drop-off points called PudoPOINTS. These points are located in various settings, including residential complexes, business centers, and shopping malls. PUDO's solution provides customers with real-time tracking and convenient parcel management through a mobile app.

When we consider the regulatory approach perspective in the context of Türkiye, it is possible to say that the delivery of postal items through parcel lockers in delivery services is currently supported legally by the regulatory authority. In this regard, the Information and Communication Technologies Authority (BTK), the sole national regulatory authority in the postal sector in Türkiye, has been working on legal regulations to determine the criteria and scope of parcel lockers for a long time. Taking into account the regulations made by other national regulatory authorities at the local level and the discussions held with postal service providers at the national level, BTK has completed its efforts to regulate parcel lockers extensively within the legal framework. In this regard, the "*Procedures and Principles for the Implementation of Delivery Services*" was published by the BTK in April 2023 to define the physical and technical qualifications of parcel lockers and to determine the legal framework for their use, as well as to define the scope of other technology-based alternative delivery services. With this legal regulation, BTK aims to ensure that postal services are provided effectively, efficiently, and sustainably. In this regulation issued by the BTK, while traditional address delivery services continue to exist as the primary delivery method, it aims to popularize the use of other technology-based alternative services according to user preferences and to ensure the rights of both consumers and postal service providers by defining their scope within a certain legal framework.

On the other hand, Türkiye states that postal service providers operating under "*Postal Services Law No. 6475*" have developed alternative delivery models, along with principles and procedures, to regulate the delivery and return of postal items. This framework, which includes parcel lockers and Pick-Up/Drop-Off (PUDO) points, is soon to be published. One of the primary environmental benefits of this new delivery approach is the reduction in carbon emissions. By decreasing the number of delivery vehicles, the model aims to minimize the e-commerce industry's carbon footprint. Additionally, this innovation is anticipated to stimulate further technological advancements, such as delivery drones or automated vehicles, as market players seek to continue reducing their environmental impact.

## AUTOMATED VEHICLES IN LAST-MILE DELIVERY SERVICES

With the advancement of technology, remotely controlled autonomous vehicles have begun to be integrated into the postal sector, as in other sectors. Due to environmental, social, and economic advantages, postal service providers have started to use autonomous vehicles in the postal sector.

It is known that many high-end cars and some trucks already use technology-centered features such as parking assistance systems, autonomous emergency braking, and lane-keeping assistance. Furthermore, many car manufacturers use fully automatic vehicles that can travel without human interaction and cope with all traffic-related issues on the road (Hillebrand, Thiele, & Junk, 2016).

Autonomous vehicles represent the beginning of the next revolution in human and goods transportation. With the rise of e-commerce globally, postal service providers have accelerated their efforts to meet customer expectations for faster delivery. As a result, there has been a significant increase in the number of online orders. Consequently, to meet the growing demand, autonomous vehicles have also been introduced into the postal sector. Thanks to advancements in electric vehicle technology, computer vision, and machine learning, these vehicles have become a reality. It is already possible to see drones delivering parcels in densely populated cities or autonomous drones moving on city sidewalks to deliver hot meals to restaurants. However, it can be said that currently, autonomous vehicles cover a limited area, typically around 10 kilometers (Kosovac, Muharemovic, Colakovic, & Lakaca, 2021).

When looking at the process of using autonomous vehicles in delivery services in the postal sector, after the commissioning of automated shipment processing machines in delivery services, efforts have been made to automate other parts of the postal delivery process. In this context, various pilot projects have been developed for the use of autonomous vehicles in the automatic delivery or collection of shipments. In this context, the first delivery by an autonomous truck took place on October 25, 2016, between Fort Collins and Colorado Springs.

A recent example of autonomous delivery vehicles in the postal sector is a small delivery robot developed by a British company designed to travel on sidewalks. It is planned to be used for ultra-fast urban deliveries at costs 10 to 15 times lower than couriers (Kosovac, Muharemovic, Colakovic, & Lakaca, 2021).

The potential application of autonomous vehicles in the postal sector can be examined in two main categories. The first is delivery to the end-user, known as last-mile delivery, and the second is the transport of mail items on routes. In this regard, the focus will primarily be on last-mile delivery in the postal sector (Lazarević & Dobrodolac, 2020).

One of the applications of autonomous vehicles used in delivery services in the postal sector is e-bike applications. The last-mile delivery service model based on e-bike usage is one of the suitable methods for urban areas compared to rural areas. One of the main reasons for this is that such autonomous vehicles require a small public space both during transportation and parking. Moreover, the working method that does not involve direct burning of fuels and emissions has a significantly positive environmental impact. Considering the effects mentioned above, it can be concluded that the e-bike application in the delivery system also has a positive effect on public health and social life.

However, when discussing the disadvantages of the e-bike application in the last-mile delivery services, it can be mentioned that the use of special cargo bicycles by some companies leads to low cargo capacity. Additionally, e-bike applications may be considered as a negative factor due to limiting terrain configurations compared to ordinary bicycles.

The presence of a wide network of bicycle lanes is a prerequisite for the implementation of the e-bike application in delivery services. This situation emerges as a limiting factor for the e-bike application, which is one of the autonomous vehicles, in the postal sector. The development of a wide bicycle lane network will pave the way for the use of e-bike applications as a new delivery service in the postal Sector (Lazarević & Dobrodolac, 2020).

During the last-mile delivery services in the postal sector, the process typically involves transporting the package from the vehicle to the recipient or at least to their doorstep. The fact that a self-employed autonomous delivery vehicle still requires a human to carry out the delivery can be considered a disadvantage. Therefore, it may limit cost savings for courier companies and may not provide a significant advantage in terms of delivery speed. However, the use of unmanned autonomous vehicles on the ground with the help of different types and sizes of drones, as in the case of drones, will improve the delivery service operations.

When it comes to using autonomous vehicles for delivery services in the postal sector, it is believed that autonomous vehicles will emerge as an effective delivery vehicle like drones when technology provides sufficient security issues both nationally and internationally and when authorities allow autonomous vehicles to be driven without human supervision as a result of legal regulations made through joint efforts.

However, postal service providers currently encounter some challenges with the use of autonomous vehicles used in the logistics sector for delivery services. The use of autonomous vehicles in delivery services may have some disadvantages, such as low cargo capacity and terrain limitations. Additionally, factors such as the presence of wide bicycle lanes and the resolution of security issues need to be considered.

In conclusion, autonomous vehicles have the potential to transform delivery processes in the postal sector. By integrating autonomous delivery vehicles into delivery services, postal service providers can increase their competitive advantage by offering customers a faster, safer, and more flexible delivery experience. However, it is necessary to consider some important factors such as security, legal regulations, and infrastructure for the widespread adoption of these technologies.

## ROBOTIC SOLUTIONS IN LAST-MILE DELIVERY SERVICES

With the advent of digital transformation and technological evolution, robots produced by human hands with the aim of assisting individuals in social life have transcended the mere physical object imagined in the past. These robots are now defined more as sophisticated structures equipped with specific algorithms and software codes, assisting in the regulation of human-environment relationships and incorporating various elements of technology. Robots, based on artificial intelligence, are disciplined technological tools capable of mimicking human cognitive processes and serving multiple functions. They have been increasingly integrated into various sectors, including the postal industry, with the primary objective of providing faster and more sustainable solutions to economic and social challenges compared to human intervention (Casino, House-Peters, Crampton, & Gerhardt, 2020).

Initially emerging in cargo and parcel logistics, robot technology in the postal sector has been involved in tasks such as parcel sorting, loading, unloading,

and warehouse picking for many years. Robots utilized in postal logistics can be applied to various functions, facilitating warehouse operations and enhancing workforce productivity. It is well-known that robots are also employed in cargo loading and unloading activities in logistics. Currently, postal service providers largely utilize robots in delivery services within the logistics sector, aiming to improve cost-effectiveness and efficiency (Nguyen, 2020).

Moreover, innovative concepts focusing on intelligent technological transportation have been developed in recent years to mitigate the adverse effects of excessive urban traffic on human and freight transportation. One such concept involves autonomous delivery robots launched from trucks. A truck can load a series of postal shipments assigned to customers into a central depot with the assistance of robots, facilitating delivery services. Additionally, ships are equipped with small autonomous robots capable of delivering postal shipments allocated to end-users. During the final stage of delivery, autonomous robots deliver the shipments to specifically designated end-users. Subsequently, these robots return to robot depots located in city centers. This process summarizes the delivery services conducted with robots in its simplest form (Hillebrand, Thiele, & Junk, 2016).

Furthermore, the ability of end-users benefiting from delivery services to track the delivery process using smartphones, which are also used to unlock the cargo compartment for retrieving the shipment upon robot arrival, is crucial for consumers to perceive delivery robots as a significant option.

In addition to drones, which enable unsupervised delivery by dropping parcels onto the balconies of recipients' homes, the use of autonomous robots for delivery is currently not feasible for unsupervised delivery to the user's home address due to the requirement for customers to be present for unlocking the cargo compartment and retrieving the shipment (Boysen, Schwerdfeger, & Weidinger, 2018).

The pace of development of relevant technologies in robots is crucial not only for cargo/parcel logistics but also for the widespread adoption of robot use in last-mile delivery services. Reducing the costs of suitable robot models is a primary condition for the widespread use of robots in delivery services. While many countries continue to use robots in the logistics sector, the use of robots in last-mile delivery services is a relatively new phenomenon. International and national

postal service providers have accelerated project efforts to promote the use of robots in last-mile delivery services. Several European countries are developing new solutions and algorithms for using robots in the delivery of shipments to end-users. In Türkiye, efforts to use robots in last-mile delivery services in the postal sector are parallel to those in Europe. However, it can be said that the use of robot technology in last-mile delivery services faces a challenging and costly process that is currently not feasible in the short term.

## DRONES USAGE IN LAST-MILE DELIVERY SERVICES

Drones, unmanned aerial vehicles widely used for military purposes, are increasingly being utilized for various specialized services (security, firefighting, healthcare, etc.) and civil sectors (various distribution services, agriculture, etc.). Furthermore, drones have recently been employed in the postal sector to shorten delivery times and increase efficiency.

Drones consist of numerous technologically advanced components that ensure efficient and reliable operation. In addition to physical parts, software support, which serves as the connection between drones and control centers, is crucial. The planned introduction of these devices into the postal sector is highly significant for the industry's dynamics.

The primary advantages of drones in package delivery include reduced delivery times, access to rugged and challenging terrains and remote locations, assistance in resolving delayed deliveries due to road traffic congestion, and reduction of environmental pollution. In addition to ecological characteristics, drones have significant potential benefits for the postal system in terms of positive economic performance, improvement of delivery times, and sustainable development. By facilitating access to remote areas and reducing the number of delivery vehicles, drones indirectly contribute to reducing harmful emissions and increasing regional accessibility for users, thereby alleviating traffic congestion (Lazarević & Dobrodolac, 2020).

International postal service providers such as Amazon and DHL are among the first to employ drones for delivery services, conducting initial tests and development efforts. The demonstration that drones can reduce delivery times significantly underscores a highly positive argument in favor of their adoption.

Drone technology, powered by an electric battery, has been observed to have

a significant environmental impact in the conservation of resources compared to traditional delivery services. Additionally, it is evident that postal deliveries are significantly less costly compared to conventional methods. However, it is important to note that investments in drone stations entail substantial additional costs (Lazarević & Dobrodolac, 2020).

In addition to their ecological characteristics, drones offer significant potential for positive economic performance, improvement of delivery times, and sustainable development of the postal system. However, several limitations, such as insufficient research on delivery distance and flight time and capacity constraints such as weight and size, hinder the development of drone delivery as an alternative delivery method. One of the most significant disadvantages of delivery by drone is the inability to deliver all postal shipments in a single trip, requiring both human labor and assistance from another vehicle (Li, Yang, & Huang, 2020).

Many countries worldwide have intensified their efforts to implement last-mile delivery services using drones. International and national companies in countries such as the United States, the United Kingdom, and Japan have initiated drone trials for last-mile delivery services. For example, in India, the first-ever pilot project for postal delivery using drones was conducted on June 3, 2022. The package was sent from the Habay village in the Bhuj Taluka to the Ner village in the Bhachau Taluka in the Kutch region. The drone covered a distance of 46 km in 25 minutes, marking the longest drone delivery under harsh weather conditions with wind speeds exceeding 31 km per hour. Compared to road transport in India, it was observed that drone delivery was five times faster in delivering shipments (Li, Yang, & Huang, 2020).

As well as in Türkiye, the General Directorate of Civil Aviation designated the İstanbul-Ankara-Eskişehir route as a drone transportation corridor for intercity cargo/parcel transportation in 2023. Given that this would be the first time a shipment would be transported between cities, this project holds great significance and is progressing rapidly. Parcel drones capable of carrying up to 4 kilograms of payload are expected to operate at a height of 120 meters from the ground. Additionally, a national postal service provider in Türkiye, Yurtiçi Kargo, successfully conducted Türkiye's first autonomous drone delivery of parcel in the Bağlıca district of Ankara. These parcel drones can carry shipments of up to 5

kg with dimensions of 25x25x15 and operate within a temperature range of -20 to 50 degrees Celsius.

Despite pilot trials conducted globally and in Türkiye for last-mile delivery services using drones, there is currently no legal framework or limit specific to the postal sector for the use of drones. Regulatory authorities at the international and national levels have not yet taken any legal precedent steps for such innovative initiatives. The aforementioned challenges and various legal barriers at the international and national levels hinder the use of drones in last-mile delivery services.

## OVERVIEW OF TÜRKIYE

## NEW DELIVERY TECHNOLOGIES REGULATIONS IN TURKISH POSTAL SECTOR

The development of e-commerce in our country has rapidly facilitated the advancement of last-mile delivery in the postal sector. Furthermore, the development of advanced, analytical, dynamic route optimization, and artificial intelligence applications enables postal providers to offer faster and more flexible delivery options to end-users. With the increasing options available, users are inclined towards alternative delivery methods outside traditional delivery routes.

In this context, users are inclined towards many alternative options where they can receive or return postal shipments, such as independent pick-up points established in workplaces, gas stations, shopping malls, and locked delivery lockers. In this regard, as long as all responsibility for delivery lies solely with the postal service provider and is limited to e-commerce shipments; the postal service provider can contract with third parties, such as merchants and businesses, to establish relationships with delivery points (pick-up points) for the recipient, and deliver services through these third parties, designate locations for delivery by contracting with the recipient as the delivery point, and provide delivery services through locked delivery lockers placed in certain areas. These alternative delivery methods have been defined by the BTK as alternative delivery methods (BTK, 2021). The use of designated pick-up points and parcel lockers is subject to a certain fee paid by postal service providers, and no additional fee is charged

to users for these services. In addition, in our country, it is possible to say that contactless delivery, without obtaining T.C. identification number and signature regardless of the delivery location of the shipments, has emerged as an alternative delivery model naturally during the Covid-19 period (BTK, 2020).

The BTK has taken steps towards alternative delivery services in the postal sector. It has examined various delivery models and operations used worldwide to determine which models would be feasible in our country. The need for these changes arises from digitalization efforts and the diverse supply and demand resulting from post-pandemic consumer preferences. In February 2021, the BTK issued the "Board Decision on the Implementation of Alternative Delivery Models for Postal Services." This decision allows postal service providers to offer delivery services through contracts with third parties, such as merchants and businesses. They can use locations like residential buildings, site management, office buildings, or shopping malls as delivery points. The BTK also requires providers to report data on the form, method, and scope of alternative delivery models every June and December.

Another significant development is the "Procedures and Principles for the Implementation of Delivery Services," introduced by the BTK in April 2023. This legal text considers the views of all stakeholders in the postal sector, including consumers and postal service providers. It also incorporates opinions from organizations such as Cullen International and ERGP about alternative delivery services in Europe. This document aims to promote the widespread use of alternative delivery services and the adoption of new technologies in the postal sector. With the legal framework published in April 2023, new technologies are encouraged to enhance competition in delivery services.

(BTK, 2023).

## CONCLUSION

In recent years, technological advancements and digitalization have significantly impacted many sectors, including the postal sector. Delivery services have been particularly affected by this technological interaction. The Covid-19 pandemic pushed consumers toward online shopping, leading to a substantial increase in e-commerce volume. This rise has positively influenced the postal sector, resulting in more parcel and mail deliveries. Consequently, the growth of e-commerce has prompted the development of alternative delivery models aimed at enhancing consumer satisfaction.

The role of technological advancements in the emergence of alternative delivery models is undeniable. It is essential to meet consumer expectations for shorter delivery times, fewer missing or damaged parcels, and lower delivery costs during the last-mile delivery phase. Additionally, postal service providers seek to reach more consumers, encourage investments in delivery services, and minimize traffic congestion, emissions, and environmental pollution.

Economic, social, and environmental factors, combined with technological support and digitalization, have driven growth in various business models in delivery services within the postal sector. Technology-driven delivery models have gained prominence to fulfill the expectations of stakeholders and improve delivery efficiency. Advances in information technology and digitalization now allow consumers to track their postal shipments in real time. This rapid development has heightened transparency for consumers through new barcode systems, access to information about software-based deliveries, technologically equipped storage lockers, and the integration of autonomous vehicles and drones into delivery services.

However, the current use of autonomous delivery vehicles, robots, and drones in consumer-to-consumer (C2C) delivery remains limited, and they have not yet been integrated into last-mile delivery services. These delivery models, which transport shipments to delivery depots, are relatively new in the logistics sector. Research suggests that widespread adoption of technology-based delivery models in last-mile services will take time. Barriers include high investment costs, legal uncertainties, and security concerns in various countries that hinder the inclusion of these models.

Furthermore, establishing a legal framework for technology-based delivery services is challenging due to diverse technology adoption rates, the lack of a common legislative framework, and the absence of a single standard practice. Additionally, there is a need for time to assess the potential benefits and shortcomings of alternative delivery models. However, the potential benefits of these new services are considerable, given their positive impact on various sectors, encouragement of technological investment in the postal sector, and reduction of environmental impact.

Currently, one technology-based delivery model being implemented is the use of lockers for delivery and return services. Smart locker systems differ across countries. Some European nations facilitate returns through lockers, while others do not offer this service. Thus, there is no unified regulation regarding locker systems among countries. Nevertheless, utilizing lockers for pickup and returns can help reduce costs for postal service providers, given that last-mile delivery services are often expensive.

Recognizing the swift growth of the postal sector and the need for efficiency in delivery services, many countries are taking regulatory measures to adapt to technological advancements and alternative delivery models. These regulations aim to improve delivery service efficiency while addressing economic, social, and environmental contributions. Countries are broadening the application of technology-based services, and regulatory authorities are working to establish quality standards, performance criteria, and data security measures. The legal framework set by national regulatory bodies, like BTK in Türkiye, will guide the future adoption of new technological models in the postal sector.

Türkiye shares similarities with EU countries in terms of regulations aimed at maintaining inter-company competition to allow alternative delivery models to operate under free market conditions, assessing the sector's development within a framework of free competition, and increasing innovation incentives. While there is no pioneering regulation on technology-driven delivery models, the "Procedures and Principles for the Implementation of Delivery Services" introduced in 2023 established regulations for parcel lockers, pick-up points, and consumer protection. Additionally, these procedures define the physical and technical requirements for parcel lockers and the scope of delivery service implementation, serving as a guide for the delivery service execution.

Overall, the development and implementation of alternative delivery models are vital for revitalizing the postal sector, increasing postal shipment volumes in line with consumer expectations, channeling various new technological investments into the sector, and achieving positive environmental factors. The existence of new technology-based delivery models is crucial for establishing a service structure based on delivery service diversity, consumer expectations, and service efficiency in last-mile delivery service.

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