

# Last Mile and its Latest Changes in Express, Courier and Postal Services Bound to E-commerce

Dominika Koncová<sup>1\*</sup>, Iveta Kremeňová<sup>1</sup>, Juraj Fabuš<sup>1</sup>

<sup>1</sup>Department of Communications, University of Zilina, Zilina, 010 26, Slovakia

\* Corresponding author: dominika.koncova@stud.uniza.sk

---

**Abstract** Last mile delivery is influenced by both technology as well as customer requirements and their preferences. Recently, technologies such as drones, automated guided vehicles (AGVs) or robots have come to the fore to deliver parcels to their addressees or authorised recipients, instead of delivering them solely by couriers or into letters or parcel lockers. It cannot be argued that delivery by courier or to letter or parcel lockers is unattractive, but, in terms of innovation, it is already possible to regard these forms of delivery as a standard that has been in practice for some time. It is therefore necessary to discuss technologies that have both automated elements and sensors or a certain degree of implemented intelligence. Drones and AGVs are just such devices. Thus, this paper is devoted to comparing the advantages and disadvantages of using drones and AGVs.

**Keywords** last mile delivery, distribution, postal items.

**JEL** R41, L62, L91

---

## 1. Introduction

Delivery of postal items is an area that hasn't changed in a long time as a scope. However, changes are occurring in the way and form of delivery. Whereas in the past people used delivery mainly in the form of direct collection from a postman or courier, today they are also comfortable with letterboxes. Parcel lockers, mailboxes or automated parcel lockers are particularly time efficient for them, as they are usually accessible 24/7, unless they are located, for example, in shopping malls, which have limited opening hours. This availability allows recipients to access them at a time that suits them without having to wait in queues at post offices or the stress of uncertainty about when the courier or delivery person will arrive. Conversely, for some postal customers it is still essential that mail is delivered directly into their hands.

In terms of the form of postal item, the current trend of a reduction in the number of letters and an increase in parcels, also as a result of the development of e-commerce, must be considered. Particularly, there was a significant boom in 2020 and 2021, when the situation in the mail market has been strongly influenced by measures to ensure the reduction of the spread of COVID-19. [1]

Last Mile is an area that focuses on mail delivery as part of the provision of postal services. Currently, postal items can according to the contractually agreed terms be delivered in several ways. Mail carriers and couriers seek direct delivery to the addressees or to the authorised recipients. If the addressee is not reached, further action is taken according to

the contractually agreed terms (e.g., depositing the parcel with a neighbour, at the nearest post office or distribution point) or these staff will attempt redelivery at a different time. Other methods of delivery may consist of depositing parcels at the post office, depositing parcels in the appropriate mailbox (parcel, letter, combination thereof, or parcel machine), or delivering parcels following a change of delivery address based on the addressee's request. However, not all these services are used by all postal operators. On the contrary, the delivery of parcels by innovative methods such as delivery by drones, automatically self-driving vehicles, or droids (robots) is already being pilot tested abroad or has already been introduced in practice. The final stage of the courier service, parcel express, involves delivering packages to customers' doorsteps without the assistance of a human. In numerous cases, in those innovations are used technologies from the industry 4.0, such as exponential technologies, technologies from IoT using sensors, machine learning or even artificial intelligence. [1], [2] In various cases, however, the choice of an appropriate delivery method is made to reduce the burden on the environment, due to efforts to reduce emissions [3]. As parcel quantities rise, more delivery vans enter city centres, worsening traffic, pollution, and the health of the populace [4].

The last mile issue is summarized in the introduction of the problem. The second chapter focuses on a situational analysis of the last mile in e-commerce at the global level. In the paper is presented comparison in pros and cons that last mile in e-commerce brings. The results present the current

state of the art of the subject by means of a synthesis and the findings of the analysis are summarised in the conclusion.

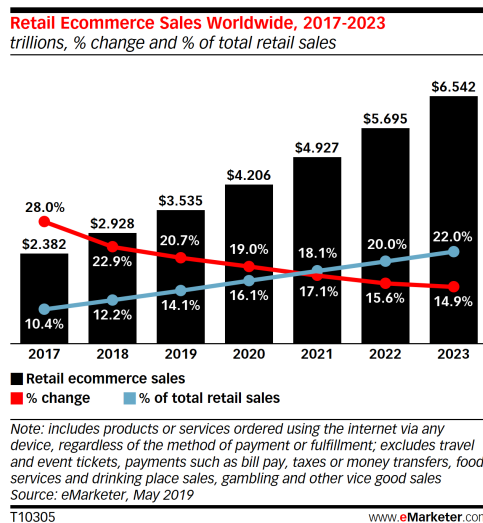
## 2. Current situation of the last mile

Customers preferences regarding forms of delivery are changing with the time. According to Pitney Bowes BOX poll survey (released in February 2022) of consumers behaviour regarded in the Article of Elizabeth Baker (released in June of 2022), preferences of customers for at-home delivery changed. This change is shown in Table 1, where the key reasons behind customers decision-making were cheap or free of charge delivery options, time, and quickness of delivery [5]. However, because of the geographical dispersion of houses and the frequency of unsuccessful deliveries, home deliveries are presently inefficient. [4]

**Table 1.** Delivery options preferred by customers. Source: [5].

Choice	Consumers	Reason behind choice
Free delivery on home	64 %	Free of charge
Curbside pickup	37 %	Fast delivery
Later delivery	59 %	Waiting time

Delivery, however, does not necessarily have to consist of delivering postal items. There are many customers, which pre-order delivery for their food, shopping, supplies and so on. Thus, last mile has changed and is still changing to fulfill customers' demands, with ensuring as much quality as possible while decreasing time of delivery to minimum.



**Figure 1.** Global revenue forecast (from 2019) from e-commerce retail sales for 2017-2023, shown in trillions U.S. dollars, percentage year-on-year change and as a % of total retail sales. Source: [7].

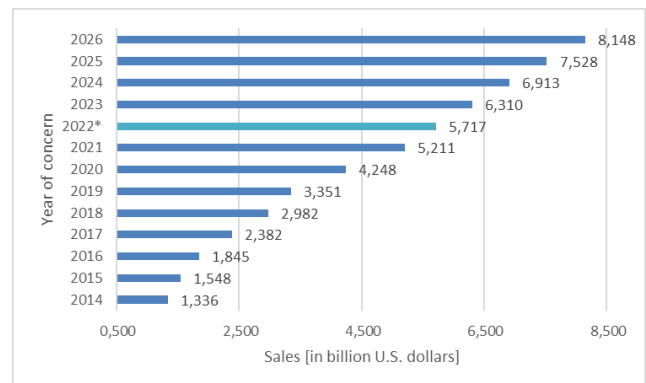
To point out the necessity of implementing new technologies to the last mile, it is necessary to state what is the current and projected development of retail sales, especially in the field of e-commerce. Indeed, e-commerce is the main cause of the increase in volumes, especially in parcel shipments, as

ordinary consumers have recently been shopping gradually online. [6]

Forecast of global e-commerce situation in retail from 2019 for years 2017 up to 2023 is displayed in the Figure 1.

As was shown retail in electronic commerce is increasing which brings new challenges for the logistic sphere in the sense of thinking new ways, or rethinking the old ones, of how to deliver the specific postal item to the final consumer in the shortest possible time while losing the least number of sources necessary to do so.

On the other hand, there is other report not so much different from the previous one (from 2022) displaying global e-commerce situation in retail with the forecast up to 2026 from 2014. This is displayed by the Figure 2.



**Figure 2.** Global revenue forecast (from 2022) from e-commerce retail sales for 2014-2026, shown in billions U.S. dollars. Source: [8] modified by authors.

As can be seen in both figures (Figure 1 and 2), sales from retail e-commerce are growing despite the despite country-specific restrictions in 2020-2022. However, this growth has been slowed down slightly as can be seen in Figure 1.

As there are many ways to ensure that a parcel is delivered to a chosen location or to a chosen addressee, there will be similarly many different types of innovations in this area. Examples include autonomous or self-driving vehicles (hereafter AGVs) with either partial or total autonomy of driving of the vehicle depending on the type of vehicle, drone delivery or delivery by vehicles with multimodal delivery capability depending on the current weather conditions. [9], [10]

Drone delivery is problematic depending on the choice of the type of drone (choice of propulsion, choice of payload, choice of battery capacity, choice of range, etc.), the legislative requirements of individual countries and regions, the way in which delivery is made either directly from a fixed or mobile base (logistics hubs, sorting centres, processing centres, operations, parcel vending machines, vehicles with a take-off platform, etc.). [10]–[12] In addition to their technical restrictions and limited practical applicability, drones' potential for last-mile delivery is hampered by their generally lengthy flight times each delivery [13]. In particular, the idea of deploying UAVs and associated infrastructure (examples include precise landing stations, automated pickup and drop-off systems, specialized software programs, UTM, etc.), specifically for the last-mile delivery, is garnering appeal. [4]

For self-driving vehicles (AGV), it is similarly challenging to choose between the suitability of using a self-driving vehicle, i.e., without a driver on board, [14], [15] or a self-driving vehicle with an employee on board to supervise the dispatching of shipments as well as to control the correct operation of the vehicle. Also, similarly with drones, there are legislation restrictions concerning the self-driving of vehicles to consider while deciding for this technology in many states. Korea Post's AGVs are being pilot tested. These are driven autonomously via AI. These vehicles could be simplistically called a parcel machine or a self-service kiosk on wheels, as they can act as a standalone post office where parcel collection is based on electronic communication with the device. [14] However, some countries, i.e., Belgium, France and Germany are at the forefront of legislation to change permission to the public roads for these vehicles. [16], [17] There are also AGVs which are tele-driven by tele-drivers remotely. Those are considered to be safe, as there are drivers with experience and training to adhere to careful driving styles. [18] Autonomous vehicles will fundamentally alter last-mile package delivery during the next ten years. They should provide nearly all of the X2C (in other words anything to consumer) volumes, according to expectations. Higher levels of flexibility and dependability are available with autonomous delivery at a reduced price. [13]

Multimodal mail delivery is specific in that all the facilities suitable for the delivery of a mail item to the addressee or to an authorised recipient of such a mail item are located in a single central vehicle. Based on the parameters and weight of the consignment as well as the distance of the forwarding address from the nearest possible stopping point of the central vehicle, it is necessary to select the appropriate type of delivery equipment. Such a device may be, for example, a drone, a cargo-bicycle, or the courier himself may arrange the delivery. [9]

Similarly, innovations are also necessary in the field of delivery by courier as some postal items require a different approach to the addressee. There are some innovations concerning enhancing cargo-bikes, e-scooters or AGV following the bike driven by employee. Those vehicles are usually constructed with lightweight components so to facilitate work of those employees. Subsequently, those vehicles are mostly constructed to reduce the impact on environment of the region while lessening time spent on delivery. [19]

### 3. Results

In the paper are explained obstacles of last mile as well as current solutions to the problem. Mostly in abroad are tested some innovative technologies that enhance the performance and time of delivering goods to customers. For this reason, was in this paper presented comparative analysis of the advantages and disadvantages of 2 selected innovative technologies (drones and AGVs), which resulted in our conclusion.

#### 3.1. Advantages of last mile for e-commerce

As a result of the implementation of new innovations in the last mile, new positive aspects are emerging in the delivery of shipments to the target customer. These aspects can be seen specifically in the noticeable reduction of delivery times from the original 2 days to around 6 hours within urban centres. Another positive aspect is the development of reverse logistics related to the return of goods. Usually, individual e-shops provide the possibility to fill out a form, which makes the work of employees faster and more efficient as well as increases customer satisfaction. Many young people devote their time to pursuing and using new technologies, so it can be argued that they are attracted by the concept of introducing innovations into different systems and want to try out the use of such services, e.g., delivery by drones. Among other things, the younger generation is influenced by the desire to use greener forms of transport, both delivery with the aim of reducing environmental impact. [6], [9], [19], [20]

Some advantages of drone delivery are displayed in the Table 2. There are shown some benefits as well as either possible impacts or threats of specified aspects from the perspective of authors of this paper.

**Table 2.** Benefits of drone delivery. Source: [21]–[23] own elaboration.

	Positive aspect of implementation	The threat or the impact of the aspect
1	Quick delivery to almost everywhere.	Limited capacity of the delivery as well as limitations of the distance accessibility.
2	Every participating side has enhanced time management thanks to implementation.	Error may occur in submitting the correct address of delivery.
3	Decrease in environmental impact caused by emissions.	Possible reduction of job opportunities because of a change in the system of logistics of delivery.
4	It is a time saving technology for organisations as regular employees may pay attention to routinely operations of the company.	Possible improvement of quality of delivery, though, there may occur dissatisfaction of the customers with the fewer social contact with the employees of the organisation.
5	Secure system of delivery as there are no traffic congestions in the air caused by drivers or health issues bound to couriers.	Possibilities of i.e., drone failing, impact of drone with the birds, loosening grip on the delivered package, not suitable weather conditions for the drone flight and so on.
6	Greater level of effectiveness thanks to automatic navigation via GPS.	As GPS navigation is not always accurate, there may be variations in the actual delivery location compared to the GPS information.
7	Favourable impact for shareholders as the cost-savings processes would be implemented, which would lead to decrease in expenses and increase of profit.	Potential rewards for specific employees on higher levels of management.
8	Lower consumption rates due to shopping online.	Reducing unnecessary waste.

These days, there is a lot of opportunity to reduce logistical costs by using drone solutions to transport packages, food, or

medical supplies. Due to the extremely short time between item dispatch and delivery, drones decrease the number of missed deliveries and have no driver or truck expenditures (e.g., 30 minutes). From the point of view of consumer preferences, drone delivery along with mobile phone applications to assure scheduling and traceability could create the conditions for meeting the maximum probability of demand. This is since a system like this would combine home delivery with variable delivery schedules, information tracing, and lower prices. [4] Some advantages of delivery by AGVs are displayed in the Table 3. There are shown some benefits as well as either possible impacts or threats of specified aspects from the perspective of authors of this paper.

**Table 3.** Benefits of delivery by AGV. Source: [24], [25] own elaboration.

	Positive aspect of implementation	The threat or the impact of the aspect
1	An AGV by taking the position of a human employee saves a business from having to pay recurring expenditures associated with a new hire.	Possible reduction of job opportunities because of a change in the system of logistics of delivery.
2	AGVs are designed with a focus on safety (with many different sensors) which enable them to function safely around people and structures. This results in lower expenses and less downtime, which helps many enterprises become more profitable.	AGVs can work in environments where people cannot or are not able to work as well as they should, including in extreme environments, or in close proximity to potentially dangerous objects.
3	AGVs can take part of the human element's propensity for inaccuracy out of workflows, which reduces waste and boosts production to 24/7, making operations more accurate and productive.	Positive changes in warehouse management systems.
4	By starting with a small number of AGVs and gradually increasing company's fleet to a fully or mostly automated operation, rather of investing a large sum of money at once, companies can avoid making a very high initial expenditure.	Danger associated with potential danger to other road users due to self-driving vehicles.

Some companies are also changing their delivery models in the last mile due to new trends and aspects as well as due to modification of national legislation. Therefore, shipments that once had to be delivered at least 1 time a day may be changing in some areas depending on the type of delivery.

### 3.2. Disadvantages of last mile for e-commerce

Changes in last mile may have many benefits, however, there are also drawbacks bound to implementation of innovative technologies in delivery. Some are not so concerning, while some may present potential risk concerning efforts to retain regular customers.

Generally, for last mile, for example, there may be seen decrease in the quality of products sold via e-shops in comparison to quality of products sold in stone shops as the customer is able to check the quality of the product in presence in those stone shops. This, however, does not necessarily

concern each e-shop as some guarantee full recharge, shall the customer not be happy with received goods. [19] Although the quality of a product sold through an e-shop is not directly related to the last mile, it can influence the demand for the products of that e-shop. As the e-shop cooperates with a postal operator operating the last mile, this may lead to a decrease in demand for the postal operator's services due to a decrease in the e-shop's customers. Also, some customers demand the contact with and advice from the product sellers in stone shops, whereas in online environment they may only rely on reviews listed on websites or information from friends.

Some disadvantages of delivery by the AGVs are stated in the Table 4. There are shown some negatives as well as either possible impacts or opportunities of specified aspects from the perspective of authors of this paper.

**Table 4.** Drawbacks of delivery by AGV. Source: [24], [26] own elaboration.

	Negative aspect of implementation	The opportunity or the impact of the aspect
1	In comparison to hiring staff or using other tools like forklifts, buying an AGV will probably be more expensive in the short run.	Savings are usually fully realized over the long term.
2	AGVs will occasionally need to be repaired, just like any piece of machinery. Although personnel won't directly operate AGVs, there will inevitably be some operational lag time while staff is educated and AGVs are incorporated.	New job opportunities for programming staff in organisations as well as job opportunity for development staff.
3	Given that this is what they were designed to do, AGVs are most useful in procedures involving repetitive actions.	Decrease in mistakes caused by personnel.
4	It may not be appropriate to use AGVs with a business model which frequently responds to trends or is otherwise agile.	Rapid change may be challenging with AGVs because they operate using predetermined systems and procedures.

Some disadvantages of drone delivery are stated in the Table 5. There are shown some negatives as well as either possible impacts or opportunities of specified aspects from the perspective of authors of this paper.

**Table 5.** Drawbacks of drone delivery. Source: [21]–[23] own elaboration.

	Negative aspect of implementation	The opportunity or the impact of the aspect
1	Devices such as drones are pricey. With ability of accurate delivery, the price is up to 500 U.S. dollars per device.	New job opportunities for programming staff in big organisations as well as job opportunity for development staff.
2	Requires advancements in battery technology to function.	Innovations in the capacity of batteries incorporated into such devices, to last longer than one third of the hour.
3	Require expertise with the product on a technical level without employing the pilots to fly such devices.	Lesser job opportunities for trained pilots.

4	Increase in the possibility of operational problems of drones as it is operating on the current technologies.	Innovations in technologies bound to operation of the unmanned devices with the aim of challenging decrease in risk factors bound to current technologies.
5	Possibility of the delivery drones being stolen. It could provide another option to compromise our data privacy. There exists a potential risk for property damage.	New legislative and regulation measures to counterattack the risk of thefts.
6	Pose a privacy risk, we must consider, for residents of the area where the drones will deliver.	As the device is using the real-time camera recording for the delivery, there may occur less thefts in the location of delivery.
7	Shipping costs will increase rapidly.	The time spend on delivery is considered similar to express delivery, with however only half an hour (that is the objective) instead of current few hours (depending on the location of delivery).
8	Less employment options for unskilled workers.	Increase in trained and skilled employees as the new positions would require new skills.

No matter how many drones an operator controls, since labour costs and other costs are influenced by flight duration, the cost of delivery per package cannot be as low as it would be for last-mile delivery using AGVs. Even while drone delivery is more advantageous from a sustainability standpoint as the number of ton-kilometres per one package and the associated energy needs are currently 15 times smaller, even if one cuts a drone's current capital expenses in half or double its lifespan. As a result, future metropolitan street scenes will be dominated by AGVs with lockers. Only dependable, rapid deliveries in sparsely populated areas will be made using drones. Drones are a more profitable option than AGVs in those circumstances. [13]

Also, both drones and AGVs are restricted by their capacity, speed levels, noise level or the range of vehicle. Thus, there are still fields that are necessary to consider while picking such a technology for implementation.

Comparison of the advantages and disadvantages of drones as well as AGVs are displayed in the following table (Table 6).

**Table 6.** Comparison of suitability of the device according to displayed criteria for drones and AGVs. Source: own collaboration.

Decision-making criteria	Selected delivery technologies	
	Drones	AGVs
Improves time management and saves time of delivery.	✓	✓
Suitable for delivery of products.	✓	✓
Safety promotion during distribution of goods.	✓	✓
The costs of acquiring and maintaining the device.	X	X
Technical familiarity, knowledge in programming.	X	X
Capacity of the device.	X	X

Capacity of battery, battery defects, operating time.	X	X
Navigation, sensors, unmanned vehicles.	✓	✓
Changes in legislation and regulatory means.	X	X
Costs of device in comparison to employment of employee.	✓	✓
Privacy of citizens in the delivery area.	X	✓
Produced emissions of CO <sub>2</sub> bound to delivery.	✓	✓
Prevention of criminality in the area.	✓	✓
Impact on shareholders.	✓	✓
The prestige of the company.	✓	✓
Mistakes.	✓	✓
Performance of 24/7, without the time of maintenance or blackout.	✓	✓
Environment requirements restrictions.	X	X
The weather conditions	X	X

As was shown in the Table 5, both technologies bring benefits for choosing them to deliver products, i.e., decrease in mistakes, decrease in traffic accidents (if the device is correctly programmed and has a not-lagging connection via Wi-Fi), operating time for up to 24/7. However, as there are pros, those technologies also bring cons, mostly in costs and technological demands as well as difficult regulatory restrictions.

## 5. Conclusions

The growing problem of package theft from doorsteps is not addressed by drone delivery of products to a front yard. Question stands, whether this type of criminal activity will simply expand with the automated, non-personal items' delivery by drones (which is done even more away from the front door), or not. The testing of deliveries by drones to a multi-family complex makes the concept of drones flying through apartment corridors with deliveries seem like science fiction.

Anyone wishing to automate their operation but concerned that AGVs cannot fulfill their unique requirements may pick other alternatives for distribution. You may increase the productivity and profitability of your company by utilizing the many different types and technologies of warehouse automation or even delivery automation. Depending on what stage of the distribution process they will be used in, there are several conveyor systems, automated storage & retrieval systems (AS/RS), overhead trolley conveyors, and autonomous mobile robots (AMRs) that one may want to take into consideration as alternatives to AGVs. The biggest difference between AGV and AMR is that AMRs rely on a complex set of inbuilt sensors and maps to perceive their environment (within specific facility i.e., warehouse). AMRs can be engaged in a way that is more adaptable and instinctive.

## ACKNOWLEDGEMENTS

This research was funded by the Ministry of Education, science, research, and sport of the Slovak Republic with the grant number: 07711134.

## REFERENCES

- widespread-take-off/ (accessed Nov. 03, 2022).
- [13] T. van PELT, "Not drones, but AGVs will forever change last-mile parcel delivery," *M3 consultancy*, Sep. 24, 2018. <https://www.m3consultancy.nl/blog/not-drones-but-agvs-will-forever-change-last-mile-parcel-delivery> (accessed Nov. 04, 2022).
- [14] Yonhap, "Korea Post tests autonomous mail delivery vehicles," *The Korea Herald*, Oct. 28, 2020. <http://www.koreaherald.com/view.php?ud=20201028000976> (accessed Nov. 03, 2022).
- [15] Press, "For the first time in Europe, an autonomous unmanned vehicle delivered a parcel on public roads," *sUAS News – The Business of Drones*, May 13, 2022. <https://www.suasnews.com/2022/05/for-the-first-time-in-europe-an-autonomous-unmanned-vehicle-delivered-a-parcel-on-public-roads/> (accessed Nov. 03, 2022).
- [16] "Why Ziegler Group is bringing Autonomous Delivery Vehicles to Europe?," *Ziegler*, Jan. 17, 2022. <https://www.zieglergroup.com/post/gr/why-ziegler-group-is-bringing-autonomous-delivery-vehicles-to-europe/> (accessed Nov. 03, 2022).
- [17] P. Davies, "You can now drive partially 'hands-free' in France. This is what's changing," *Euronews*, Sep. 01, 2022. <https://www.euronews.com/next/2022/09/01/you-can-now-drive-partially-hands-free-in-france-this-is-whats-changing> (accessed Nov. 04, 2022).
- [18] "A new approach to driverless mobility," *Vay*. <https://vay.io/> (accessed Nov. 03, 2022).
- [19] T. Corejova, P. Jucha, A. Padourova, M. Strenitzerova, K. Stalmachova, and A. Valicova, "E-commerce and last mile delivery technologies in the European countries," *PRODUCTION ENGINEERING ARCHIVES*, vol. 28, no. 3, pp. 217–224, 2022, doi: 10.30657/pea.2022.28.26.
- [20] I. Kremenova and D. Koncova, "Green delivery v oblasti poslednej míle v poštových podnikoch na Slovensku," *Pošta, Telekomunikácie a Elektronický obchod*, vol. II, pp. 37–41, 2021, doi: 10.26552/pte.C.2021.2.6.
- [21] L. Gaille, "18 Delivery Drones Pros and Cons," *Vittana.org*, Feb. 11, 2019. <https://vittana.org/18-delivery-drones-pros-and-cons> (accessed Nov. 08, 2022).
- [22] "Pros And Cons Of Delivery Drones," *Grind Drone*, 2022. <https://grinddrone.com/info/pros-cons-delivery-drones> (accessed Nov. 09, 2022).
- [23] T. Battery, "What are the pros and cons of drones delivery? - GensTattu," Aug. 23, 2021. <https://genstattu.com/blog/what-are-the-pros-and-cons-of-drones-delivery/> (accessed Nov. 09, 2022).
- [24] C. Benevides, "Advantages & Disadvantages of Automated Guided Vehicles (AGVs)," *Conveyco.com*, Jan. 05, 2021. <https://www.conveyco.com/blog/advantages-disadvantages-automated-guided-vehicles-agvs/> (accessed Nov. 09, 2022).
- [25] A. Pastor Tella, "Advantages of AGV - 11 Explained Benefits of Automated Guided Vehicles," *agvnetwork*. <https://www.agvnetwork.com/advantages-of-automated-guided-vehicles> (accessed Nov. 09, 2022).
- [26] "AGV Disadvantages: 5 Cons of Autonomous Mobile Robots You Must Know." <https://www.agvnetwork.com/agv-disadvantages#environment> (accessed Nov. 09, 2022).
- [1] D. Koncova and I. Kremenova, "Identification of disruptive exponential technologies of Industry 4.0," *Pošta, Telekomunikácie a Elektronický obchod*, vol. I, pp. 10–15, 2021, doi: 10.26552/pte.J.2021.1.
- [2] I. Kremenova and D. Koncova, "Selected touchless technologies in supply chain," *Pošta, Telekomunikácie a Elektronický obchod*, vol. II, pp. 42–47, 2021, doi: 10.26552/pte.C.2021.2.7.
- [3] "Autonomous Last Mile Delivery Market Size | Global Report 2028," *Market Research Report*, Mar. 2022. <https://www.fortunebusinessinsights.com/autonomous-last-mile-delivery-market-105598> (accessed Nov. 02, 2022).
- [4] "The roadmap to scalable last-mile drone delivery - White paper," *UVL robotics*, 2022. <https://www.uvl.io/white-paper/UVL-Roadmap-to-scalable-last-mile-drone-delivery.pdf> (accessed Nov. 04, 2022).
- [5] "As COVID-19 restriction ease, Elizabeth Baker explores the ways e-commerce delivery companies are using scientific research to futureproof their growth," *Postal and Parcel Technology International - UKi Publication Viewer*, pp. 22–26, Jun. 2022. Accessed: Nov. 02, 2022. [Online]. Available: <https://www.ukimediaevents.com/publication/cce9daf8/26>
- [6] A. Pharand, "Work Together," *Postal and Parcel Technology International - UKi Publication Viewer*, Jun. 2022. <https://www.ukimediaevents.com/publication/cce9daf8/82> (accessed Nov. 04, 2022).
- [7] S. Chevalier, "Global retail e-commerce sales worldwide from 2014 to 2026 | Statista 2022," *eMarketer*, Jul. 2022. <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/> (accessed Nov. 04, 2022).
- [8] E. Cramer-Flood, "Worldwide Ecommerce Forecast Update 2022," *Insider Intelligence Trends, Forecasts & Statistics*, Jul. 29, 2022. <https://www.insiderintelligence.com/content/worldwide-ecommerce-forecast-update-2022> (accessed Nov. 04, 2022).
- [9] "Fleet of Fancy," *Postal and Parcel Technology International - UKi Publication Viewer*, Jun. 2022. <https://www.ukimediaevents.com/publication/cce9daf8/8> (accessed Nov. 03, 2022).
- [10] "Delivery drones for better local supply in rural areas – Wingcopter GmbH," Sep. 28, 2022. <https://wingcopter.com/drone-express> (accessed Nov. 03, 2022).
- [11] "Drone Delivery Solutions," *UVL ROBOTICS*. <https://www.uvl.io/delivery> (accessed Nov. 03, 2022).
- [12] "Package Delivery by Drones: Still Years Away from Widespread Take Off," *Parcel Pending*. <https://www.parcelpending.com/blog/package-delivery-drones-still-years-away->