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**THE INTRODUCTION OF AN ALTERNATIVE DELIVERY NETWORK OF GOODS TO ALLOW FOR INCREASED OVERALL HUMAN SECURITY AND EFFICIENCY**

<b>Abstract:</b>	<p><i>Recent technological developments, as well as the outbreak of the COVID-19 pandemic, resulted in the rapid growth of e-commerce and therefore a huge increase in parcels delivered worldwide. Traditional practices fail to meet new requirements and companies seek new approaches to satisfy increased demand and fast-growing customer needs.</i></p> <p><i>In this context, the resolving of problems related to the “last mile” (the final delivery stage when goods are handed over to the recipient) became a topic of scientific research, as it involves navigating complex and often unpredictable urban environments, dealing with traffic congestion, and making multiple stops to deliver individual packages to different addresses. This part of the delivery process is considered the most challenging and expensive. The research focused on the introduction of an alternative delivery network, based on the “sharing economy” principles and the use of recent technological tools, such as Blockchain, IoT, etc.</i></p> <p><i>The proposed alternative delivery network not only does it addresses some of the operational problems related to the “last mile” but also allows for increased security and transparent monitoring throughout the final leg of the delivery process.</i></p>
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**How technological advancements and the pandemic introduced new business needs**

Gradually over the past 20 years, the postal sector -as we knew it- ceased to exist and a new business model emerged, where traditional postal services were set aside, and new products/services

emerged to meet new and fast-growing customer needs. Technology, at first, played a key role in paving the way for the big change to come. Between 2000 and 2023, internet users, as a percentage of the global population, grew almost by 1.400%, while in some regions (e.g., Africa) growth exceeded 13.000%<sup>433</sup>. E-commerce pioneers (such as amazon.com), after holding on during early turbulent times, are currently well-established and facing fierce competition from numerous new entrants in this rapidly growing market. Retail e-commerce sales are expected to reach 6,9 billion USD by the end of 2024 from 1,3 billion USD in 2014<sup>434</sup>.

In 2020, the world faced an unexpected threat in the form of a global pandemic (COVID-19). The pandemic kick-started a fast-paced transformation process of customers' purchasing habits. E-commerce growth reached 19% globally during 2020 (on top of a 9% expected growth) and 22% during 2022 (on top of a 12% expected)<sup>435</sup>. What's more important, looking closely at the figures, is that e-commerce growth is there after the pandemic threat is gone, which is a shred of strong evidence that customer behavior is significantly transformed and the process of purchasing goods over the Internet will soon replace traditional purchasing habits. This argument is based on a series of studies indicating that a constant growth of 8%-10% will continue to take place until 2026<sup>436</sup>.

In this context, companies are now very much aware of the importance of electronic order management as well as Supply Chain Management in general, and how these drive revenues and profits. The former depends heavily on what we call "overall customer experience" regarding delivery speed, flexibility, and security while the latter on achieving the lowest possible order fulfillment costs.

### **Problems related to the "last mile" and innovative practices to cope with them**

What companies (e-shops mainly) strive to achieve is a balance between efficient customer service, low distribution cost, and safe delivery of goods. At the end of the day, it all comes down to how companies operate within what we call "the last mile", or, in other words, the final delivery stage when goods are handed over to the recipient. Some common problems associated with the last mile of postal items delivery are:

- Inefficient delivery routes: Postal workers may have to drive long distances to deliver packages to isolated or rural areas, which can be time-consuming and expensive.
- Traffic congestion: Delivery trucks can get stuck in traffic, leading to delays and missed delivery windows.
- Address accuracy: Incorrect or incomplete addresses can make it difficult for postal workers to find the recipient's location, leading to delayed or undelivered packages.
- Package theft: Porch piracy has become a significant problem in recent years, with thieves stealing packages from doorsteps and mailboxes.
- Restricted access: In some cases, postal workers may be unable to access certain buildings, leading to missed deliveries.
- Weather conditions: Inclement weather, such as heavy rain or snow, can make it difficult for postal workers to deliver packages safely and on time
- Lost Parcels: A significant number of parcels go missing during the delivery process due to the lack of an efficient monitoring system.

Postal operators and transportation companies, currently, are seeking to exploit technological advancements to tackle all the above, minimize cost and enhance delivery efficiency. Several innovative practices have emerged in recent years regarding mail and goods delivery, such as:

- Predictive analytics: Some companies use predictive analytics to optimize their delivery routes and schedules. By analyzing data on factors like traffic patterns (using telematics) and delivery history, companies can identify the most efficient delivery routes and reduce delivery times and, by extension, delivery costs.

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<sup>433</sup>Miniwatts Marketing Group, <https://www.internetworldstats.com/stats.html>, (16.05.2023)

<sup>434</sup>Statista, <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>, (16.05.2023)

<sup>435</sup>International Trade Administration, <https://www.trade.gov/impact-covid-pandemic-ecommerce>, (16.05.2023)

<sup>436</sup>eMarketer Insider Intelligence, <https://on.emarketer.com/rs/867-SLG-901/images/eMarketer%20Global%20Retail%20Ecommerce%20Forecast.pdf>, (16.05.2023)

- Smart lockers: Smart lockers, like those provided by Amazon and UPS, allow customers to pick up their packages at a convenient location, such as a grocery store or gas station. This reduces the need for multiple delivery attempts and helps to prevent package theft.
- Drones: Companies like Amazon and UPS are experimenting with the use of drones for package delivery. Drones can deliver packages quickly and efficiently, especially in remote or hard-to-reach areas.
- Autonomous delivery vehicles: Self-driving delivery vehicles are being developed and tested by companies like Ford and Walmart. These vehicles have the potential to increase efficiency and reduce costs in the delivery process.

The development and final deployment of some of the above is still at an early stage since the maturity level of the associated technologies is still low. Moreover, most of them require significant investment in assets, equipment, and other resources, increasing the risk of poor future returns, should the market and/or the competition not eventually evolve as initially expected.

### **An alternative delivery network**

Traditional postal services either fail to provide an acceptable customer experience (e.g., collection from local post offices by the recipient) or fulfill customer needs at the expense of increased delivery costs (e.g., multiple failed delivery attempts due to recipient absence, erroneous recipient address, etc.).

Normally, each postal operator deploys a delivery network using either its resources in association with self-operated access points, or 3<sup>rd</sup> party resources and assets within the context of a mutual agreement (e.g., franchisees). Either way, postal operators are expected to build such a network from scratch, be responsible for its smooth operation and use it exclusively to fulfill their own operational needs. The problem lies in that the building, handling, maintenance, and continuous modification of such a network, designed to meet current requirements and follow constantly changing customer traits, is no walk in the park for any postal operator, no matter how big or small the company is.

Moreover, continuous changes in the product mix of postal products/services (e.g. major drop in the demand for traditional postal letters in conjunction with a dramatic rise of parcels and small parcels, as a result of what we call the “electronic substitution” or simply a sudden decision of a major client to switch supplier and choose a competitor) enhance the investment risk of building such a network, since none of its characteristics (capacity, delivery options, technologies, etc.) can be taken for granted by any single postal operator, with the small players to appear a lot more vulnerable<sup>437</sup>

Taking all the above into account, a challenging research topic came up, aiming to:

- reduce investment risk;
- enhance delivery efficiency;
- improve customer satisfaction;
- reduce distribution and delivery costs.
- ensure privacy and data security.

The research finally focused on the introduction of a new alternative delivery network model, based on the “sharing economy” principles, that can be implemented with the use of recent technological tools, and more specifically, the use of Blockchain technology.

In this context, a wide platform will be created, able to hold all existing parcel delivery points from all collaborating partners (postal operators), allowing every operator to make use of any available delivery point when such a need comes up. Moreover, local businesses and outlets may also join the marketplace acting as parcel storing and/or pick-up points. Before going into detail on the proposed model, the basic components of the value chain are presented below.

<b>Component</b>	<b>Role in the value chain</b>	<b>Basic Needs / Challenges</b>
<b>Customer/ Consumer</b>	Selects and purchases desired goods through the Internet.	Low transaction cost, goods receiving at the desired time and place, goods overall receiving the

<sup>437</sup> Haya R. Hasan, Khaled Salah, *Blockchain-based proof of delivery of physical assets with single and multiple transporters*, in “IEEE Access”, Vol. 6, 2018, pp. 46781-46793

Component	Role in the value chain	Basic Needs / Challenges
		reliability, support mechanisms to cope with potential problems.
<b>E-shop</b> (Manufacturers, Wholesalers, Retailers, etc.)	Informs the customer on available goods on sale along with their characteristics and assists in choosing the desired goods, within a secure transactional environment.	Sales and profit maximization, decrease in returns and proper handling should they occur, customer request handling, transaction security, delivery time minimization, and an overall increase in customer satisfaction.
<b>Sender</b> (Manufacturers, Wholesalers, Retailers, etc.)	Sends postal items (goods) to people or companies.	Low cost, efficient transportation, and transportation time minimization.
<b>Carrier</b> (Warehousing /Transportation, companies, Postal operators)	Companies that receive goods from Senders, store, transport, and deliver them to recipients (Customer/ Consumer).	Low operational cost, transportation efficiency and security until the final delivery of goods to the recipient, decrease in delivery time, increase in successful delivery attempts, minimization of returns.
<b>Recipient</b> (Customer/ Consumer)	Selects and purchases desired goods through the Internet.	Low transaction cost, goods receiving at the desired time and place, goods overall receiving the reliability, support mechanisms to cope with potential problems.

**Table 1: Alternative network value chain<sup>438</sup>**

To come up with the optimum network, a 3-factor approach was used:

- The first factor is the Expected Parcels per Capita (EPpC), which depends on the average daily parcel deliveries per person of a given geographical area and the estimated market share for the specific area.
- The second factor is the Pickup Point Capacity (PPC) which depends on the characteristics of the pickup point in terms of size, location, type, opening hours, etc.
- The third factor is the estimated number of people ( $P_i$ ) that are expected to choose the alternative network to collect their parcels. The number of people is subject to the distance between the resident and the nearest Pickup Point, according to the following formula<sup>439</sup>:

$$P_i = \sum_{j=1}^n M_j * \exp(-\lambda * d_{ij}) \quad (1)$$

where:

- $P_i$  is the potential number of people attracted to the pickup point I,
- $M_j$  is the population of the area j,
- $d_{ij}$  is the distance between i and j, and
- $\lambda$  is the exponent of the function.

<sup>438</sup> Sifis Plimakis, Alexandros Triantafyllakis, Ioannis Papastilianou, Nikolaos Ladogiannis, *PI.1: Operational Model&Processes*, Research funded by the Operational Program Competitiveness, Entrepreneurship, and Innovation, under the call Research-Create-Innovate, Athens, p.18, 2023

<sup>439</sup> Hans Skov-Petersen, *Estimation of distance-decay parameters -GIS-based indicators of recreational accessibility*, Danish Forest and Landscape Research Institute, Copenhagen, 2001, p. 5

The estimation of the exponent parameter  $\lambda$  is crucial. The higher the value of  $\lambda$ , the greater the decline of influence on the population as the distance increases. A distance-decay parameter measures the relationship between observed interaction patterns and distance when all other determinants of interaction are constant. The parameter is estimated as the best fit to the current situation, represented by an empirical data set. Distance-decay, both in terms of the function involved and the parameters, varies between different regions, for different activities, and different modes of transport. Distance-decay parameters are functions of spatial structure as well as interaction behavior<sup>440</sup>. Hereby the modeling of spatial behavior is not just a consequence of the available transport system – which again is, at least partly, a function of the local topography, etc. - but also social differences, etc. Hence, the parameter  $\lambda$  could be different in rural and non-rural areas as well as in high and low commercial areas.

Therefore, the  $\lambda$  parameter for the calculation of the estimated number of people ( $P_i$ ) that are expected to choose the alternative network to collect their parcels could accept multiple inputs based on the social, physical, and commercial characteristics of the given area.

The aim is to maximize the profit from a potential number of people that will choose an alternative delivery point with the minimum number of Pickup Points (Smart Locker and Commercial Stores). Hence, optimal profit can be calculated according to the following formula:

$$\max [Profit] = \sum_{j=1}^n \sum_{i=1}^{m_j} \left( P_i * EPpC_j * \left( GP - \frac{SC_i}{PPC_i} \right) \right) \quad (2)$$

where:

- n total number of areas
- $m_j$  total number of pick-up points of area j
- $P_i$  is the potential number of people attracted to the pickup point i,
- $EPpC_j$  is the expected parcels per capita of area j
- GP is the average gross profit per parcel (price minus fee & unit variable cost)
- $SC_i$  is the setup cost of pick-up point i (Smart Locker purchasing cost, installation, etc.)
- $PPC_j$  is the parcel capacity of the pick-up point i

### Increased security in the delivery of goods and other benefits

Blockchain technology can be used to enhance the security and efficiency of postal services in several ways. Here are a few examples:

- *Package tracking*: postal services can use Blockchain to track packages and parcels in real-time as they move through the delivery process. This would enable customers to monitor the progress of their packages and would help to prevent theft and loss.
- *Identity verification*: blockchain can be used to verify the identity of senders and recipients of mail and packages. This would help to prevent fraud and identity theft and ensure that packages are delivered to the right recipient.
- *Secure data exchange*: postal services can use Blockchain to securely exchange data and information with other parties, such as customs agencies or law enforcement. This would help to protect sensitive information and would ensure that only authorized parties have access to it.
- *Payment processing*: postal services can use Blockchain to process payments for services such as delivery fees. This would help to reduce fraud and would make it easier for customers to make payments quickly and securely.

Overall, Blockchain technology has the potential to improve the security, efficiency, and transparency of postal services, making them more reliable and trusted by customers and is expected soon to play a crucial role in the delivery of goods coming from e-shops, since it allows the sharing and validation of all participants without requiring a relationship amongst them or the existence of a proxy/mediator. More specifically, a public Blockchain key can be used to solve the issue of “personalized receipt”, which will authenticate the users right after they enter the platform. Moreover,

<sup>440</sup> Stewart Fotheringham, *Spatial structure and distance-decay parameters*, in "Annals of the Association of American Geographers", UK, Vol. 71, No. 3, 1981, pp. 425-436

details such as receiver name, receiver address, the association of the delivery code with both the sender as well as the receiver, and the authentication of the receiver, (when such a thing is required), will be stored unaltered in the Blockchain. In addition, a “digital signature”, provided by the Blockchain platform, could be used in all transactions that will take place and will be stored within the transaction, allowing every member to authenticate every bit of data. The digital signature used in the process of parcel receipt is expected to be the most efficient and innovative solution to the issue of “personalized receipt”<sup>441</sup>.

Furthermore, shortly, Blockchain will play a dominant role in the transparent monitoring process of goods, since the exact location of goods can be monitored using GPS devices, while actual data related to the arrival of goods to every station, as well as the delivery code, can also be stored in the Blockchain<sup>442</sup>.

Additionally, Blockchain is expected to play a vital role in coping with issues related to the recording and monitoring of critical-security actions, since key actions, such as item shipment, item delivery, failed deliveries, and timestamps of all events will all be stored within the Blockchain, as mentioned above.

Apart from data security, the proposed alternative delivery network is expected to increase physical items’ security by reducing the risk of theft, loss, obliteration, etc., since it is based mainly on smart lockers, a delivery alternative that was introduced to cope with this issue along with providing the recipients the ability to collect their items at a convenient location, anytime they wish<sup>443</sup>.

Currently, parcel theft is on the rise, and it is considered to be a growing problem, should no appropriate measures are not taken promptly. According to a recent survey<sup>444</sup>, more than 1 billion packages were either stolen or lost globally between May 2021 and April 2022, with the UK witnessing the largest increase (500 base units), from 7% of the total population affected to a staggering 12% during the 12 months. According to the findings of the survey, one in ten people across the world said they had at least one parcel lost or stolen during the 12 months and almost one-third of the global population have suffered a parcel loss at least once in their lifetime.

The use of smart lockers can increase parcel security in many ways, such as:

- *Secure location*: By providing a secure location for package pickup, smart lockers eliminate the need for packages to be left unattended on doorsteps or in mailboxes.
- *Access control*: Smart lockers are accessed using unique codes or mobile app authentication, which prevents unauthorized access and reduces the risk of package theft.
- *Secure storage*: Smart lockers are designed with security in mind, using features like reinforced steel construction and tamper-proof locks to protect packages from theft or damage.
- *24/7 monitoring*: Smart lockers are typically monitored by security cameras and staffed with personnel who can assist with package pickup. This helps to deter theft and ensure that packages are delivered safely.
- *Efficient package retrieval*: Smart lockers can improve the speed and efficiency of package delivery, allowing customers to pick up their packages at a time and location that is convenient for them.
- *Minimum manual handling*: Since fewer people are involved in the handling of parcels delivered through smart lockers, the possibility of loss/theft is considerably reduced.

Besides security, the use of smart lockers offers more benefits to consumers, businesses, and the community in general, such as:

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<sup>441</sup> Serkan Karakas, Zafer Acar, Berk Kucukaltan, *Blockchain adoption in logistics and supply chain: a literature review and research agenda*, in “International Journal of Production Research”, UK, 2021, p. 1-24

<sup>442</sup> Dounia Marbough, Tayaba Abbasi, Fatema Maasmi, Ilhaam Omar, Mazin Debe, Khaled Salah, Raja Jayaraman, Samer Ellahham, *Blockchain for COVID-19: review, opportunities, and a trusted tracking system*, in “Arabian journal for science and engineering”, No. 45, 2020, pp. 9895-9911

<sup>443</sup> Anuj Batta, Mohina Gandhi, Arban Kumar Kar, Navin Loganayagam, Vignesh Ilavarasan, *Diffusion of blockchain in logistics and transportation industry: an analysis through the synthesis of academic and trade literature*, in “Journal of Science and Technology Policy Management”, No. 12(3), UK, 2021, pp. 378-398

<sup>444</sup> *The Penn Elcom Global Parcel Theft Report 2022*, p. 4, Global Parcel Theft Report 2022 | pennparcelbox-usa, (21.05.2023)

- *Convenience*: smart lockers offer a convenient way for consumers to receive their packages. They can be in a variety of locations, including apartment buildings, office buildings, and shopping centers, allowing consumers to pick up their packages at a time and location that is convenient for them.
- *Efficiency*: smart lockers can improve the efficiency of package delivery by reducing the need for delivery drivers to make multiple stops to deliver packages. Instead, packages can be delivered to a central location, where they can be sorted and stored for pickup.
- *Cost savings*: smart lockers can help businesses save money on delivery costs by reducing the need for delivery drivers and eliminating the need for re-deliveries due to missed deliveries.
- *Sustainability*: smart lockers can help reduce the environmental impact of package delivery by reducing the number of delivery vehicles on the road and promoting more efficient package delivery routes.

## Conclusions

The main topic of the research was the introduction of an alternative delivery network, based on the “sharing economy” principles and the use of recent technological tools, aiming not only to address some of the operational problems related to the “last mile” but also to allow for increased security and transparent monitoring throughout the final leg of the delivery process, contributing to increased location & storage security, advanced monitoring, identity verification as well as secure data & payments handling.

The implementation of the proposed alternative network will pave the way for future security improvements, by incorporating technologies to enhance monitoring capabilities, such as temperature & humidity control, required in the cases of perishable goods/foods, pharmaceuticals, etc.

Moreover, the proposed alternative network could immediately be implemented with the use of current knowledge and technology and be effortlessly adopted by postal operators and transportation companies.

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