

Delivery Models in Last Mile Logistics

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Abstract In logistics the key problem of last mile is how to deliver goods from distribution hub to end users in cities and built-up areas. The paper deals with an issue of last mile delivery. The main objective of the paper is to analyse possible solutions how to deliver consignments to end customers. To achieve the aim, we realized secondary research in which we identified seven basic delivery models. Some of the delivery models are traditional, but there are delivery models which are a matter of the near future. One of the most appropriate solutions how to enhance effectiveness in the process of last mile delivery is to take advantages of every identified delivery model. Results of the research also imply a comparison of delivery models.

Keywords Last Mile, Delivery Models, Drones, Droids, AGVs

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1. Introduction

At present, we very often meet with the term of last mile, but a lot of people do not know what the term means. The last mile or last kilometre is a phrase widely used in the field of electronic communications, transportation, logistics, and internet industries. It can be described as a segment of delivery of products to customers located in dense areas. In supply chain management and transportation planning the term of last mile is defined as the movement of people and goods from a transportation hub to a final destination. Typical examples of the final destination are homes, retails, restaurants and other businesses.

The term of last mile was originally used in the field of electronic communications to refer to the final leg of the telecommunications networks that deliver services to customers. Then the term of last mile has been applied to supply chain management. The last mile delivery is a part of city logistics or urban logistics. There are lots of definitions of city logistics and it is very difficult to say which definition is the best. The city logistics can be described as “The process for optimizing both logistics and transport activities done by private companies in urban areas while considering the traffic environment, traffic congestion and energy consumption within the framework of a market economy” (Taniguchi et al., 1999). The city logistics also includes the transport of materials, waste collection, retail deliveries, postal and courier services. [1] [2] [3] [4]

2. Analysis of the Current State

In everyday life the last mile problem is quite a simple one. The public transport does not take people exactly where they need to go, and there are various types of transport that are not coordinated. Of course, everyone does not possess a car or other type of vehicle and it is very important to say that parking is not always available in every part of city or other place. Another problem is a poor infrastructure and lots of traffic jams.

In logistics the key problem of last mile is how to deliver goods from distribution hub to end users in cities and built-up areas. There are innumerable problems that the last mile delivery faces.

Poor Infrastructure

In developing countries there is an insufficient network of transport infrastructure what causes lots of problems associated with the delivery of goods. There is a lack of roads, highways, bridges, terminals and so on. Limited network of transport infrastructure means long journeys, inefficient routes, high costs of delivery of goods, time delays and other very serious problems. [5] [6] [7] [9]

Inefficiency

One of the main problems of last mile logistics is inefficiency. The inefficiency is caused by providing individualized shipment services to often unreliable destinations through constantly changing routes. Another issue of the inefficiency is a level of unpredictability in transit and customer availability in places of delivery. Carriers also must

count with consignment thefts and costs associated with this fact. There are whole range of issues associated with last mile logistics that can be a source of inefficiency. [5] [6] [7] [9]

Transparency

As in other areas of social life we can monitor increased demand of customers for value-added services. One of the main requirements is transparency of the product. In general, people have always had the desire to know, anticipate and to have an overview. Due to the requirements of customers postal and logistics companies have had introduced various new products into their product portfolios. One of the most important services is the possibility of tracking a consignment. Nowadays, Track & Trace services provide information about details of the delivery status and the last performed operation in the shipment process.

In the modern on-demand era, tracking services do not satisfy needs of customers because they want to have a real-time visibility of the consignment in every minute of the delivery. Customers want to know where the courier is and when he will arrive. [5] [6] [7] [9]

Various Types of Goods

Type of goods can be a big challenge of the last mile delivery. There are two category of consignments: generic and specific. Specific consignments require special arrangements because they may cause damage of the environment, for example toxic, fragile, flammable, perishable or large sized consignments. Due to the fact there are special conditions for vehicles (temperature requirements, special requirements regarding dangerous consignments, side loader, tailgate lift, etc.). The last mile delivery of specific goods requires very complex planning that costs lots of time, money and knowledge. [7] [8] [9]

3. Methodology

The primary aim of the paper is the identification of last mile delivery models and the possible solutions how to efficiently deliver shipment to end customers. Other objective of the article is to inform readers about the concept of city logistics and the last mile delivery problems. To achieve the goals, we realized secondary research in which we used various scientific methods. Among basic methods of the secondary research belong method of collecting and processing data, analysis and synthesis of knowledge, methods using the principles of logic and logical thinking and the comparison method. The main sources of the secondary research are information materials of foreign authors dealing with the issue of the last mile delivery.

4. Results

There are various solutions of the last mile delivery problems on the market. It is very difficult to propose an optimal solution for all regions. All solutions of the last mile delivery

should be designed with regard to the specifics of the particular region.

At present, we can find various delivery models. Some of the operational models are traditional, but there are delivery models which are a matter of the near future. There are identified seven operational models.

4.1. Traditional Models of Last Mile Delivery

Now we know three basic traditional models of last mile delivery. Every of the traditional models has some advantages and disadvantages.

Today's Model

In today's model the delivery is provided by authorized person of the logistics or postal operator. By the term "authorized person" we mean a courier or postman. The authorized person picks up the parcels at a consolidation point and delivers them to the addresses. In today's model, there is very popular hub and spoke concept. The hub and spoke network is based on the existence of one logistics centre (hub) from which a certain territory is served in a spoke way. Typical delivery vehicles are large vans. [10] [11] [15]

Model of Bike Couriers

In model of bike couriers, delivery is provided by employees of the postal or logistics company. These employees deliver small number of parcels by bikes. Bike couriers are used in big cities in point-to-point delivery. Typical examples of consignments are B2B documents, food or pharmaceutical products. [10] [11] [15]

Model of Crowdsourcing

Crowdsourcing is a network where any members who have signed up as drivers can choose to perform a specific delivery order. The main benefit of the model of crowdsourcing is flexibility in supply. [10] [11] [15]

4.2. Future Models of Last Mile Delivery

In this chapter, there are identified four modern last mile delivery models that can improve last mile delivery process. Each of the models brings certain benefits and threats.

Delivery by Drones

Drones are autonomous aircrafts or unmanned aerial vehicles (UAVs) that can carry parcels to their destinations along the most direct route. The maximum weight of transported parcels is up to 15 kg. Primary condition of the delivery by drones is supervising.



Figure 1. Drone Delivery

(Source: Jamie Condliffe. Delivery Option: Drone. Arrival Estimate: 2020. 2016. Online Available: <https://www.technologyreview.com/s/602527/delivery-option-drone-arrival-estimate-2020/>)

There are lots of studies indicating that cargo drones can play a significant role in last mile delivery. Many large companies like Amazon, Google or Airbus have launched research programs for drones that develop very quickly. In some rough environments like Africa or Canada, cargo drones transport medication to long-distance areas.

Cargo drones can help to resolve problems that densely populated regions face nowadays. Among the most important issues belongs inefficiency of delivery in the last mile, pollution of air or overcrowding of roads by cars.

Of course, we have to say that there are lots of obstacles in implementation of drones in cities. Among the most significant barriers belong legislative – laws and regulations. It is very necessary to exact rules how the drone transport should work. Other very relevant obstacle is cybercrime because various connected devices can be hacked and subsequently misused. It follows that safety and security should be the number one in designing drones. There are far more issues that must be solved in the case of the implementation of drones in the last mile logistics. [10] [11] [12] [15]

Delivery by Autonomous Ground Vehicles (AGVs) with Lockers

Autonomous ground vehicles are vehicles that do not need an on-board human presence. These vehicles deliver parcels without any human intervention. Customers get notifications about the exact arrival time. AGVs contain lockers where customers can pick up the parcels. These autonomous ground vehicles are called mobile parcel lockers.

The operation of AGVs needs to be supervised. One supervisor could manage route eight to ten autonomous ground vehicles. Benefits of AGVs are flexibility, safety, scheduling, exact tracking or accountability. [10] [11] [13] [15]



Figure 2. Autonomous Ground Vehicles with Lockers

(Source: Disha Amin. AUTONOMOUS GROUND VEHICLES (AGVS) WITH LOCKERS. 2018. Online Available: <https://logisticsmgpsupv.wordpress.com/2018/05/14/autonomous-ground-vehicles-agvs-with-lockers/>)

Delivery by Semiautonomous Ground Vehicles

In model of semiautonomous ground vehicles, there is still required a delivery person, but he could theoretically use the driving time more efficiently to take care of sorting or smaller administrative tasks e.g., scanning or announcing arrival while the vehicle does the driving. There are lots of advantages and disadvantages in the delivery by semiautonomous ground vehicles. Among minuses of this delivery belongs higher investment cost, because AGVs are more expensive than classic delivery cars or vans. Sometimes, the movement of the delivery person can be limited because of obstacles on the way. [10] [11] [13] [15]

Delivery by Droids

Droid is a small robotic machine or autonomous vehicle which comes in various shapes or sizes. In logistics, droids are bigger than a regular parcel.



Figure 3. Droid: Self-driving Robot

(Source: Tiny self-driving robots have started delivering food on-demand in Silicon Valley — take a look. Melia Robinson. 2018. Online Available: <https://logisticsmgpsupv.wordpress.com/2018/05/14/autonomous-ground-vehicles-agvs-with-lockers/>)

Delivery by droids is provided to the doorstep. These vehicles are equipped with GPS and camera for navigation. To ensure safety in delivery, droids are opened with a unique code known only to the customer. Droids also use sensors to avoid obstacle on the road. The speed of the droid is 5 to 12

kilometres per hour, but the speed depends on the type of the droid. Like drones or AGVs, droids have to be monitored by human operators. One operator or supervisor would manage 50 to 100 of droids due to the small size and low speed. Delivery by droids is very ecological because droids do not pollute air like vehicles and they work with low noise. The energy consumption of the droid is equal to light bulb, so we can say that this solution of the delivery is very economic. [10] [11] [14] [15]

4.3. Comparison of Last Mile Delivery Models

Each of the models examined comes with benefits and limitations. In the table 1. there are summarized the key advantages and disadvantages of each model and also the stage of use.

Table 1. Comparison of last mile delivery model

<i>Model</i>	<i>Benefits</i>	<i>Limitations</i>	<i>Stage of use</i>
Today's	Personal contact between business and customers, acceptance by the public, very low investment cost, providing consultations to customers by delivery person	Noise, high-cost solution, pollution of air, poor or overcrowded road infrastructure, fatigue of driver	Utilization in every country
Bike Couriers	Ecological delivery, low-cost solution, noise	Possibility to deliver only small consignments for short distances, fatigue of driver	Utilization in big cities
Crowdsourcing	Flexibility in supply, lower costs of delivery	Thefts, delivery person is not authorized, pollution of air, noise, fatigue of driver	Utilization in developed countries
Drones	Fast and flexible delivery, environmentally friendly solution, possibility to reach remote or hard-to-reach locations more cheaply, solution of poor infrastructure problem	Legislative, Supervising – they must be monitored by human operators, maximum weight of parcels is 15 kg, cybercrime - safety and privacy issues, delivery distance limitations, noise, higher investment cost	Pilot version of use
Autonomous Ground Vehicles	Fast and flexible delivery (scheduling, exact tracking or accountability), low-cost solutions, environmentally friendly, cost-efficient to reach remote locations,	Supervising – AGVs must be monitored by human operators, cybercrime - safety and privacy issues, higher investment cost	Experimental stage of use
Semiautonomous Ground Vehicles	Possibility to use the driving time more efficiently	Cybercrime - safety and privacy issues, higher investment cost, sometimes obstacles in movement of the delivery person	Utilization in some areas
Droids	Low-cost solutions, environmentally friendly, low-noise device	Supervising – they must be monitored by human operators, low speed, possibility to deliver only small consignments, cybercrime - safety and privacy issues, theft issues	Pilot version of use

5. Conclusions

The development of modern technologies and digitization significantly changes the logistics and postal services. In last

mile delivery postal or logistics operators can apply various achievements of modern technologies. Due to development of modern technologies we can see lots of new delivery models. The main objective of the new delivery models is to reduce carbon footprint. All the modern last mile delivery models are environmentally friendly and their impact on the environment is minimal. One of the most prospective models is drone delivery that can resolve current problems of last mile like poor infrastructure, overcrowding of roads or inefficiency. However, we have to state that modern delivery models do not provide an opportunity of personal contact between businesses and customers. A very serious risk of modern delivery models is cybercrime and potential issues with safety and privacy. Finally, we have to conclude that every delivery model has some advantages and disadvantages. Each delivery is different and it is very important to select optimal delivery model for a particular type of consignment.

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