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THE USE OF DRONES IN E-COMMERCE LOGISTICS AND SUPPLY CHAIN MANAGAMENT

A Literature Review

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<p>Abstract</p> <p>Today, drones are considered to be on the most advanced supply chain management instruments, connecting warehouses to outlet points and individual customers. Companies are looking for new markets, services, technologies, and, of course, new customers. The profitability of a business directly depends on the efficiency of the organization of the supply chain, and the goal of the efforts of logisticians is to have the required stocks at the right time in the right place and create a flexible supply system in which the product and the client are close to each other.</p> <p>Such tasks have always faced logisticians and were solved with varying degrees of efficiency and labor costs. However, today the level of technology development is able to support any initiatives of companies pursuing ambitious goals in the field of digital transformation. Modern IT tools ensure the implementation of many requirements arising in warehouses - key links in the supply chain.</p> <p>In the near future, humanity will have to solve several problems on a global scale: climate change, powerful demographic shifts, shrinking natural resources, as well as problems with crops due to global warming in parallel with the growing demand for food.</p> <p>The use of drones in the supply chain has become one of the main tasks of giant companies, each of them has already designed its own flying carrier and is already conducting tests. This article will cite the possible the current usages of drone in e-commerce logistics and the implications it might have on such field, the advantages and disadvantages of it.</p>	
<p>Keywords Unmanned aerial vehicle, UAV, Microdrone, Warehouse, Supply chain, E-commerce.</p>	

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1 INTRODUCTION

Drones are attracting attention as a way to solve the world's logistics problems. Demonstration experiments have already been repeated at major e-commerce companies such as Amazon, and the future of drones flying overhead for product delivery should not be long. Legislation is being developed at a rapid pace in many countries to utilize drones for logistics. There are still many issues to be solved, but it is expected that they will solve serious logistics issues such as a shortage of drivers and deterioration of the working environment.

The thesis analyzes the possible and current uses of drones in e-commerce logistics and the implication it might have on it in the future, whether it is possible for such devices to be utilized at the present time and the solutions it might provide for the current industry.

In general, drones are attracting attention as a way to solve the world's logistics problems. Demonstration experiments have already been repeated at major e-commerce companies such as Amazon, and the future of drones flying overhead for product delivery should not be long. Legislation is being developed at a rapid pace in many countries to utilize drones for logistics. There are still many issues to be solved, but it is expected that they will solve serious logistics issues such as a shortage of drivers and deterioration of the working environment.

Despite the challenges of drone delivery in the United States, some large companies are concerned about the future of drone delivery. In early September 2020, Amazon was approved by the Federal Aviation Administration (FAA) to start delivering drones as an air carrier. It is the third company in the United States after UPS and Alphabet subsidiary Wing. Amazon also has drone development centers in the United Kingdom, Austria, France and Israel.

2 DRONES AND HOW THEY WORK

2.1 Definition of a drone

A flying drone, it is a multi-, quadro-, hexa, octo or just a copter, is a robot with a camera, controlled by a person remotely using a remote control, or through an on-board computer. Drones can have a very different technological design. They are equipped not only with screw engines, but also with various types of turbines. They are divided into permanently controlled and only transmitting signals. In general production, civilian devices are currently in the lead in number and military in importance. Whereas recently they were used exclusively by the military.

Usually, all aerial drones controlled by an operator from a remote control on the ground are called a drone. The term drone was originally used in Old English to refer to a male bee whose only work is to mate with the queen bee. Translated from English, drone means bumblebee, and the main rea-

son for this name was the noise emitted by the apparatus, and similar to the sound of bumblebees flying.

2.2 How the name of the unmanned vehicle was born

The origin of the word "drone" is still controversial among linguists. The most well-established opinion on this matter argue that the name of the UAV arose at the turn of 1934-35, when low-flying biplanes appeared in the world, buzzing like a swarm of bees (drone). The similarity of drone with these devices was striking: they were "lazy", could not maneuver, even accelerate, while producing a characteristic monotonous hum.

For a quarter of a century, only target aircraft were called in this way, but in the fifties and especially the sixties of the last century, all drones somehow naturally ranked as drones, from cruise missiles to unmanned spacecraft at that time. In the late nineties, the United States Air Force developed military Predator UAVs and Hellfire missiles, which were first used after the September 11, 2001 "terrorist attack." At this time, with the light hand of journalist Bob Woodward, the phrase "Predator drone" appears - and soon in colloquial and then official (written) speech, all the technical means moving through the air and water without a pilot - from military vehicles to multicopters palm-sized - began to be called drones. Some, especially principled, linguists argue that drones can only be called military aircraft that shoot missiles or conduct reconnaissance. Nevertheless, it is generally accepted that any modern drones, including the widespread quadrocopters, are essentially drones.

2.3 The history of the creation and production of drones

It is generally accepted that the advent of electricity and radio became the catalyst for the creation of remotely controlled vehicles. This technology was used by the Austrians in 1849, using wires to control balloons. Later it was talked about attempts to use the technology to control the diaphragm. But it was only in 1899 that Nikola Tesla was able to introduce a radio-controlled vessel. The history of the creation of unmanned aerial vehicles goes back to the First World War. Even then, people tried to make flying torpedoes. However, the projects did not reach not only mass implementation, but did not go beyond the level of constructing concepts and calculations. They tried to test some prototypes in Germany, Britain and the United States, but they were not crowned with success. The developments formed the basis for the creation of cruise missiles, which were actively used by the German army during the Second World War. At the same time, attempts were made to create winged torpedoes. In the interwar period, UAVs were used mainly as targets. Some relatively stable use of drones can only be attributed to the late 60s and early 70s of the 20th century. During this period, the USSR created the La-17R unmanned reconnaissance aircraft, the Tu-121 supersonic cruise missile, which became the basis for the development of the Tu-123, Tu-141 and Tu-143 jet

reconnaissance aircraft. According to various sources, the "Flight" modification is still used now, already in the form of an improved and modern Tu-300.



Figure 1 The Kettering "Bug" UAV (United States Air Force)

The use of unmanned aircraft in the United States was somewhat more extensive. In addition to reconnaissance targets, drones also played the role of delivering deep-sea mines needed to combat submarines. Such a mission was assigned to a radio-controlled combat helicopter QH-50 DASH. But the main goal was still to collect data on the state of the enemy. So, during the Vietnam War, US Army drones flew 3435 sorties. Their main task was aerial reconnaissance. Another country that has historically actively developed its own programs for the use of unmanned aircraft is Israel. UAVs were used by her during the war with Egypt, the coalition of Arab countries and Lebanon. During the hostilities related to the conflict with Syria, the locations of the radar stations were identified using UAVs, after which they were suppressed by missile strikes.

2.4 Drone design features

Drones or UAVs are similar in design to a helicopter, with spaced beams on which propellers are installed. Depending on the purpose, the number of engines and propellers on drones can be from four to eight. Although sometimes there are devices with a large number of engines.

In the middle, all the necessary electronic stuffing for control, the so-called flight controller, is installed, and stands are attached for safe landing of the device. The flight controller is powered by a battery and interacts with altitude sensors, a gyroscope, and a signal transmission and reception system.

On a signal from the control panel or according to a pre-programmed program, he can change the speed, altitude, and perform other actions typical of a variety of drones. Drones, according to their flight characteristics, are conventionally divided into the following classes:

- Micro. The lightest UAVs, weighing up to 1 kg, can stay in the air for 1 hour, gaining an altitude of 1 km.



Figure 2 A picture of a Micro-drone.

- Mini. The weight of the drones is up to 50 kg, they can be in the air for 5 hours, and the flight altitude is from 3 to 5 km.
- Mid class. UAV of middle class, weight can reach 1 ton. Duration of stay in the air 15 hours. The drones are capable of flying at altitudes up to 10 km.
- Heavy UAVs. Such drones are used for long flights lasting more than 24 hours. Their weight exceeds 1 ton, and they can rise to a height of 20 km.

The design of the drones includes satellite navigators and a programmable module, depending on the flight conditions. In cases where the UAV makes video recording and transmits information to the control panel, a memory card and a transmitting device are mounted in it.

2.5 Types of drones

Copters are difficult to classify, conditionally they can be divided into the following categories:

- Commercial - for express delivery of parcels, as well as for agricultural needs
- Military - for observation, reconnaissance and dropping bombs (a separate article will be released soon about this)
- Civilians - they help control the territory and provide security
- Search engines - they help in finding victims in places where disasters have occurred

Space is the drones of the future. They are being developed at NASA to search and collect soil samples on other planets.

Perhaps one more type can be distinguished - amateur. Those who are friends with physics are probably wondering how to make a flying drone on their own ? Great news for you - ready-made kits for assembling copters have already been invented.

2.6 How household drones appeared

As the history of the emergence and development of drones shows, for a long time these drones were used by people for purely military purposes. However, UAVs gradually began to be used in various sectors of the national economy and for scientific research. But consumer, or household, drones, in particular the quadcopters so popular today, appeared at the turn of the twentieth and twenty-first centuries thanks to fans of radio-controlled flying models. At this time, smartphones were already widely used in everyday life, and amateur designers realized that these gadgets have everything that is needed for an autopilot and remotely controlled vehicle. Mobile phones became cheaper and more convenient to use their parts in drones. In addition, the necessary components began to appear on the market.

2.7 What smartphone parts are useful for household drones:

- Gyroscope: This small sensor makes the drone go where you tell it in the form of a contactless command;
- Accelerometer: Another mobile sensor that helps the drone maintain altitude, determine the direction and speed of movement;
- Microcomputer: A processor that every year makes the drone more "smart" and perfect. By the way, modern manufacturers produce them for both mobile phones and UAVs
- GPS-navigator which helps to orientate in space not only for a person, but also for a drone
- Video camera: The precision (respectively, the price) of both a smartphone and a drone depends on its quality.

It is worth noting that drones produced by reputable companies, even having acquired a commercial purpose, were at first very expensive and required experienced specialists for their management and maintenance. Therefore, no one could have imagined that soon these devices would become available to the average consumer. However, in 2010, startup Parrot showed off the AR Drone, controlled by smartphones iPad or iPhone and equipped with two video cameras. This was a real breakthrough in household drone construction, thanks to which, soon (starting in 2013), numerous drones of the most diverse design and price appear on the world market. It was then that quadcopters became the most popular household UAVs, and the Chinese company DJI became the world leader in the production of consumer drones, which still holds the lead in this field.

3 TECHNOLOGY

Each propeller acts like a small helicopter. The up / down movement is controlled by the speed of the propellers. For flight left / right, forward / backward, a tilt at a certain angle is used. The technology is simple, but its implementation requires the most complex software modules and systems.

The principle of the drone is based on a simple algorithm: Copter propellers operate in different modes, rotating clockwise and counterclockwise in pairs. This method of rotation generates thrust, due to which the light quadcopter rises into the air implemented a smooth deceleration of the propellers so that the technique gradually sits gently on the ground. Accelerating the rotation of the screws from one side will give a tilt and movement in the chosen direction. Acceleration of all propellers at the same time will give rise to an even greater height. The control system subtly controls each motor, which allows you to keep the drone in the air without moving.

The technology of the current generation demonstrates amazing possibilities, contains many programmed flight modes. The principles of operation of a quadcopter are changing and supplemented with new features.

4 CAPABILITIES OF MODERN COMMERCIAL UAVS IN LOGISTICS

Advances and forecasts of experts and major publications in the field of logistics predict that flying drones will act as a catalyst for changes in supply chains. Undoubtedly, drones were and still remain the prerogative many departments. However, the capabilities of modern commercial UAVs are significantly expanding in the logistics field.

Today in the logistics business the time has come to search, because we live at a time when the world is changing literally before our eyes and it is unreasonable to ignore it. Companies are looking for new markets, services, technologies, and, of course, new customers. The profitability of a business directly depends on the efficiency of the organization of the supply chain, and the goal and the efforts of logisticians is to have the required stocks at the right time in the right place and create a flexible supply system in which the product and the client are close to each other.

Of course, such tasks have always faced logisticians and were solved with varying degrees of efficiency and labor costs. The latest EU legislation for example only applies to outdoor operation of the unmanned aerial vehicle (UAV) system. However, today the level of technology development is able to support any initiatives of companies pursuing ambitious goals in the field of digital transformation. Modern IT tools ensure the implementation of many requirements arising in warehouses - key links in the supply chain. According to surveys, about 60% of warehouses plan to increase investment in technology, which is not surprising.

4.1 Amazon case

Amazon, E-commerce giant have been testing new drones for flights for thousands of hours. The drones are equipped with a system that detects and avoids obstacles such as electric wires and chimneys, making full use of machine learning and artificial intelligence.

On August 2020, the company has received approval from the US Federal Aviation Administration (FAA) for commercial drone delivery of goods. Amazon Prime Air Vice President David Carbon said the retailer plans to ship packages by drone to customers around the world.



Figure 3 Amazon Air Prime Drone being tested for a trial

Amazon is not the first company to receive such approval, logistics company UPS and Wing, owned by Alphabet, have already begun tests for delivery drones. UPS delivers medical supplies by drone to the hospital campus in Raleigh, North Carolina, and Wing uses drones to deliver small packages over short distances in Virginia.

Research conflicts have been rising since concerning the delivery costs of drones. Some experts argue that the use of drones in shipping is insanely expensive and doesn't sound realistic yet. Distribution centers are needed, which must be within a radius of 10 miles. What's more, drones cannot transport more than 5 pounds (2.2 kg), while traditional trucks can carry around 1,000 pounds (about 450 kg). The cost of drones will be huge compared to trucks.

On the other hand, others argue that the use of autonomous drones for package deliveries can result in operational costs that are at least 70% lower than a van delivery service, most of those savings come from avoiding traffic. The co-founder of the UAV development company Kiva Systems, estimated the cost of delivering cargo by drones no more than 2 kg "on the last mile" \$ 0.1. In comparison, ground delivery of cargo with similar parameters ranges from \$ 2 to \$ 8. However, there are other estimates: ARK Investment Management is a research company that estimated the cost of shipping a cargo in 30 minutes at \$ 1. At the same time, the following variables were taken into account: the costs of deploying UAVs - groups, technical and informational support, as well as the percentage of orders that can be processed using the UAV. Big profits follow from the savings. Even

with huge investments. Companies will be drawn to each other using drone technology to respond to the emerging demand for fast delivery.

Drone delivery in general could save a lot of time and money on rough roads and congested areas . However, a question that arises is whether Amazon customers want Amazon Prime packages to be delivered from the air.

4.2 Zipline

Zipline is a US medical product delivery company. In 2016, the company began collaborating with the Rwandan government to build and operate a medical distribution center in Muhang . Rwanda has mountainous terrain, poor road conditions and a long rainy season, making the air delivery system more cost effective and timely than traditional road transport. As of May 2018, they have delivered over 7,000 units of blood using drones. By October 2020, Zipline had completed more than 70,000 drone medical deliveries and expanded operations across Rwanda and Ghana. Their drones are small electric fixed-wing aircraft that allow them to fly fast and long distances (up to 180 km round trip on a single charge) in any weather seen in Rwanda. The zipline drone is used to assist takeoff to enter the flight, and for landing they use an aerofinisher -inspired mechatronic recovery system. During delivery, the Zipline drone does not land, but instead descends to a low altitude and drops the package to the ground, decelerated by a parachute-like air brake . In 2020, Zipline began deliveries between medical institutions Novant Health in Kannapolis and Huntersville, North Carolina.

5 ADVANTAGES AND DISADVANTAGES

5.1 Possible advantages

Drones can be safer when you consider that most aircraft accidents are due to "human factors". Automation of production and supply chains is the main goal of using drones.

The use of vehicles as well are very polluting for the environment. Countries and companies around the world have been lobbying and promoting "green production", stimulating the development of this direction by imposing high taxes on industrial waste. Using drones is a completely sustainable process. Electricity is the only resource that is used.

5.2 Expected benefits

Most expected benefits will deal with economic benefits. Here, it is primarily expected that drone-will support logistics services and lead to lower costs for companies in the rapidly growing and price sensitive logistics sector. Societal benefits comes also after that, creating for example careers and jobs for drone pilots and increasing safety on roads by avoiding traffic and decreasing accidents. Drones contribution to the improvement of (urban) traffic will be huge. Delivery and passenger drones could relieve the pressure on already congested streets and allow faster commuting in the air.

5.3 Potential Problems

Using a drone to deliver goods around town (first and last miles) is the most tangible and exciting future in the logistics industry. But you will also have to face a lot of problems. With privacy and security concerns multiplying in a densely populated urban environment, the most moral challenge is creating the necessary conditions for the logistics infrastructure - especially integration into existing urban environments. UAVs are the main threat to the information security of not only citizens, but also companies if their flight altitude is very high. Which is the case with most drones used today.

Another major problem is the cost of bills, there are a number of bills that limit drone flying in air-space. It is also necessary to register these devices at the state level, moreover, this procedure is necessary for drones owned by people who use them for entertainment. Again, there is a certain boundary in the technical characteristics of the device, which makes registration unnecessary.

In the United States, temporary rules have been in effect:

- M <25 kg.
- Speed <160 km / h.
- Altitude <152 m.

In addition to the above restrictions, it is also prohibited to use drones near airports and at night. Dropping any objects from drones to the ground is prohibited, while the device itself must always be within sight of the people responsible for it. This created a lot for a number of companies, in particular, Amazon, whose logistics process did not include tracking the drone, but, on the contrary, remote monitoring. However, Amazon will continue its research and development of the project and will attempt in the future to induce the US FAA to amend these regulations.

Also, there is a vivid example of the use of one of the major problems using drones in the supply chain, which takes us to Russia, where one company decided to follow Amazon by delivering pizza using drones. However, the drones did not hit the wall or even collide with the legal framework, but with the birds. Birds can fall into the blades of the drone, and the bird will also die, as well as damage the UAV along with the cargo. From this, three problems arise at once, which will need to be solved: the harm caused to wildlife, the repair of the device, the client's dissatisfaction. In this case, the most significant problem is harm to wildlife. Kidnapping a drone, shooting at them are risks that will arise, and they have always been cases for such acts. These risks are an integral part of life, and the main thing is that it will be possible to track the drone during the abduction only by its last location, because there are always blind spots provided that the camera is used, putting these devices at high risk. Finally, collision with nature: A car, a train, and a person can overcome weather conditions to varying degrees. Unfortunately, the weight of the drones is too small to withstand wind or rain. Changes in weather conditions entail changes in flight time and speed. It will be necessary to predict the days of possible deliveries if the country's climate is changeable. It will be nec-

essary to take measures to possibly make the drones heavier without losing technical characteristics, protect them from moisture, and, ultimately, increase resistance to weather conditions.

The limited amount of flight time is also another problem. For small drones, the best power supply is through LiPo batteries with 3-6 cells in series, but even so, 30 minutes of airtime is the limit.

Challenges of adapting the existing legal framework are also rising, to ensure a fair balance of interests and enforcement deficits.

Threats to privacy and physical safety are among the top complications for drones, with collisions, crashes, accidents and injuries being highly probable. The threat of potential misuse of drones by criminals and terrorists also plays an important role. Social issues, environmental interrelations and economic problems are also being mentioned when drones disadvantages are being discussed.

6 DRONES IN WAREHOUSES

The task of inventorying products or goods for any manufacturer, seller and transporter is one of the most important and does not lose its relevance.

Most modern warehouses are huge spaces, under the roof of which thousands of items are stored, grouped in small batches. The flow of goods can be infinite, so the principle of storing certain products has to be revised constantly. At the same time, it is necessary to skillfully use the warehouse space. And during the period of sales, real chaos can ensue, which nevertheless should be somehow contained and controlled. Great difficulties could be observed during the period of self-isolation, when restrictions were imposed on the number of working personnel, and the warehouse employees themselves went on long sick leave.

In order to always be aware of the latest information on the availability of products, warehouse workers, as a rule, carry out an inventory manually. Quite often, a forklift comes into play, without which it is simply impossible to get to the high shelves of the warehouse.

These methods can already be considered outdated, as well as carrying certain risks and inconveniences. For example, working at height can be extremely dangerous for beginners. Accidents are not uncommon. In addition, the inventory using lifts is slow and dreary, and the probability of errors due to the notorious human factor has not been canceled.

When inventory is a time-consuming process, there are a number of other negative consequences. First of all, warehouse checks are becoming less and less frequent. This means that managers are no longer fully in control of the situation, and this will certainly affect the work of the entire warehouse and the company in the future.

Secondly, routine manual checks in one way or another threaten with a decrease in attention to all the nuances, and as a result - an increased risk of probable errors due to the "human factor".

6.1 Drones solve inventory tasks

A young company from Budapest, Aeriu Ltd., decided to take the path of unmanned innovation. The startup, which turns 3 in the summer of 2021, is developing software and has already attracted the Scandinavian furniture giant and the German multinational engineering and technology company as its main clients. The Aeriu team managed to create software for more efficient inventory of warehouses.

The principle of operation is simple. A drone is piloted by warehouse workers to quickly collect data from the labels of goods lying on the shelves. Usually these are barcodes and indicators of the location of products in the warehouse. At the push of a button, these images are uploaded to the cloud by a specially designed software for multi-step analysis. Several tools are used for inventorying at once, because despite the fact that warehouse operations are usually standardized within one company, the same can hardly be said about the entire warehouse and logistics industry.

Optical Character Recognition (OCR) model "reads" numbers and letters written in different languages. This information can be used to locate product packages throughout the warehouse. The model with barcode reading detects and recognizes the presence of a particular product, comparing it with information in the archive of documents and products of the company. Aeriu also helps warehouse operators create an inventory map that clearly shows what is in the company's warehouse and where.

In addition to processing the data obtained from the drone, the developed neural network uses deep learning skills to solve one very important and at the same time rather complex task - determining free space. So, the platform was taught to understand that the lack of products in one place or another in the warehouse is also extremely necessary information.

This success of the Hungarian company was made possible, among other things, thanks to the quick and easy access to the "stuffing" of DJI drones, which are functional, reliable and versatile. By relying on the quality of the design and capabilities of DJI drones, Aeriu said they were able to fully focus on software development.

6.2 What has changed in the practice of warehouse management

The coronavirus pandemic has created problems for many warehouse management companies around the world. Lack of staff and social distancing requirements in the workplace have become a real problem, preventing regular inventory taking. At the same time, it was in 2020 that the indicators of Internet commerce increased, which was directly related to warehouse management. The confusion in this market threatened a number of problems and delays in the supply chain of the goods.

Whatever the national regulations for the use of heavy equipment in warehouses, it is unlikely that anyone would question the fact that inventory using drones is several times safer than the traditional manual method. In addition, launching a drone is more environmentally friendly than using a powerful forklift, which consumes about 72 kW / h, while the drone consumes 100 times less electricity.

CONCLUSION

The thesis cited the possible the current usages of drone in e-commerce logistics and the implications it might have on such field. While the future of drones is still absurd and controversial and might take a few years in my opinion, especially to gain societal acceptance seeing thousands of flying objects all over the sky, many companies and experts though are feeling optimistic towards such technology. Time and money are two of the main sources that needs to be put for improvements and research.

Millions are being invested to revolutionize such technology that can add a massive lift to the current logistics companies, the progress might still take some time as many hurdles arise when discussing such technology.

In general, a a lot of research and work should be put on to analyse the effective usage of such devices and whether or not they might revolutionize the e-commerce industry. Until then, drones can be used in many fields and solve many problems and their current benefits are unquestionable.

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