UNMANNED AIRCRAFT SYSTEMS IN LOGISTICS – LEGAL REGULATION AND WORLDWIDE EXAMPLES TOWARD USE IN CROATIA

Aleksandar Erceg
Josip Juraj Strossmayer University of Osijek,
Faculty of Economics in Osijek, Croatia
E-mail: aerceg@efos.hr

Biljana Činčurak Erceg
Josip Juraj Strossmayer University of Osijek, Faculty of Law Osijek, Croatia
E-mail: biljana.cincurak@pravos.hr

Aleksandra Vasilj
Josip Juraj Strossmayer University of Osijek, Faculty of Law Osijek, Croatia
E-mail: avasilj@pravos.hr

Abstract

Business logistics is important for delivering products in time, without damage and with the lowest possible costs. With current technology developments, there are many ideas and projects about how to reach this goal. One of these developments includes unmanned aircraft systems (UAS) - widely known as drones, for use in logistics as a tool to deliver products to their final users.

The use of unmanned aircraft systems is not new and they are presently used for different applications worldwide, from military purposes to filming and crop control. Recently the idea about using drones in logistics has been tested by different logistics companies for different purposes, from last mile deliveries of ordered products to deliveries from fast food restaurants. Due to this the question arises - can it be done in Croatia? If yes, by whom, and for what purposes in logistics?

This paper will provide a definition of unmanned aircraft systems and present various applications thereof, as well as the types currently used throughout the world. Since unmanned aircraft systems are starting to become a part of logistics, different examples of drones' use in logistics worldwide are presented. We will analyse legal regulation in Croatia, possible problems, and will also consider who could be potential users of unmanned aircraft systems in logistics, either for last mile deliveries or for some other purpose. In conclusion, we will propose further research in this field and how it may influence further development of business logistics

Key words: unmanned aircraft systems, drones, legal regulation, logistics, Republic of Croatia

1. INTRODUCTION

Business logistics is considered as a part of supply chain, which includes inventory management, transportation and distribution. Due to its importance, business logistics is part of management in every company, regardless of whether it is a manufacturing or service company. This importance is stressed further because logistics *creates value for customers and suppliers of the firm, and value for the firm's stakeholders* (Ballou, 1997: 118). Although the marketing system of business logistics also encompasses the consideration of profit, business logistics has the same idea as modern military logistics (Ito, 2016). This means that besides the efficiency in transporting things, mobility is also common Drones were put into practice in military but they also have potential in other areas of use, one them being business logistics. A statement by Amazon CEO Jeff Bezos that drone delivery *will be as normal as seeing mail trucks* (O'Brien, 2015) shows that change is coming to business logistics. This statement is confirmed by research conducted by The Material Handling Institute (Deloitte, 2015) about the future of supply chain technology. The findings showed the importance of driverless vehicles and/or drones as emerging technologies that will play an important part in the supply chains of future.

The aim of the paper is to investigate the legislation and potential for drone use in business logistics in Croatia. The paper gives an overview of the term unmanned aerial vehicle. Different types and applications of drones are presented and explained. The third section examines legal regulation of drone usage in Europe and Croatia. The paper presents global examples of different uses of drones for deliveries of fast food orders, mail, or for last mile delivery. It looks upon current and potential use of drones in Croatia. Finally, the paper provides implications for further research of the use of drones for last mile delivery of goods and their potential impact on business logistics in Croatia.

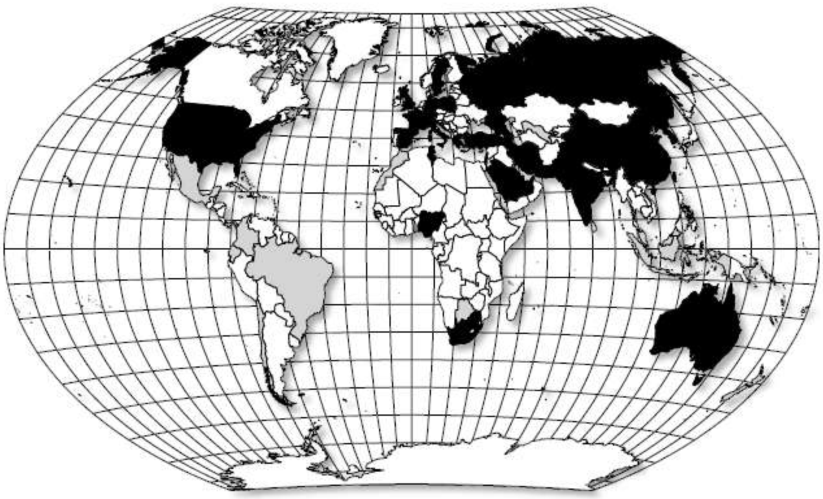
2. UNMANNED AERIAL SYSTEMS – DRONES

Since the first airplane and the Wright brothers, there was an idea of unmanned aerial systems, and this was a huge challenge for engineers and scientists. The first unmanned aircraft (balloons filled with explosive content) were used by the Austro-Habsburg Empire in 1849 during their attack on Venice (Consortiq, 2016). History remembers the Wright brothers' airplane from 1916 and the drones used by the British Navy for target practice from 1933 (Gonzalez-Aguilera and Rodriguez-Gonzalvez, 2017). To have and to control an aircraft without a pilot was always a huge challenge, both from the military and civilian standpoint.

When speaking of drones in the European context, it should be noted that there is no established terminology that regulates this matter. The current nomenclature for unmanned civilian or military aircraft is varied: drone, unmanned aerial vehicle (UAV), unmanned aircraft system (UAS), remotely piloted aircraft system (RPAS) or aircraft (RPA). The terms RPAS and RPA refer to the rules set by ICAO, and ICAO does not use the term 'drone'. To avoid confusion, including concerns about liability and insurance, it would be advisable to work towards using the ICAO terminology in the European context. *In accordance with the Commission communication, the term UAV is used to mean an unmanned, autonomously functioning aircraft. An RPAS is an aircraft controlled remotely by a third party. The term 'drones' is now firmly established in public parlance for all types* (European Parliament, 2014: 90). A drone can be defined as an *aircraft without a human pilot on board* (Estampe, 2015: 15).

Previously, drones were mainly connected to the military, where they were used largely for two purposes: reconnaissance and surveillance, and ground attacks. The use of drones has many benefits based on their flight system (either remotely controlled or autonomous) and their sensory system needed to attain precise positioning information and a great variety of data. The number of developed types of drones has been significantly increased recently, and their use has been moving away from military to civilian purposes (Figure 1)

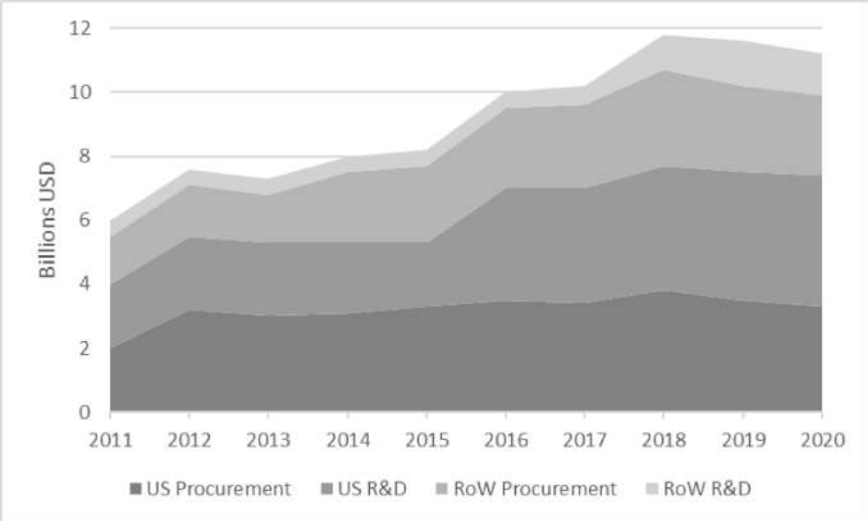
Figure 1. Global trends in UAV proliferation



Source: adapted from Horowitz and Fuhrmann, 2015

Black areas are countries that are developing armed UAV programs, while grey areas represent countries that are developing unarmed UAV capabilities. It is important to state that the proliferation of drones is still poorly understood (Horowitz & Fuhrmann, 2015) and that it is today's reality for regulators, start-ups, policy makers (local, regional, national) and companies around the world. Purchase of drones and investments in their research and development will continue to grow in the next years (Figure 2).

Figure 2. World drone forecast



Source: adapted from Cavoukian, 2012

Another study (Finnegan, 2015) predicts that the value of the worldwide production of drones will grow from current 4 billion USD/year to 14 billion USD/year within the next ten years. Based on current and future developments in drone R&D and potential areas of use, the main advances of drones can be seen in *(1) the emergence of new sensors that allow the improvement of the geometric and radiometric resolution, as well as the spectral range; (2) the evolution of new platforms that improve robustness and increase autonomy; (3) the development of software, from the navigation and communication with the platform to the processing and analysis of the images captured; (4) new applications in emerging sectors: logistics, disaster assistance, security and surveillance, health and marine science, among others* (Gonzalez-Aguilera and Rodriguez-Gonzalvez, 2017: 1). UAV market today is mainly intended for military applications (72%), followed by consumer (23%) and civilian applications (5%). The most rapid growth is predicted for civilian application of UAVs, but application in this sector is starting from a very low base (Finnegan, 2015). Since the UAV civil and commercial market is still in its incipient phase, there is a significant potential and a potentially wide range of applications where UAVs can be used to replace current solutions or be used in areas where there are no existing solutions (European Commission, 2007).

2.1. Types of UAVs

Today, there are many different types of UAVs available on the market for commercial and civilian purposes. Generally, UAVs are usually classified according to measurements or specifications, which are not only related to endurance or range, but also to price, maximum take-off weight, the engine used, and price. Thus, there are possible categorizations of drones based on their range (short or long), price (expensive or inexpensive), payloads (high or low), complexity of models (complex or non-complex), number of blades (quadcopter, octocopter, multicopter), etc. Heutger (2014) and Kelek (2015) divide UAVs based on build type into several groups: fixed-wing, tilt-wing, unmanned helicopter and multicopter, which are known mostly as drones (Table 1).

Table 1. Advantages and disadvantages of different types of UAVs

Types	Advantages	Disadvantages	Example
Fixed wing	Long range Endurance	Horizontal take-off, requiring substantial space or support Inferior maneuverability compared to VTOL (Vertical Take-Off and Landing)	
Tilt wing	Combination of fixed wing and VTOL advantages	Expensive Technology complex	
Unmanned Helicopter	VTOL Maneuverability High payloads possible	Expensive Comparably high maintenance requirements	
Multicopter	Inexpensive, Low weight Easy to launch	Limited payloads Susceptible to wind due to low weight	

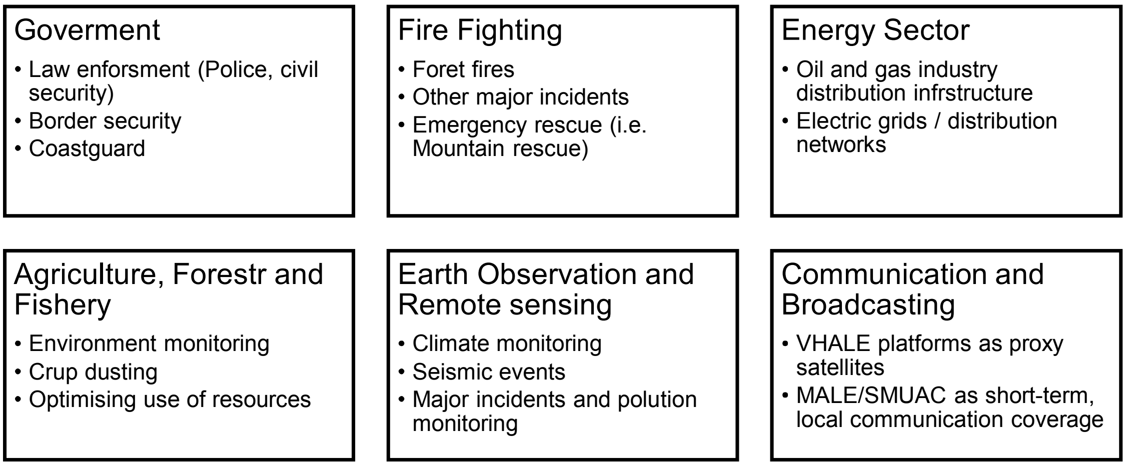
Source: adapted from Heutger, 2014 and Kelek, 2015

Another possible categorization of UAVs is into three groups: rotary wings, fixed wings and lighter than air. This categorization looks upon launching capabilities, areas needed for manoeuvring, speed, endurance, load capacity and altitude capability. Each of these groups have their own advantages and disadvantages, but they all have enormous potential in the future for all different applications UAVs can be used for.

2.2. Application of drones

With increased demand and production, the drone market is being accepted by a growing number of different industries. The drone market is predicted to see significant growth in the media and entertainment industry (Global Market Insights, 2016). Civil and commercial market applications of drones can be divided in several different ways (Figure 3).

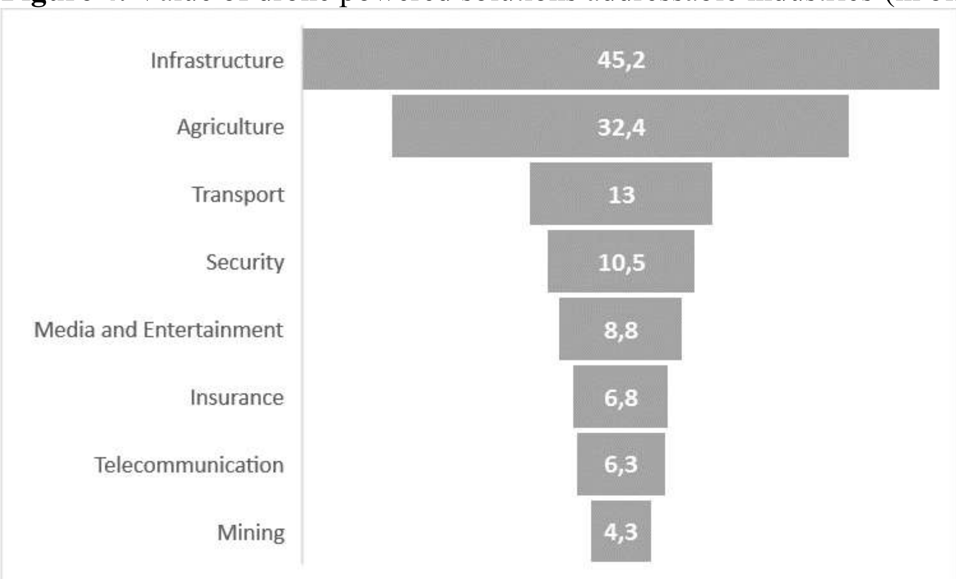
Figure 3. Civil and commercial drones market segmentation



Source: adapted from Frost & Sullivan, 2007: 7

The importance of different drone applications can be seen in the value of businesses and labour in different industrial sectors which can use drones (Figure 4).

Figure 4. Value of drone powered solutions addressable industries (in billions USD)

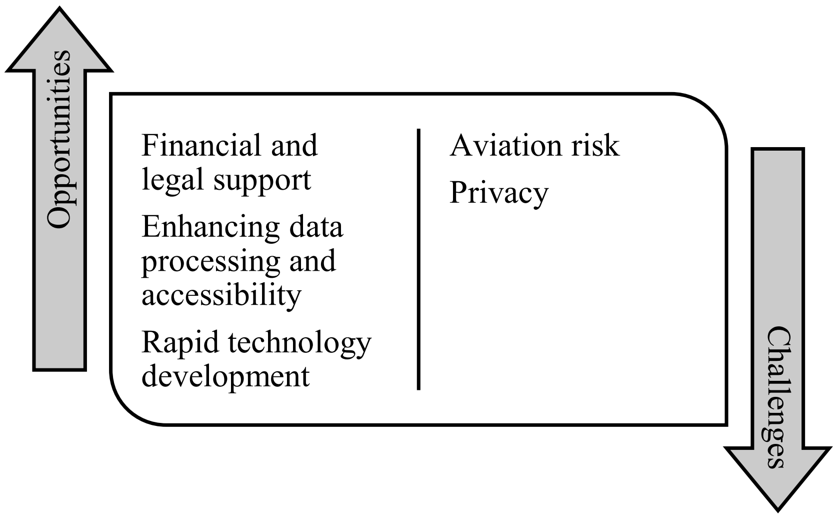


Source: adapted from Mazur & Wisniewski, 2016: 4

The total drone powered solutions value in presented industrial sectors is more than USD 127 billion. The highest potential for the application of drones is in infrastructure (railways, roads, energy, and oil & gas) with a total value of USD 45 billion (Mazur & Wisniewski, 2016). Other sectors in which drones have or will have significant use are: insurance, media and entertainment, telecommunications, agriculture, security, and mining.

In the transport sector, development projections for the use of drones are admirable due to technology improvements, which are seen every day. Although drones were not seen as an integral part of the transport industry, nowadays the transport sector uses drones for their accessibility, cost of operations and their speed compared to other transport choices. The main areas for drone use in transport are parcel deliveries, spare parts deliveries, food delivery, and medical logistics. Since drones and helicopters are very much similar, it is possible to predict that some operations currently performed by helicopters will be performed by drones in the future (Smith, Mazur & Wisniewski, 2017). Further use in the transport sector faces several key opportunities and key challenges (Figure 5).

Figure 5. Key opportunities and key challenges for use of drones in the transport sector



Source: adapted from Smith, Mazur & Wisniewski, 2017: 12

The key opportunities for further drone use in the transport sector are in finding financial and legal support (like Israeli and Chinese governments do for their drone industries) and to continue with rapid technology development, which leads to lower prices of final products – drones. The key challenges primarily include the issue of safety, where it is needed to develop complex air management systems to prevent possible air collisions, and secondly, the issue of privacy, since drones fly over various types of sites and collect a massive quantity of information, and currently there is no regulation regarding the collected data. Additionally, Rosenberg (2009) stated several significant market barriers for commercial and civil application of drones: (i) lack of operator training and safety standards; (ii) limited payload capacity and space restrictions; (iii) no secure non-military frequencies; (iv) liability for civil operations; (v) incomplete or immature air space regulations that encompass UAV systems; (vi) negative consumer perception.

3. LEGAL REGULATION

With the advancement of technology, the ever-increasing use of drones is becoming more and more common. To date, most flights conducted by drones have taken place in segregated airspace to avoid danger to other aircraft. Drones are increasingly being used in the EU, but under a fragmented regulatory framework, since each Member State has its own rules. So far, only a few countries, including the Republic of Croatia, have legally regulated this area, but due to unexplored possibilities and constant progress of unmanned aircraft, this area will need to be constantly upgraded and legally regulated. In May 2015, the Republic of Croatia adopted the Ordinance on unmanned aircraft systems (Official Gazette, 49/2015, 77/2015).

Table 2. Regulation by country

Country	Possibility of commercial flights	License required to fly	Possibility to perform BVLOS flights	License required for BVLOS flights	Insurance required for commercial flights	Training required for pilots to obtain license
Poland	✓	✓	✓	✓	✓	✓
UK	✓	✓	✓	✓	✓	✓
China	✓	✓	✓	✗	✓	✓
Canada	✓	✓	✓	✗	✓	✓
Germany	✓	✓	✗	✗	✓	✓
France	✓	✓	✓	✗	✗	✓
South Africa	✓	✓	✓	✗	✗	✓
Indonesia	✓	✓	✗	✗	✓	✓
Australia	✓	✓	✗	✗	✓	✓
Brazil	✓	✓	✓	✗	✗	✗
Mexico	✓	✓	✗	✗	✗	✓
USA	✓	✓	✗	✗	✗	✗
Japan	✓	✗	✗	✗	✗	✗
Russia	✗	✗	✗	✗	✗	✓
Argentina	✗	✗	✗	✗	✗	✗

Source: adapted from Mazur & Wisniewski, 2016: 21

The legal issues of drones are regulated at three levels: international, European and national (Croatian) (Table 2). Solving this legal issue is initiated through work of **International Civil Aviation Organization (**ICAO), European Aviation Safety Agency (EASA) and Croatian Civil Aviation Agency (CCAA), but also includes the European Organization for the Safety of Air Navigation (EUROCONTROL), Joint Authorities for Rulemaking on Unmanned Systems (JARUS), etc.

Observing the international regulation, it should be emphasized that according to Article 8 of the Convention on International Civil Aviation (ICAO, 1944) *no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in* *accordance with the terms of such authorization. Each contracting State undertakes to ensure that flight of such aircraft without a pilot in region open to civil aircraft shall be so controlled as to obviate danger to civil aircraft*. In accordance with the above-mentioned, European countries are increasingly adopting ordinances governing the legal framework for the implementation of UAS flight operations. Most of the adopted legal frameworks regulate this matter in a similar way, and differ according to the categories of unmanned aerial vehicles, the areas above which flight operations are performed, the conditions for flying operations, etc. (Mudrić & Katulić, 2016: 126). It must be mentioned that ICAO has published Circular 328 (2011) on Unmanned Aircraft Systems (UAS) and amended Annexes 2, 7 and 13 to the Chicago Convention to accommodate Remotely Piloted Aircraft Systems (RPAS) intended to be used by international civil aviation (EASA 2015b).

The development of unmanned aircrafts has started a new chapter in the history of air transport. The current situation, regarding drone regulation in the EU is not fully satisfactory since legislation in Member States is not harmonized and there is no obligation of mutual recognition of certificates or authorizations. An unmanned aircraft operator authorized in one Member State must obtain another authorization in another Member State if they want to operate there. Furthermore, current EU legislation assumes that unmanned aircraft below 150 kg are operating locally. However, there are small unmanned aircraft that can fly very high or can operate at long distances, which could affect several Member States and thus need multiple authorizations. For that reason, the Commission has proposed, under the 2015 EU Aviation Strategy, to create a risk-based framework for all types of drone operations, which will ensure the safe use of drones in civil airspace and create legal certainty for the industry. Concerns related to privacy and data protection, security, liability and insurance or environment will also be considered (European Commission, 2017).

The Commission works together with the EASA. Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (Text with EEA relevance) (European Commission, 2008), known as Basic Regulation (European Parliament, 2008) mandates the EASA to regulate UAS and RPAS, when used for civil applications and with an operating mass of 150 kg or more. Experimental or amateur-built RPAS, military and non-military governmental RPAS flights, civil RPAS below 150 kg, as well as model aircraft, are regulated by individual Member States of the European Union.

The current division of competence between Union and Member States regarding regulation of unmanned aircraft, which is based on a threshold of 150 kg, is generally deemed obsolete. The rules for unmanned aircraft should evolve towards an operation centric approach, where risk of an operation is made dependent on a range of factors (European Commission, 2015:7).

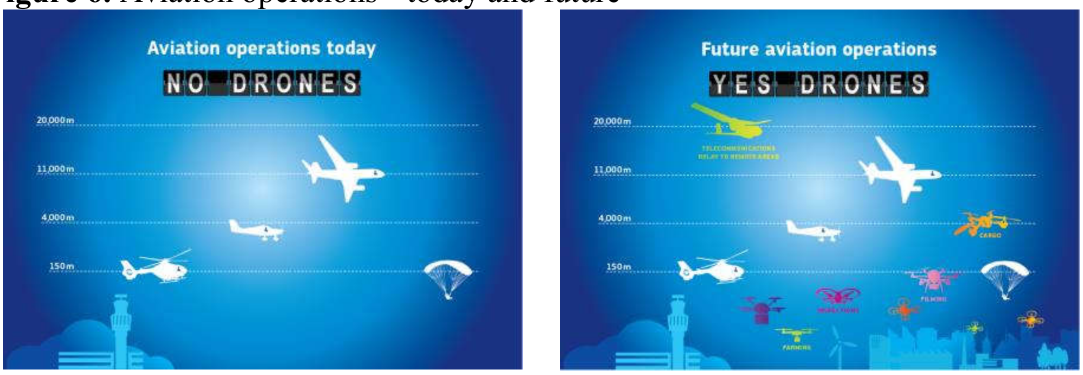
European Commission published the Proposal for a Regulation of the European Parliament and of the Council on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008 of the European Parliament and of the Council, COM (2015) 613 final (2015/0277 (COD), which prescribes new demands based on past experiences and problems encountered.

Aviation safety is the main objective of the European Commission's (2015) proposal, but it is also a part of a larger context - fostering jobs and growth, developing the internal market. Unmanned aircraft manufacturing has a cross-border dimension, since many unmanned aircraft are bought online, are imported or at least have imported parts. Mutual recognition in the internal market is difficult to achieve in the presence of detailed and diverging national standards and rules. In addition, many operators are developing cross-border activities, so they should be able to use the same unmanned aircraft and the same operating requirements with the same pilot at different places in the Union to develop their businesses. Large delivery companies have expressed their intentions to organize their services at European level, which requires common rules. (European Commission, 2015:4).

The Proposal contains provisions (Articles 45-47) that create the legal basis to provide for more detailed rules on unmanned aircraft. Annex IX of the Proposal contains the essential requirements concerning the design, production, operation and maintenance of unmanned aircraft that need to be complied with to ensure safe operations.

These provisions bring legal certainty to this rapidly expanding industry that includes many small and medium-size enterprises and start-ups. For safety reasons, all drones are covered, from small 'toys' to large unmanned aircraft. As risks arising from drone operations vary, the rules should be proportionate and *consider the extent to which other air traffic or people on the ground could be endangered. Higher-risk operations will require certification, while drones presenting the lowest risk would just need to conform to the normal EU market surveillance mechanisms* (European Council, 2016).

Figure 6. Aviation operations - today and future



Source: adapted from European Commission, 2017a: 3-4

EASA published a Technical Opinion (EASA, 2015a) that *does not include new draft legal text beyond the one that has been proposed by the Aviation Strategy. Its purpose is to lay the foundation for future work, illustrate the contents of the draft changes to the Basic Regulation and serve as guidance for Member States (MS) to develop or modify their regulations on unmanned aircraft*. It includes 27 concrete proposals for a regulatory framework and for low-risk operations of all unmanned aircraft irrespective of their maximum certified take-off mass (MTOM). The EASA also produced ’prototype’ regulation (supplemented by an Explanatory note) in 2016 that presents a ‘prototype’ regulation for to the operation of unmanned aircraft in the ‘open’ and ‘specific’ categories and its purpose is to inform and consult stakeholders in view of the ongoing negotiations on the review of Regulation (EC) No 216/2008 and in view of giving indications on the possible direction that EASA will take on its implementation (EASA, 2016).

We can say that although there are obvious efforts to bring a suitable legal framework for drones at EU level, it is obvious that this job will be difficult and long-lasting. All civil aviation activities carried out on the territory and in the airspace of the Republic of Croatia are regulated by the Air Traffic Act (Official Gazette, No. 69/2009, 84/2011, 54/2013, 127/2013, 92/2014). Air Traffic Law prescribes in Article 93a that conditions for the safe use of unmanned aircraft, unmanned aircraft systems and model aircraft, as well as the conditions to be met by persons involved in the management of these aircraft and systems are determined by a special regulation. Based on this provision, the Ordinance on unmanned aircraft systems was adopted in 2015.

In accordance with Article 2, point 2 of the Ordinance, an unmanned aircraft is an aircraft intended for the operation without a pilot in aircraft, which is either remote controlled or programmed and autonomous, and the term unmanned aircraft system (UAS), according to point 13, is a system designed to perform flights with aircraft without a pilot that is remote controlled or programmed and autonomous. It consists of unmanned aircraft and other control or programming components necessary for the control of unmanned aircraft, by one or more persons.

The provisions of the Ordinance, in accordance with Article 1, paragraph 2, shall apply to unmanned aircraft systems, with operating mass up to and including 150 kilograms that are used in the Republic of Croatia. The provisions of the Ordinance, pursuant to Article 2, paragraph 3, shall not apply to unmanned aircraft systems when they are used for state activities (military, police, security intelligence, customs, search and rescue, firefighting, coastal guarding and similar activities or services).

With regard to operating mass, unmanned aircraft, according to Article 3 of the Ordinance, are divided into three classes. In Article 4, the Ordinance clearly defines the classification of flight areas in relation to buildings, population and presence of people. The flight operations category is determined by the level of risk that their performance represents for the environment, in accordance with Annex 1 of the Ordinance (Table 3).

Table 3. Flight Operations Categories

Unmanned Aircraft System Class	Area of flight performance class			
	I Unbuilt area	II Built uninhabited area	III Inhabited area	IV Highly inhabited area
Class 5 OM* < 5kg	A	A	B	C
Class 25 5 ≤ OM < 25 kg	A	B	C	D
Class 150 25 ≤ OM ≤ 150 kg	B	C	D	D

Source: Ordinance on unmanned aircraft systems, Annex I., 2015
*OM – operating mass of an unmanned aircraft

Regarding the safety of flying, Article 11 of the Ordinance prescribes general conditions for flying unmanned aircraft. Flight must be performed in a manner that does not represent a danger to life, health, or property of people due to impact with a surface or due to loss of control over UAS and that does not endanger or interfere with public order, and this must be ensured by the operator. Some provisions from Article 11, paragraph 2 will in practice lead to the greatest restrictions on the use of unmanned aircrafts.

One of the most problematic provisions is the one on flight performance during daylight (Article 11, paragraph 2, point a) because it prevents full exploitation of the technological capabilities of unmanned aircraft. This is especially true in cases of night-time recording, delivery, protection and rescue, etc. It has already been suggested that under such strict conditions and with the use of additional night-time equipment, such night flights could be performed. As Mudrić and Katulić (2016: 137) cited, the CCAA has concluded that performing UAS flight operations at night is not a reliable and safe way to conduct UAS flight operations, and has rejected such proposal.

Article 11, paragraph 2, points f), g), h) and j) prescribe flight distances from certain objects: from humans, animals, buildings, vehicles, vessels, other aircraft, roads, railways, waterways or transmission lines – not less than 30 meters during the flight; from a group of people – minimum 150 meters; unmanned aircraft flight takes place within the operator's visual line of sight and at a distance of not more than 500 m from the operator; unmanned aircraft flight takes place at a distance of at least 3 km from the airport. However, Article 14 of the Ordinance predicts some exceptions to these provisions, so that flight operations (which are performed in a way different than the one prescribed in Article 11, paragraph 2, points f), g), h) and k)) exceptionally can be performed if the operator has previously obtained the approval of the Agency, and in the case from point i) (that an unmanned aircraft flight takes place outside the controlled airspace) if it obtains approval for the special use of airspace from the competent air traffic control.

As one of the problems of UAS, we can mention the fact that we do not have an UAS registry, which should be implemented based on comparative legal solutions. As Mudrić and Katulić (2016: 147) cited, UAS registries or registries of operators of UAS flight operations are present in legal frameworks for performing UAS flight operations in the Czech Republic, Italy, the Netherlands and Sweden.

Although Annex 5 of the Ordinance provides the fulfilment of certain requirements relating to flight operations, relating to the age of the operator, the psychophysical ability, knowledge of the aviation regulations and ability to manage the system depending on the category of flight operations, they are not strict; therefore, questions concerning the safety of performing such flights as well as issues related to liability for damage in correlation with the sufficient ability of the operator of flight operations are raised. These problems should be considered in the following revisions or amendments of the Ordinance, especially if one considers that changes to the legislation envisaged at the European level will certainly be necessary.

4. DRONES IN LOGISTICS – WORLDWIDE EXAMPLES

Drones in logistics are being tested for last mile deliveries of parcels. Last mile delivery is considered as the last part of the supply chain and *as the most inefficient due to its specificities such as a spatial distribution of relatively small receiving points, demands for more frequent but smaller shipments, delivery time windows, etc.* (Slabinac, 2015: 1). Big multinational e-commerce companies (Amazon, Google) have significantly invested in research and development of drone technology for last mile deliveries. Various other companies worldwide are currently working on developing technology, drones and resources (people, warehouses) to put drones in use for logistics purposes. Estampe (2015) noted five ways in which drones will be impacting future transport possibilities and logistics in the not-so-far future: (i) save money, (ii) eliminate human error, (iii) keeping humans at home, (iv) delivering goods to places where people would not usually deliver, (v) monitoring and protecting transport lanes.

Heutger (2014) divided the use of drones in logistics into four sub-categories: (i) urban first and last mile, (ii) rural delivery, (iii) surveillance of infrastructure, and (iv) intralogistics. The demand for urban first and last mile will significantly grow due to the e-commerce annual growth rate. Use of drones will secure huge help for cities by taking traffic into air from roads. Drones will provide a huge relief for rural delivery services, since companies will be able to surpass poor infrastructure or challenging geographical settings. Drones will improve the cost side of rural deliveries, as well as quality of delivery services. Use of drones will help in monitoring and surveillance of logistics infrastructure (warehouses, docks, yards,) and in guiding various logistics operations (e.g. moving of forklifts and other vehicles on sites). In the final, fourth sub-category, the use of drones will be of great importance, since drones can support intra-plant transport and emergency transports, which are today performed by helicopters. From the previous four sub-categories, the two most promising are urban first and last mile (improvements in speed and flexibility) and rural deliveries (connecting people in remote locations to worldwide trade networks). Table 4 presents some of the examples where drones are used in logistics for last mile deliveries.

Table 4. Current examples of drone usage worldwide

Company	Application
DHL	DHL Parcel successfully tested its third Parcelcopter generation for deliveries of parcels in Bavaria (Germany) and urgent deliveries of medical supplies to the island of Juist in the North Sea.
Amazon	Testing Prime Air delivery service with drones. Parcels will weigh up to a maximum of 2.36 kg and should be delivered up to 30 minutes after the order. This delivery option should take over up to 80% of all the deliveries Amazon makes. Successfully conducted a 13-minute drone delivery trial in England – in Cambridge.
Google	Testing drone deliveries in Virginia, USA. The project is currently on hold, due to the regulation and technical issues.

7-eleven	Tested drone fast food deliveries in Nevada, USA.
J.D.com	Chinese online store delivered purchased products to their customers.
Domino's Pizza	In New Zealand, they have started with drone deliveries of ordered pizzas.
National postal companies	Swiss Post tested drone deliveries during 2015; Finish post tested delivery of parcels in inhabited urban environment – from Helsinki to the island of Suomenlinna; Croatian post in Mostar has tested drones for parcel deliveries in autumn 2016; French post started with regular drone deliveries in Provence –drones deliver parcels once a week; Australia – started testing parcel deliveries within cities due to drones' flight range.
Maersk	Tested use of drones for spare parts deliveries, which could lead to savings in logistics – the company used drones to deliver a box of cookies to a tanker from a nearby seaside town.
Mercedes Benz	Presented a complete logistics system for delivery of products, which consists of vans with an automated warehouse part and drones that will be delivering packages. The goal is that all parts of the supply chain are digitally connected (from supplier to delivery receiver).

Source: authors' research, 2017

The latest report from Gartner presented a not so bright future for drones in logistics (J. D., 2017). Although Amazon is promoting its drone delivery and has patented their *flying storage*, Gartner predicts that market share for drone delivery by 2020 will not be higher than 1% of total deliveries. Their prognosis is based on complex logistics problems and that return on investments has yet to be proven in this segment. Since all companies look upon costs, earnings and return on investment, this could be the main problem for greater use of drones for logistics purposes worldwide.

5. DRONES IN CROATIA – USAGE AND OPPORTUNITIES

Due to the development of technology and current trends in use of drones worldwide, Croatia will also be a place where drones will be used in many different applications. There are already several Croatian companies that are using, and even more that are considering using of drones in their businesses. This will mean that Croatia will be part of global trends, from drone operators and pilot education, to production of drones. Currently, there are more than 130 companies in Croatia which use drones for their businesses. Most companies offer different media and entertainment services, surveillance of land, graveyards, and infrastructure. Until recently, there was only one drone manufacturer in Croatia (Hipersfera), but a few months ago two new companies started drone production (Tarsier drones and

Kapetair) (Ivezić, 2017). Current and potential drone use in Croatia was a research subject, and authors (Vlahović, Knežević & Batalić, 2016: 3985) concluded that *implementing delivery drones is in line with business processes perspective*. This offers potential for further automatization of organizations' processes and potential for further improvements in efficiency of organizations' operations, especially in areas of flexibility, service responsiveness, costs and maintenance. The next table presents several examples of current use of drones by some of the biggest companies in Croatia.

Table 5. Current examples of drone usage in Croatia

Company	Application
Agrokor	Already uses drones in agriculture with which they have some savings in production, and at the same time they have increased productivity. They are preparing for use of drones in other companies and doing pilot training. In their newspaper and parcel distribution company, they see huge potential for drone use in logistics.
Hrvatski telekom	They are evaluating the use of drones in automation of mobile network planning to save on operating costs. Inside the Deutsche Telekom group, drones are already being used for testing signal quality around mobile base stations and for examining mobile base stations. They are also examining drone development and will assess when they will use drones in development of different parts of their business.
Žito grupa	The company is very interested in testing new technologies and potential use of drones in their business. They are evaluating the use of drones for collecting data from planted seeds, for creating digital orthophoto charts, and for analysing the condition of farmland.
Hrvatska elektroprivreda –	The company uses drones for controlling power lines in inaccessible terrain. With drones, they do not need to switch off the electricity while they check for potential malfunctions.
Vipnet	They consider drones as one of elements which, with smart and innovative application can provide huge benefit to their business and are willing to try them as soon as possible.

Source: adapted from Bačelić, 2016

Most of the current use of drones in Croatia is connected to production or to technology use in telecommunications companies. There is currently only one Croatian company preparing to test drones for logistics purposes – Tisak. They are currently waiting to receive the first delivery of drones for logistics purposes and will start with preparations for first trial deliveries of parcels. The Overseas Trade representative (UPS licensee in Croatia) sees drones as the future and concludes that drone deliveries will suit the users who accept new technologies better and faster the most. According to them, the future of logistics industry in Croatia and in the world, will be shaped by new technologies as the telecommunications industry was shaped by smartphone development. The Croatian Post is looking at global trends in parcel deliveries, but for them, drones are not such a reliable delivery tools since they depend on weather conditions, have short-range for deliveries and there is an issue with airspace regulation (Logistika.com, 2014).

Dronefest conference, which is being held every year in Zagreb, is also important for future drone use in Croatia. This conference presents the latest information about drones from several aspects of doing business (drone legislation and regulation, different business possibilities, drone types, etc.) and presents an excellent place for the promotion of further use of drones in Croatia. The conference organizer, IN2 company is one of the leaders in introduction of drone usage in Croatia, since they work on development of software for controlling and using drones in agriculture and infrastructure sectors.

Currently, the main barriers for faster and massive introduction of drones in Croatian businesses and logistics are lack of and slow introduction of legal regulation of drone usage.

6. CONCLUSION

Drones are already being used for civil purposes and are expected to increasingly affect our daily lives. The most promising uses of drones are in safety inspections or infrastructure monitoring, in disaster relief or photography, with good potential for transport of goods. The key opportunities for the use of drones are financial and legal support and continuation of rapid development, while the key challenges are the question of safety and privacy issues.

RPAS are controlled by a pilot from a distance and form part of the broader category of Unmanned Aerial Systems (UAS), which also includes aircraft that can be programmed to fly autonomously without the involvement of a pilot. To use their full potential, drones should be part of air transportation, and regulated in an appropriate manner. A key factor in safely integrating UAS in non-segregated airspace will be their ability to act and respond as manned aircraft do. European legal framework must enable progressive development of the commercial drone market while protecting the public interest. Safety and privacy are the most important concerns. Therefore, an appropriate regulatory framework is required. The principal objective of the aviation regulatory framework is to achieve and maintain the highest possible uniform level of safety, thus drones must comply with aviation safety rules. Enlargement of the drone market is hindered because there is no adequate regulatory framework in most Member States. Several Member States have started developing national rules, the Republic of Croatia being one of them, but the absence of European standards will slow down the development of drone market. Development of the complete regulatory framework for UAS will be a long effort, lasting many years.

The main use of drones in logistics is seen for last mile deliveries of parcels, and the main four logistics categories are: urban first and last mile, rural deliveries, surveillance of infrastructure, and intralogistics. Although many companies are testing drones in logistics, the latest reports, which are based on complex logistics problems are not promising. Croatian companies primarily use drones for various media and entertainment services, surveillance of land and crops, and infrastructure. Currently, there are several Croatian companies thinking about testing drones in logistics, but there is still no definite decision for introducing them in delivery operations. The main barrier for faster introduction of drones in logistics in Croatia is lack of and slow introduction of legal regulation of drone usage.

Since the use of drones in logistics is still new in Croatia, we recommend further research in the following directions:

a) Investigate possible connection between legal regulation and the use of drones in businesses, especially in logistics;
b) Investigate if the development of drone production industry in Croatia can initiate greater use of drones in Croatian companies in different sectors and not only in logistics;
c) Investigate possible savings for companies in Croatia by introduction of drones for last mile deliveries instead of traditional logistics vehicles.

7. REFERENCES

Air Traffic Act, Official Gazette, No. 69/2009, 84/2011, 54/2013, 127/2013, 92/2014.

Bačelić, M. (2016). Kako se u biznisu možete koristiti bespilotnim letjelicama, *Lider*, 08.01.2016., str. 24-28

Ballou, R.H. (1997). Business Logistics - Importance and some Research Opportunities, *Gestao & Producao*, Vol. 4 (2), p. 117-129.

Cavoukian, A. (2012). Privacy and Drones: Unmanned Aerial Vehicles, Information and Privacy Commissioner, Ontario, Canada,

Consortiq (2016). A Short History of Unmanned Aerial Vehicles (UAVS), [available at: https://consortiq.com/short-history-unmanned-aerial-vehicles-uavs/, access January 31, 2017]

Deloitte (2015). The 2015 MHI Annual Industry Report: Supply chain innovation—

Making the impossible possible, [available at: https://www2.deloitte.com/content/dam/Deloitte/dk/Documents/process-and-operations/2015%20MHI%20Industry%20Report.pdf, access January 31, 2017]

EASA (2015a). Opinion of a technical nature Introduction of a regulatory framework for the operation of unmanned aircraft [available at: https://www.easa.europa.eu/document-library/opinions/opinion-technical-nature access May 7, 2017]

EASA, (2015b). Unmanned Aircraft Systems (UAS) and Remotely Piloted Aircraft Systems (RPAS) [available at: https://www.easa.europa.eu/unmanned-aircraft-systems-uas-and-remotely-piloted-aircraft-systems-rpas, access May 3, 2017]

EASA (2016). 'Prototype' Commission Regulation on Unmanned Aircraft Operations [available at: https://www.easa.europa.eu/system/files/dfu/UAS%20Prototype%20Regulation%20final.pdf access May 9, 2017]

Estampe, D. (2015). *Planning the Future Supply Chain Together - New Technologies: Big data, 3d Printers, Drones*, White paper, Kedge Business School

European Commission (2007). Study Analyzing the Current Activities in the Field of UAV, [available at: https://ec.europa.eu/home-affairs/sites/homeaffairs/files/e-library/documents/policies/security/pdf/uav_study_element_2_en.pdf,, access February 4, 2017]

European Commission (2015). Proposal for a Regulation of the European Parliament and of the Council on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008 of the European Parliament and of the Council, COM (2015) 613 final (2015/0277 (COD)

European Commission (2017a). Drone infographics: A look into the aviation of the future [available at: https://ec.europa.eu/transport/sites/transport/files/modes/air/doc/drones-infographic.pdf, access May 10, 2017]

European Commission (2017b). Unmanned aircraft (drones) [available at: http://ec.europa.eu/transport/modes/air/uas_en, access May 2, 2017]

European Council, Council of the European Union (2016). Aviation safety, EASA and drones rules: Council adopts its position [available at: http://www.consilium.europa.eu/en/press/press-releases/2016/12/01-aviation-safety-easa-drones-rules/ access May 9, 2017]

European Parliament (2008). Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (Text with EEA relevance), OJ L 79, 19.3.2008, p. 1–49

European Parliament (2014). Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council — A new era for aviation — Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner COM (2014) 207 final, OJ C 12, 15.1.2015, p. 87–92.

Finnegan, P. (2015). Press release: UAV Production Will Total $93 Billion, [available at: http://tealgroup.com/index.php/teal-group-news-media/item/press-release-uav-production-will-total-93-billion, access January 31, 2017]

Frost & Sullivan (2007). Study Analyzing the Current Activities in the Field of UAV, [available at: https://ec.europa.eu/home-affairs/sites/homeaffairs/files/e-library/documents/policies/security/pdf/uav_study_element_2_en.pdf, access March

7, 2017]

Global Market Insights (2016). Unmanned Aerial Vehicles (UAV)/Commercial Drone Market Size By Product (Rotary Blade, Fixed Wing, Nano Drone, Hybrid), By Application (Government, Media & Entertainment, Agriculture, Energy), Industry Outlook Report, Regional Analysis, Application Development, Price Trends, Competitive Market Share & Forecast, 2016 – 2023, [available at: https://www.gminsights.com/industry-analysis/unmanned-aerial-vehicles-UAV-commercial-drone-market?utm_source=globenewswire.com&utm_medium=referral&utm_campaign=Paid_Globnewswire, access March 10, 2017]

Gonzalez-Aguilera, D. & Rodriguez-Gonzalvez, P. (2017). Drones—An Open Access Journal, *Drones*, Vol 1(1), p. 1-5.

Heutger, M. (2014). Unmanned Aerial Vehicles in Logistics – A DHL Perspective on Implications and Use Cases for the Logistics Industry, DHL Customer Solutions & Innovation [available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/DHL_TrendReport_UAV.pdf, access March 12, 2017]

Horowitz, M.C. & Fuhrmann, M. (2015). Droning On: Explaining the Proliferation of Unmanned Aerial Vehicles, [available at: http://dx.doi.org/10.2139/ssrn.2514339, access January 29, 2017]

ICAO (1944). Convention on International Civil Aviation, [available at: http://www.icao.int/publications/Pages/doc7300.aspx, access April 27, 2017]

Ito, Y., (2016). *Insights for logistical realization of unmanned vertical take-off and landing aircrafts (UVTOLAs),* Japan Marketing Academy Conference Proceeding Vol. 5 (2016)

Ivezić, B. (2017). Naši dronovi kreću u lov na investicije, *Poslovni dnevnik,* [available http://www.poslovni.hr/tehnologija/nasi-dronovi-krecu-u-lov-na-investicije-326026 access March 31, 2017]

J.D. (2017). Analitičari poručuju: Zaboravite na dostave letjelicama zrakom još neko vrijeme, T-Portal, 14.2.2017. [available at: https://www.tportal.hr/tehno/clanak/analiticari-porucuju-zaboravite-na-dostave-letjelicama-zrakom-jos-neko-vrijeme-20170214, access March 31, 2017]

Kelek, B. S. (2015). Blue Sky Birds Come to the World, *Journal of International Trade, Logistics and Law*, Vol. 1(1), p. 41-49.

Logistika.com.hr (2014) Počela dostava dronovima, [available at: http://www.logistika.com.hr/home/transport-i-spedicija/1635-pocela-dostava-dronovima, access February 11, 2017]

Mazur, M. & Wisniewski, A. (2016). Clarity from above - PwC global report on the commercial applications of drone technology, PricewaterhouseCoopers, [available at: http://www.pwc.pl/en/publikacje/2016/clarity-from-above.html, access January 31, 2017]

Mudrić, M. & Katulić, T. (2016). Regulacija sustava bespilotnih zrakoplova u hrvatskom, europskom i međunarodnom pravnom okviru, *Pravo u gospodarstvu*, Vol. 55(1), p. 123-158.

O'Brien, T. (2015). The Future of Supply Chain Technology, [available at: http://www.ccpe.csulb.edu/citt/Documents/spDocuments/Archive_PDF_150525_TheFutureofSupplyChainTechnologypdf.pdf, access January 31, 2017]

Ordinance on unmanned aircraft systems, Official Gazette, 49/2015, 77/2015.

Rosenberg, A. S. (2009). An evaluation of a UAV guidance system with consumer grade GPS receivers. Ph.D. dissertation, University of Arizona. [available at: http://www.casa.arizona.edu/data/abigail/Abigail_Rosenberg_Final_Dissertation.pd, access February 11, 2017]

Slabinac, M. (2015). *Innovative Solutions for a "Last Mile" Delivery – European Experience*, 15th international scientific conference Business Logistics in Modern Management, Segetlija, Z., Mesarić, J., Karić, M., Potočan, V., Rosi, B., Jereb, B., Trauzettel, V. (ed.) Faculty of Economics in Osijek, Osijek, 15 October 2015, p. 117-129.

Smith, J., Mazur, M. & Wisniewski, A. (2017). Clarity from above: transport infrastructure, PricewaterhouseCoopers, [available at: http://www.pwc.pl/en/publikacje/2016/clarity-from-above-transport-infrastructure.html, access February 11, 2017]

Vlahović, N., Knežević, B. & Batalić, B. (2016). Implementing Delivery Drones in Logistics Business Process: Case of Pharmaceutical Industry*, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering,* Vol. 10(12), p. 3948-3953.