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Research Article

UAVs in Practice: Benefits, Concerns, Examples, and Managerial Implications

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Abstract

Technological progress is reflected in the drone market. As a result, new possibilities for the use of drones in various industries are emerging. However, new opportunities also create new threats that menace people's lives and the security of businesses. Many companies have already implemented drones into their processes, which creates a source to learn from. Therefore, authors will try to answer basic questions, such as what added value the use of drones can bring to companies, what dangers may arise, what are the limitations, and how managers should approach the decision-making process about drones. In the first step of the methodology, the literature was analysed, followed by the analysis of other materials such as corporate reports and newspapers. Subsequently, managerial implications were created through deduction and generalization. Based on them, recommendations for drone management were proposed. Managers should identify potential drone uses for their businesses. It is also necessary to identify the potential dangers arising from the misuse of drones by external entities. SWOT analysis is appropriate for the analysis of possibilities and risks, benefits, and limitations. One of the main limitations of the use of drones in practice is the legislation, which differs in each country. This may result in increased costs for complying with the legislation.

Keywords: Drones, benefits, concerns, management

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Introduction

Drones potentially yield lower energy consumption and reduce greenhouse gas emissions, thus reducing the carbon footprint and enhancing environmental sustainability (Chiang et al. 2019). There are countless areas where drones are being used or have a great potential for their application, such as: cinematography, tourism, crisis management, marine or underwater purposes, etc. (Yaacoub et al. 2020). It is predicted that more than 10,000 drones will be operational for commercial use within the next five years, mainly due to their advantages over commercial helicopters when it comes to costs and budget (Yaacoub et al. 2020; Thiels et al. 2015). The drone worldwide market revenue is predicted to grow from present 26 billion U.S. dollars (2021) to 43 billion U.S. dollars until 2025 (Statista.com, 2021). The number of use cases of using drones in the commercial sector rises by the day, however, they are not always positive in nature. Often, drones are used for criminal activities, which spawns a security concern (Weaver, 2014; Statista, 2015; Yaacoub et al. 2020). Where there are malicious activities, new legislation is necessary. So not only the companies need to tackle the physical drone limitations, such as battery life and flight range (Cokyasar, 2021), they also need to study the legislation not to break any laws. For international companies, it might be a huge problem as the legislation is not entirely unified in different countries (Yaacoub et al. 2020). This article provides an overview of examples (use cases) where the drones are commercially used in a positive and in a negative way. Practical examples are analysed from the area of construction, sport, and gaming industry along with examples of fields such as logistics and delivery services, humanitarian aid and natural disaster mitigation. Therefore, the emphasis is placed on the drone use case analysis. The literature review is divided into two main parts – benefits of the drone usage, and the limitations and concerns related to the use of drones. Based on the literature review and the use case analysis, the managerial recommendations are proposed. Existing systems that have been created to address the limitations and concerns related to drones are also mentioned in the discussion part of the article, where the authors also draw conclusions. The mission of the article is to try to recommend how managers should act in relation to drones.

Literature Review

Benefits of using drones

Drones, due to their versatility, are increasingly used in marketing (Beninger and Robson, 2020). Since the size of drones is variable (they can either be small as a palm or huge enough to carry a heavy load) (Beninger and Robson, 2020), they might also be used in other fields, such as in logistics or delivery services and many others.

Specific benefits for various stakeholders depend on specific field of use. For instance, in delivery (particularly in the concept of last-mile drone delivery, which is gaining a lot of popularity) (Beninger and Robson, 2020), the potential benefits are mainly travel time, emission and costs reduction (Lemardelé et al. 2021); in public health, the main strength lies in its potential to decrease the travel time for diagnosis and treatment (Laksham, 2019). In logistics, it is possible to deploy drones into warehouse operations and retail settings to reduce operational costs (Beninger and Robson, 2020). Drones can also be equipped with various sensors (thermal sensors, cameras, chemical sensors (Moeyersons et al. 2021) that can help in surveying the object of interest, such as in an agriculture case mentioned in (Bacco et al. 2018), where various sensors are used to identify the driest sections of a field quickly, thus allowing farmers to allocate their water resources more economically. Additionally, as drones have been equipped with different sensors, they have been increasingly more capable of capturing multiple data sources and send them to the cloud for further processing and analysis (Moeyersons et al. 2021). As many companies are minimizing the amount of waste produced or many of them at least plan to implement structured waste management (Hrušovská et al. 2020), it might be a fitting idea to consider drones in an effort of making the waste management process efficient (waste transport – for instance). Especially if there is a hazardous waste to be moved.

Limitations and concerns related to the use of drones

In general, there are many problems that limit the drone use in commercial sector, such as: battery life and the flight range (Cokyasar, 2021), the maximum weight limit (Alwateer et al. 2019), one-at-a-time package carrying, possible dangers

posed by the technology failure, and legal regulations also pose a barrier for the implementation of drones. Companies must study them carefully so they do not break any laws, which might be resource consuming. There are several general rules for flying a UAV (Unmanned aerial vehicle – in this case used as a synonym to 'drone') according to Transport Authority (2019):

- *Altitude* – counts from the highest obstacle within a radius of 30 meters from the UAV in uncontrolled airspace. It is also allowed to fly at uncontrolled airports. At some airports, it is possible to fly to a height of more than 120 meters.
- *Distance* – the horizontal distance from the pilot is a maximum of 1,000 meters and always under visual supervision.
- *Visual contact* – the pilot must have a direct visual line-of-sight during the flight. He/she may not use DJI googles or other FPV goggles.
- *The drone gives priority* – the drone is in the last place in the hierarchy of airspace. It gives priority to all means of transport, including aircraft, balloons, helicopters, hang gliders, mainly for reasons of best manoeuvrability over the names of the means.
- *Keeping a safe distance* – the drone must keep its distance from non-participating persons, usually around 50 meters. (Transport Authority, 2019)

Very similar legal regulations are in force also in Lebanon, as was reported in Yaacoub et al. (2020). Particularly, they match in the altitude limitations, safety limitations and vehicle prioritization. But the legal regulation is not entirely uniform even in the EU countries. For instance, different countries require different certificates, licences, or registration either of a pilot or the vehicle (Yaacoub et al. 2020).

Munich Re (Statista.com, 2015) conducted a survey about the concerns resulting from the adoption of drones for commercial use. They asked a hundred risk managers of large and mid-sized companies to pick one of four factors. From them, 69% answered that the greatest risk is 'the invasion of privacy', followed by 'the inadequate insurance' (12%), 'personal injury' (11%), 'property damage' (8%).

As the invasion of privacy concern is great, *drone detection and classification* have emerged and grown recently (Aledhari et al. 2021).

Many different solutions and concepts are proposed and applied into the drone detection to make it more reliable, such as artificial neural network-based detection system that uses a deep neural network (DNN) to process the RF data, and a convolutional neural network (CNN) to process image data proposed in Aledhari et al. (2021). This, however, means increased costs for companies to ensure safety of privacy.

The rest of the three worrying factors (inadequate insurance, personal injury, and property damage) are linked with the crashes of drones, as has been documented in the examples above. Accidents are not uncommon in the commercial use of UAVs. The specific causes of these accidents can be various, e.g., non-adaptation to weather changes, failure of technologies (software, hardware), poor quality accessories, or non-compliance with general piloting rules. At present, many drones are manually controlled by the remote-control unit (Yang et al. 2018). As the complexity of the drone application will increase in the future, so will the crash accidents on a larger scale, resulting in the corresponding safety problems (Yang et al. 2018). Besides, the physical safety is not the only concern. Even the cyber security plays the role, as drones will be a part of a network (connected, for instance, via Wi-Fi) (He et al. 2017). Therefore, transmitted data need specific methods for securing too (He et al. 2017).

Materials and Methods

The aim of this article was to create an overview of commercial drone usage in various fields to deduce managerial implications and recommendations. Therefore, after a literature review was conducted, an analysis of use cases and newspaper reports was conducted. The intention of literature review was mainly to research benefits of drone use (how could companies benefit from drone usage) and dangers that result from advancement in drone technology. Induction and generalization were necessary to get to a conclusion applicable for multiple fields. The research questions are: what are the use cases of commercial drone use and what lesson can be learned to help managers in their decision making on the use of drones? The structure of the article is visualized in Figure 1 bellow.

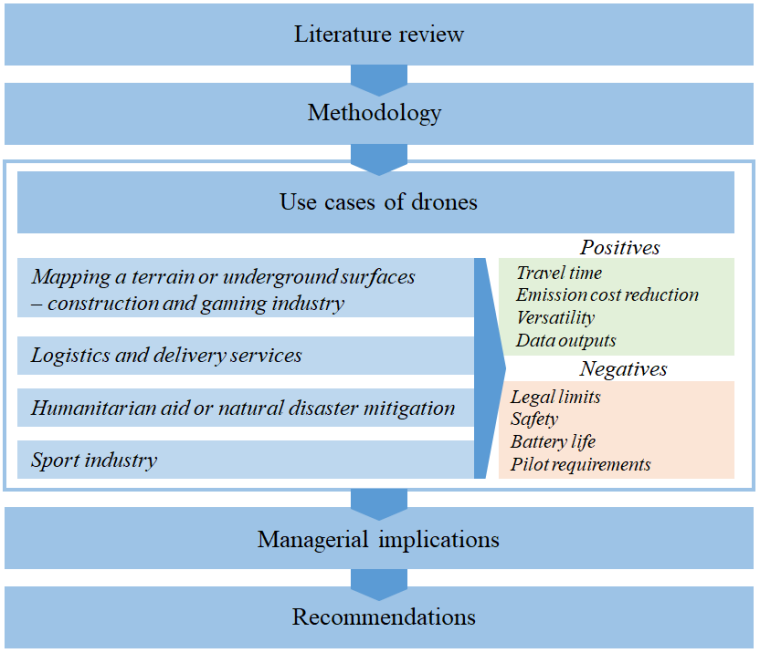

Figure 1. Visual representation of the structure of the article (own elaboration)

The idea of the graphical representation is to make the structure and logical flow of the article easier to decipher. The use case part of the article is further described along with positives and negatives arising from the use cases as this is an important part (results) of the article.

Results

Mapping a terrain or underground surfaces – construction and gaming industry

Applied geophysics is the science of measuring and interpreting physical properties to study underground conditions (Gavazzi et al. 2019). This science finds application wherever it is necessary to deal with the earth's surface (down to the depth of its core), for example in archaeology, engineering, environmental studies, mining, geothermal water, detection of remnants of military objects (mines, tunnels, explosives, etc.) from World War II (Gavazzi et al. 2019).

This branch of science uses several methods one of which is *magnetism* (Gavazzi et al. 2019). Thus, by methods using magnetism, it is possible to map terrain and the underground, but there are several techniques for performing such mapping (e.g., a magnetometer). Here it is possible to use a UAV, on which a three-component magnetometer is deployed, which allows the acquisition of additional data (Gavazzi et al. 2019). UAV terrain mapping is fast, reliable, accurate, easy to operate and cost-optimal (Zolkepli, 2021). Using UAV, it is ultimately possible to generate a 3D model of the environment (Zolkepli, 2021). Such environmental mapping is also useful in the field of construction, where, according to one of the manufacturers of drones intended for mapping (Wingtra, n. d.), a detailed analysis of the environment and the underground is required for many construction projects.

UAV terrain mapping was used for the purpose of planning of the EuroTube (a concept of ground vacuum transport through a tube), where it was necessary to plan a route along which the test equipment and EuroTube prototypes will be led. (Zwaan, 2016)

The mentioned 3D models are also used to create *virtual maps* for the purpose of *gaming*, as it was done by a software company CapturingReality. Their software can use images from drones, where the classification artificial intelligence then distinguishes terrain specifics and particular objects in it. (CapturingReality, n. d.)

Logistics and delivery services

The main goal of delivery services and transport of goods is to be quick and ensure that the right products and goods are delivered without harming to the right recipients (Zraková et al. 2019). Not meeting these requirements might mean dissatisfaction of customers (Zraková et al. 2019). Drones could innovate delivery services and transport to the higher satisfaction of customers. Amazon and DHL were among the first companies that tried to use drones for the logistics purposes in 2013 (Cokyasar, 2021). Then in 2017, the UPS company tested the so-called concept of the Truck launched UAV. It is a delivery vehicle, which is traditionally driven by a UPS employee, but it also serves as a base for a drone or as a dock. When the drone is in the vehicle, it charges itself. The courier scans the shipment, inserts it into the cage, which serves as an insertion of the shipment into the drone and the drone then catches the scanned shipment. The drone is controlled automatically by software, but the courier must indicate the place where the package is to be delivered on the satellite image. He must do this based on his experience. If the drone delivers the shipment, the courier continues the traditional delivery. (Perez and Kolodny, 2017)

Although the use of UAVs in the delivery sector can reduce operating costs (by up to 60% in the historic centre of Barcelona) (Lemardelé et al. 2021) and reduce externalities such as environmental pollution by internal combustion engines or road wear (by 70% in the historic centre of Barcelona) (Lemardelé et al. 2021), the concepts are still being researched and there is no definitive optimal solution yet. There are still many barriers, such as the fact that the UAV delivers only one package at a time, plus the range and the maximum weight of the shipment are also limited. The profitability of the concept of UAVs emitted from a vehicle strongly depends on the total operating costs of the UAV per unit distance (Lemardelé et al. 2021).

Humanitarian aid or natural disaster mitigation

Drones are able to fly over damaged areas and identify the damages caused by a hurricane, for instance. Also, they can locate people buried under debris after an earthquake, or they are able to access difficult areas where they might transport food and water. They could also be used for the supply transport of drugs in remote areas, to local hospitals and even directly to the injured patients at the scene (Thiels et al. 2015). For instance, WakeMed Health, which has partnered with the State Department of Transport, after a series of successful tests, has been able to deliver medicines in remote parts of Africa with the help of various partners, but mainly via the use of the UAV technology (Robakowska et al. 2018).

Sport Industry

There are several techniques that football coaches use to analyse matches or training sessions, and from the drone-collected data, data analyst can mine information such as that Lionel Messi creates more space by standing still or by jogging, rather than by running, as it would be expected (Shahidul, 2020). The report of the Coral, which states details of impacts of technology on sports, examines how some professional clubs of football, American football (NFL) and rugby are currently using drones to further improve their training and to gain a competitive advantage over the competing clubs. The unique perspective of the action and the view offered by the drones help the coaching staff to better understand the position and formations of the players. (Boover, 2019; Boggs, 2017) It is not only football where drones might be used to train sportsmen. It has been researched how drones could be used in boxing training (Zwaan, 2016). However, it has been concluded, that with the technology present in 2016, drones were not fast and precise enough to provide a fluent sparring experience, although participants enjoyed the exercises (Zwaan, 2016).

Due to the flexibility and speed of drones and the increasingly impressive technology of on-board cameras (including image stabilization), there is a growing potential for drones to replace and complement cable stadium camera systems; for instance, SkyCam which offers many angles and heights that wired cameras are not able to offer. This would be also useful in water sports, such as surfing or rowing. These are problematic sports to capture detailed shots and various angles. There may even be potential for drones to take over the functionality of the referee. Drones provide an opportunity to document sports scenes that they cannot capture on earth, and cover situations for journalists where it would be too dangerous to send a person. In summary, drones allow getting closer to the topic and are more flexible than known camera systems. In addition, they provide sports fans with a better viewing experience. (Sports Video Group, 2014)

As until now, the discussed examples were positive in nature, however, drones may pose a danger for sport events' safety. The incident of 2014 in UK's football match might serve as an example. An unknown drone (with a video camera) carrying a sectarian flag was flown over the pitch, which caused worries about potential safety disruption of sport matches. (Weaver, 2014)

This is not the only case of sport event disruption. The following examples are also worth mentioning:

- During the 2nd round of the World Downhill Cup in the Italian city of Madonne, there was an accident between the racer Hirsher and a TV drone. Fortunately, the drone did not directly hit the racer or anyone within the organizers or organizational teams. According to the available information, the pilot of the drone is responsible for the accident, being allowed to take television footage exclusively off the track above the corridor without spectators. (Pravda.sk, 2015)
- Accident at the Endure Batavia Triathlon where the cameraman of this event lost control of his UAV, which subsequently collided with one participant of the event. The competitor suffered minor injuries with which she was taken to the hospital. The incident was investigated by the Civil Aviation Safety Authority (CASA), which found that the cameraman was not registered as a certified pilot for commercial purposes. (BBC News, 2014)
- In April 2014, a drone collapsed on a local triathlon course in Western Australia. The photographer lost control of his drone while capturing the event. One of the athletes suffered from minor head injuries. (SVB, 2018)
- In 2015, the drone crashed again, but this time into a group of empty seats during the US Open tennis match at Louis Armstrong Stadium in New York. The man lost control of the drone during making photographies. (SVB, 2018)
- In May in 2017, a drone crash landed in Petco Park when San Diego Padres players played the Arizona Diamondbacks. The man lost control of the drone during filming. (SVB, 2018)
- The drone flew over Levi's stadium as the San Francisco 49ers played the Seattle Seahawks, then it flew over the Oakland Coliseum, where the Oakland Raiders hosted the Denver Broncos. The suspect released leaflets in both places addressing "issues of freedom of expression". This incident took place in 2018. (SVB, 2018)

The managerial implications of listed examples are summarized in table 1 bellow.

Table 1. Summary of the specific use cases of drones with the managerial implications

Example (case of use)	Area (specification)	Managerial implications
EuroTube	construction	using drones to map the surface and underground as a new option for the process of construction planning
CapturingReality	virtual reality	scanning the environment using drones to provide a virtual map of a company, which could be used for marketing purposes – recruitment campaigns (potential recruits can take a virtual tour through the company)
UPS + Barcelona	delivery services	drones help shorten the delivery time of goods to the consumer and reduce the costs and externalities, mainly in densely populated areas
WakeMed Health	humanitarian aid	as customer relation marketing is a tool often used for brand building, it is possible to create a marketing campaign where the drones are used to deliver

		goods to those in need
Coral	sport industry	The bird's eye view of drone helps in staff technical training, not only sport training
UK football match incident, San Francisco 49ers vs. Seattle Seahawks incident	sport industry	drones may pose danger to every part of society; managers of all companies (not only sport managers) must analyze the risks drones could pose for their company in the future and they should identify optimal solutions in advance
World Downhill Cup, Endure Batavia Triathlon, US Open tennis match incidents	sport industry	human factor might fail even in drone applications; human resource management concepts must be applied, such as stuff continuous training and education to minimize the human factor failure in advance; if neglected, a public outrage dangerous to a good name of company can occur

Discussion and conclusion

Within the topic of commercial use of drones (UAVs) in connection with the managerial implications of their use, safety options and risk reduction need to be addressed. According to the literature reviewed and the practical examples analysed, these *recommendations* are proposed to evaluate the possible use cases for drones in the company, and to ensure the safety of all the people involved:

- perform *SWOT analysis* for the potential use of drones in the company as it was done by Thiels et al. (2015) for the case of medical product transport,
- identify the *key success factors* for the implementation of drones as Shahidul (2020) did in their research for logistics where they identified the three most important factors: technical aspects, government regulations, and skilled workforce,
- in relation to the decision of using the drones in some of the company processes, perform a *make-or-buy analysis*, where 'make' means purchasing the drones and paying employees for their usage and maintenance, and 'buy' means outsourcing all those activities,
- in relation to *the decision to 'make'* (from the previous point), select sufficiently competent UAV users with high-level expertise, or spend enough resources to educate and certificate them so that legal requirements are met (SVB, 2018),
- regarding *the decision to 'buy'* (as listed above), analyse the market to choose the most fitting supplier that can fulfil all the success factors for the implementation of drones,
- *analyse and evaluate the risks of security breach* by unknown drone users, or analyse potential risks of using the drones; identify the potential solutions and preventive actions,
- if the risk is high, purchase an *unmanned aircraft detection and a monitoring system* or liaise with local law enforcement authorities to gain access to the system; the top priority in ensuring security for any threat is the ability to detect it soon enough,
- *consult local law enforcement and legal counsel* on what company's security partners can do to ensure safety against drones.

The managerial decision-making process should consist of at least three essential steps: the problem definition, the core of decision-making and the implementation of the decision. These three steps are essential according to Malichová and Mičiak (2019) where several theoretical decision-making models were analysed.

Rapid developments in technology field nowadays have a significant impact on the development of innovation that is very important for the growth and competitiveness of companies (Koman et al. 2018) and this also applies to drones. Managers should consider technological innovations to address the discussed concerns and dangers. Some of the technological solutions are mentioned bellow mainly considering the risk of accidents (drone injuring a person, or damaging objects, or itself).

Optical and ultrasonic sensors and cameras or external accessories can be used to prevent possible collisions. As interest in the commercial use of UAVs has grown in recent years, it is important that manufacturers consider not only the quality of the device itself and the resulting video outputs, but especially the safety of the device itself and the evaluation of hazardous situations. It is therefore important for the current technologies to be developed and new ways to be sought to create the least possible risks to health, financial damage, whether on the UAV facility itself or on the property of potential victims. (Butuk and Ažaltovič, 2020)

Indeed, according to Sakib et al. (2021), the stress and fatigue of a pilot are leading causes of drone accidents. They also presented a systematic approach to predicting impending drone accidents using data that capture the drone pilot's physiological state preceding the accident. It is therefore possible to use data to prevent the drone accidents based on the data about the pilot, but it is possible to use data about the surrounding area as the following example describes.

DJI Airsense Geo system allows the user (pilot) to locate objects in the vicinity, using a DSB signal, which is used by aircraft and helicopters to transmit data and information. The task of this function is to warn the user (pilot) of a possible collision in advance. DJI is aware of the importance of this system and has therefore made it available to every UAV over 250 kilograms. An important system for safety is also the Geo system, which provides up-to-date information in areas that may be limited, whether for regulatory or safety reasons, thus restricting the equipment to take off, whether at airports or military bases, government buildings, nuclear power plants. and so on. The system has an informative nature, but the user (pilot) is responsible for the accidents, damage within the shutdown of this software. (Butuk and Ažaltovič, 2020)

The above-mentioned system serves as an example of accident prevention technology. Although as the system is not entirely flawless, and it merely reduces the chances of accident, it is necessary to consider implementing another prevention tool.

Parachute systems - the use of parachutes within the UAV for commercial purposes can significantly serve to protect human life, property, or to protect the device itself and its parts. As unpredictable situations such as e.g., system failure, battery discharge, propeller damage, it is therefore important as a pilot to rely on external accessories in addition to software systems. Parachute systems are available as a complementary product to the UAVs themselves, are located on top of the UAVs and in the event of an unexpected error are able to activate themselves or with the help of a pilot. (Butuk and Ažaltovič, 2020)

An example of anti-drone/anti-UAV technology is CLEARSKY ™ from Digital Global Systems (DGS), which provides increased security and operational efficiency by combining the power of patented wireless spectrum management with state-of-the-art drone mitigation. (SVB, 2018)

It appears many of the discussed benefits and problems associated with UAVs are known and are being researched. As it was demonstrated in this paper, there are even existing solutions to problems. Such as casualties that happen due to the failure of human factor, that are addressed by location systems solutions, or by the parachute systems. However, there might still be some undiscovered or not well researched threat. Further research of threats and problems of UAVs that could cause environmental or personal damages is suggested. One should not be focused solely on the sides of benefits of UAVs, without analysing risks and potential problems.

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