Master's degree thesis

LOG952 Logistics

The use of drones in oil and gas logistics

Javid Baghirov

Number of pages including this page: 52

Molde, Date: 22.10.2018

Molde University College
Specialized University in Logistics

Mandatory statement

Each student is responsible for complying with rules and regulations that relate to examinations and to academic work in general. The purpose of the mandatory statement is to make students aware of their responsibility and the consequences of cheating. Failure to complete the statement does not excuse students from their responsibility.

*Please complete the mandatory statement by placing a mark **in each box** for statements 1-6 below.*		
1.	**I/we hereby declare that my/our paper/assignment is my/our own work, and that I/we have not used other sources or received other help than mentioned in the paper/assignment.**	☒
2.	**I/we hereby declare that this paper** 1. Has not been used in any other exam at another department/university/university college 2. Is not referring to the work of others without acknowledgement 3. Is not referring to my/our previous work without acknowledgement 4. Has acknowledged all sources of literature in the text and in the list of references 5. Is not a copy, duplicate or transcript of other work	Mark each box: 1. ☒ 2. ☒ 3. ☒ 4. ☒ 5. ☒
3.	I am/we are aware **that any breach of the above will be considered as cheating, and may result in annulment of the examination and exclusion from all universities and university colleges in Norway for up to one year, according to the Act relating to Norwegian Universities and University Colleges, section 4-7 and 4-8 and Examination regulations** section 14 and 15.	☒
4.	**I am/we are aware that all papers/assignments may be checked for plagiarism by a software assisted plagiarism check**	☒
5.	**I am/we are aware that Molde University College will handle all cases of suspected cheating according to prevailing guidelines.**	☒
6.	**I/we are aware of the University College's rules and regulation for using sources**	☒

Publication agreement

ECTS credits: 30

Supervisor: Bjørnar Aas

Agreement on electronic publication of master thesis

Author(s) have copyright to the thesis, including the exclusive right to publish the document (The Copyright Act §2).
All theses fulfilling the requirements will be registered and published in Brage HiM, with the approval of the author(s).
Theses with a confidentiality agreement will not be published.

I/we hereby give Molde University College the right to, free of charge, make the thesis available for electronic publication: ☒**yes** ☐**no**

Is there an agreement of confidentiality? ☐**yes** ☒**no**

(A supplementary confidentiality agreement must be filled in)

- If yes: **Can the thesis be online published when the period of confidentiality is expired?** ☐**yes** ☐**no**

Date: 22.10.2018

Preface

This thesis is a final work as partial fulfillment for the degree of Master of Science in Petroleum Logistics in Molde University College. The basis for this research originally stemmed from my passion for innovative technologies in the industry and especially in drones.

I would firstly like to thank God for his blessing until the research is completed. I would like to express my sincere thanks to Bjørnar Aas for being my supervisor and for his guidance throughout the process of writing this thesis.

Finally, but not least my family: Dad, Mom and wife for their everlasting support, encouragement, care and belief in me a lot of things would have been impossible.

Oslo, October 2018

Javid Baghirov

Summary

This master's thesis analyses current market of drones in oil and gas industry and research future possibilities of the Norwegian continental shelf. More specifically, it seeks to discuss how different companies try to utilize UAVs in improve the situation.

The research in this field is scarce and can be unique conception for future studies. Therefore, this thesis is an explorative study where the objective is to provide a better understanding of the drone usage.

The object of the research is the modern information base, organization methods, principles of operation and the results of the efficiency of using drones in oil and gas logistics of Norway and foreign countries.

The subject of the study are the principles and methods for assessing the economic efficiency of the application of drones in order to support technological and management solutions in oil and gas logistics.

The structure of the work: the work sonsists of Introduction, three chapters, Conclusions and Bibliography.

Contents

Introduction

One of the most important tasks of any oil and gas company is to minimize the economic and environmental risks associated with exploitation. In order to control these risks, continuous monitoring is necessary. However, it is not easy to provide it. For decades, monitoring has been carried out by walking around or using manned aircraft. However, today they are replaced by unmanned aerial vehicles.

A UAV is an aircraft that performs a flight without a pilot on board and is operated automatically in flight, by the operator from the control point or by a combination of these methods.

Until recently, it was believed that unmanned aerial vehicles are used only for military purposes. Today, the scope of their application has expanded at times: now they are used by police and civilian services, including search and rescue, land management or topographic surveys.

The relevance of research. In the conditions of progressive depletion of easily recoverable reserves of oil fields, complicating production conditions and falling oil prices, companies must solve increasingly complex tasks in improving methods and technologies for prospecting, exploration and development of oil fields. Possible progress in this direction is based on the use of advanced domestic and foreign technologies, a prominent place among which is occupied by information technology (IT). The technological development of oil and gas companies is accompanied by a sharp increase in demand for information, the expansion of the use of information technology. This is facilitated by the rapid development of information systems and new areas of information production, such as "Big Data", "Internet of things", "cloud technologies", "digital deposits" and other advanced technologies. In aggregate, they are capable of creating a serious potential for increasing the efficiency of the functioning of oil and gas companies. In order to gain a competitive position in international markets, oil companies need to increase the productivity and efficiency of operations, reduce costs, rationalize production, in order to successfully enter new production regions and new markets. Achieving these goals should be accompanied by the maximum extraction of benefits from the use of new IT, increased speed and quality of decisions, processing capabilities and the interpretation of huge information flows. Experts predict that the greatest success is possible with the use of real-time management methods and technologies, scenario modeling tools and support for decision-making under conditions of risk and uncertainty. In this context, drones become a powerful means of increasing efficiency, since they can remotely solve many tasks, significantly reducing production costs and increasing the degree of operational safety.

Scientific elaboration of the problem. In the foreign literature, the works of such authors as Armstrong, M., Bratvold R., Demirmen F., Galli A., Hartke R., and others have been devoted to the concept, methods and tools of efficiency assessment used in the implementation of technologies using modern unmanned aerial vehicles. Higgins J., Laughton D., Megill G., Martinsen R., Kjelstadli R., Ross C., Smith M. Walstrom J.

The purpose of the work: to develop methodical approaches to the assessment of the economic efficiency of the use of drones in the oil industry using the methods of decision theory for various types of oil and gas business tasks and to justify recommendations for the development of these technologies in the Norwegian oil and gas industry and logistics on the basis of analysis and generalization of the results of the application of drones in the world and Norwegian petroleum industry.

The tasks of the work:

1. to analyze features and prospects of unmanned aerial vehicles in the financial sector;

2. to show out features of drones using in the oil and gas industry;

3. to conduct a generalization and identify the main factors of economic, technological, operational and strategic effectiveness of the use of drones in the oil industry and logistics, as well as benefits of material and non-material nature;

4. to develop conceptual provisions and methodological approaches to assessing the effectiveness of unmanned aerial vehicle technologies for solving practical problems of the oil industry;

5. to demonstrate the possibility of using methodological approaches to determining the effectiveness of using drones in solving a number of practical problems of the oil business.

1.0 Chapter 1. Features and prospects of unmanned aerial vehicles

In the nearest future, the use of unmanned aerial vehicles (UAVs, or drones) for commercial purposes may become a new wave of IT revolution that will cover virtually all areas of business. The introduction of unmanned aerial vehicles into the operational activities of companies will not only reduce current costs and increase the profitability of the business, but also become the basis for building new business processes.

1.1 Overview of the world market of unmanned aerial vehicles

Leading global companies, operating in different industries, are already using unmanned aerial vehicles to improve technical efficiency. For example, in the oil industry, Sky-Futures, which specializes in testing oil platforms and pipelines for such major market players as BP, Shell, Statoil and ConocoPhilips, uses drones to conduct inspections at facilities, reducing labor costs from a few weeks to several days. In the transport sector, the US railway company BNSF uses unmanned aerial vehicles for remote inspection of trails and bridges. At Easyjet and Lufthansa, drones became a tool for aviation inspections, and the world's largest retail retailer, Walmart, is developing schemes for the use of unmanned aerial vehicles for inventory management in warehouses.

In 2015, PwC opened a single technology center for the study of drones in Warsaw, which deals with the introduction, regulation and evaluation of the economic efficiency of unmanned aerial vehicles worldwide. According to the specialists of the Center, the world market capacity for deploying solutions using unmanned devices is 127 billion dollars[1].

---

[1] The global market capacity was estimated by the staff of a single technology center to study the capabilities of drones, based on an analysis of the replacement of direct costs, namely the salaries of employees and services of third parties, at average rates of key industries in 2015.

1.2 Features of regulation of unmanned aerial vehicles in Norway

According to the Minister of Transport and Communications of Norway Ketil Sulvik-Olsen, remote-controlled unmanned aerial vehicles or drones are becoming more sophisticated technologically and more affordable, which opens up broad opportunities for their use by government services and business. Drones find their use in construction, in the transportation of goods, in search and rescue operations, in mapping, monitoring the operation of various infrastructure facilities. In Norway, drones are already being used by state control and inspection services, companies in the oil and gas industry, as well as branches of the Norwegian Red Cross. In addition, the piloting of drones, as well as the implementation of photo and video with their help in recent years has become a popular hobby in many countries of the world.

Nevertheless, the growing popularity of the new technology forces us to develop strict rules regarding its use, which is being done not only in Norway, but also in the European Union countries, of which the kingdom is not a member. The strategy presented by the Norwegian Ministry of Transport contains 25 goals, the main one being the creation and implementation of rules designed to ensure not only the safe use of airspace, but also the ease of technology implementation. It is proposed to strengthen the control and supervision of the use of drones, while encouraging their use in the public sector. The Norwegian government also intends to sponsor research and technology projects on drone and to assist companies involved in promoting this technology and offering ready-made commercial solutions for those who want to use drones in business or government activities

1.2.1 Regulations

The use of unmanned aerial vehicles for commercial purposes is widespread, so the legislative and regulatory framework for their use has been constantly changing.

Quadrocopters, drones and other devices formally fall under the definition of an unmanned aircraft (Article 32 of the Air Code) or an unmanned aerial vehicle (Government

Decree No. 138 of 11.03.2010). For the first time, the concept of an unmanned aircraft was introduced into the Air Code of the Norway by Law Act of 11 June 1993 No 101.

In Norway, all users of unmanned aircraft have to know the regulation of drones. Especially, the ones who use it for commercial purpose. There are three types of Remotely piloted aircraft system organization (RO): RO1, RO2, and RO3. RO2 and RO3 types have to pass an exam to get a certificate. Category RO1 should declare to the Civil Aviation Authority regarding operation in compliance with regulations. The altitude is limited to 120 meters, for RO1 and RO2. We will mainly focus on RO2 and RO3, since RO1 is less than 2.5 kilos and is not appropriate for petroleum industry.

Operators of **RO2** must get the licence from CAA Norway before starting the flights. Maximum weight of UAV is limited to 25 kg and maximum speed to 80 knots. (Chapter 5, Section 29. RO2)

To register an UAV, the owner of the drone must register on a special portal and fill out the application. Then, at the specified address, he will receive a registration identification sign, which must be fixed on the body of the drone.

Transportation of passengers is not allowed at all in Norway for now but trasnportation of goods is permitted where this is specified in the licence from the CAA Norway. (Section 12)

Registration is not limited to - drones can not be run anywhere. In particular, those wishing to fly to central Oslo need a special permit. You can get it only in exceptional cases (for example, shooting a movie).

The US Federal Aviation Administration has approved the following restrictions for commercial drones: the weight of the device should not exceed 55 pounds (25 kg), they can travel at a height of not more than 400 feet (122 meters) at a speed of not more than 100 miles per hour (161 km / h).

It is possible to control drones only at daylight hours, and the device itself should be within sight of the pilot.

Until recently, all drones used for commercial purposes in the United States were subject to registration. However, in May of last year this requirement was canceled by a federal court decision. In the UK, the Civil Aviation Authority (CAA) follows similar rules. In addition to them, drones with cameras are prohibited from approaching people closer than 164 feet (50 m).

The Global Drone Regulation Database website provides an interactive map reflecting legislation on drones in different countries.

1.3 Research of the modern market of drones

1.3.1 Overview of the drones market

For a long time, drones - unmanned aerial vehicles - were considered a futuristic gadget from science fiction, but today it is difficult for them to surprise anyone. The tone in the industry is still asked by the military - it is they who account for two-thirds of all manufactured drones.

They use drones for reconnaissance, interception of communication and defeat of targets. The use of drones in business is only gaining momentum. They are already used for aerial photography, patrolling, geodetic surveying, monitoring of various objects. Gradually they are included in other industries. Below, let's look at the commercial scope of drones in more detail.

According to the forecast of ARK Invest, by 2020 32% of drones will be engaged in agriculture. Other large employers will be companies of the oil and gas sector and logistics services:

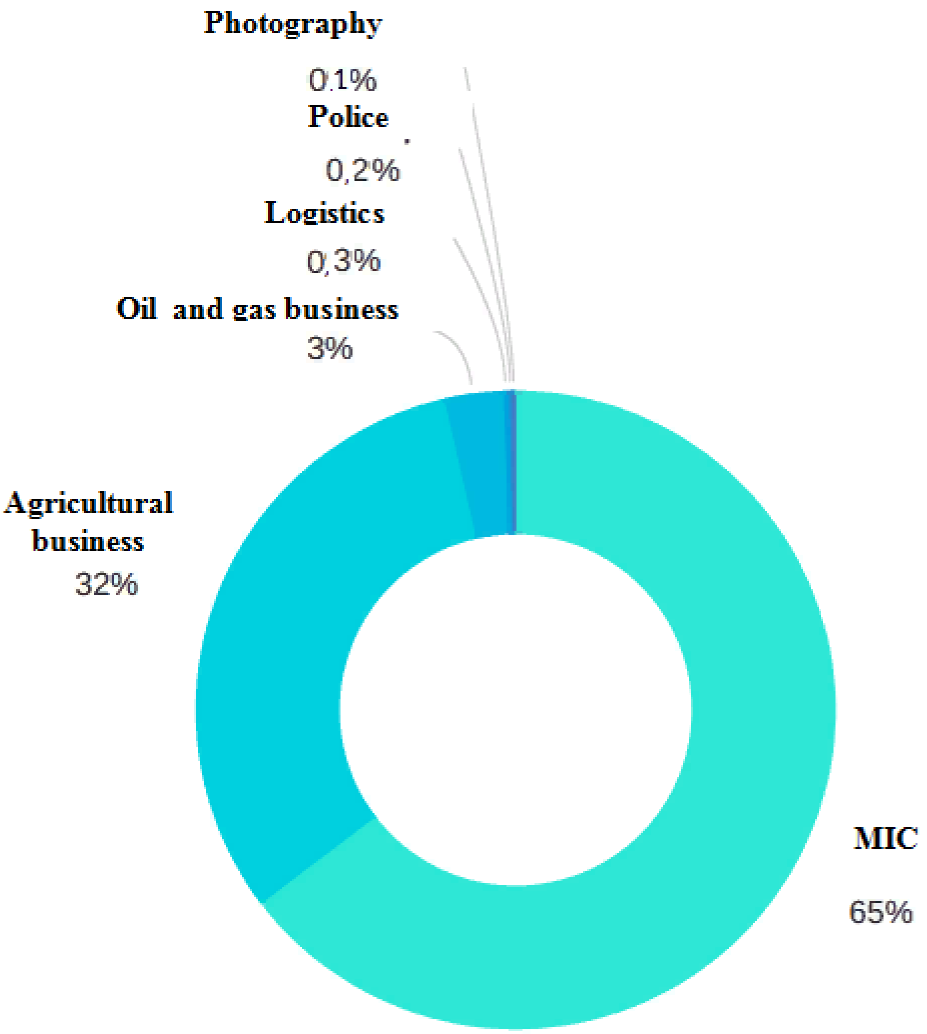

Figure 1. Using drones by spheres

Taking into account this forecast, we have detailed the application of drones in these and other areas.

Agriculture Application: spraying fertilizers and poisons for insects, monitoring the condition of farmland and the chemical composition of plants Manufacturers: DJI, Sentera, Lockheed Martin, Insitu, senseFly, Aerialtronics Companies implementing drones in agriculture: Sentera, MicaSense, Tetracam, Agribotix Drones for monitoring cultivated fields, equipped with multispectral cameras.

This technology allows you to quickly collect a large amount of information about light absorbed by plants and reflected from them. Based on the data obtained, a conclusion is then made about the state of planting. In addition, not only drones, but also aircraft are used to collect information from fields.

Timely analysis of planting can identify diseases or a lack of fertilizers. For the delivery of the necessary fertilizers, the DJI quadrocopters, which have gained popularity due to stability, reliability and relatively low cost, are most often used. Recently, DJI introduced a new model of a drone, ground for agriculture. The device is capable of carrying up to 10 kg of cargo.

According to the Juniper research, in USA in 2016 up to 48% of commercial drones were involved in agriculture. By 2026, this figure can reach 80%.

Logistics Application: delivery of goods

Manufacturers: DJI, Flytrex, Flirtey, Matternet, Project Wing

Companies implementing logistics drones: Amazon, Dodo, DHL, UPS and other Drones allow logistic services not only to cut costs for the "last mile" (most expensive part of delivery), but also deliver parcels to hard-to-reach places.

In the summer of 2017 Amazon also applied for a tower-hive patent, from where drones with parcels fly to the addressees.

Logistic company DHL began working on the delivery of parcels drones much earlier than Amazon. It even delivered the parcel to a pharmaceutical company located on an island in Germany using her parcelcopter (a possible translation of the "messenger"). Parcelcopter was introduced to the public in May 2016. In the framework of the test tests, the drone delivered 130 parcels in various temperature and climatic conditions.

In McKinsey expect that in the future, drones and unmanned vehicles will deliver up to 80% of all parcels.

Infrastructure Application: Wi-Fi provision, safety inspection and other Manufacturing companies: DJI, Aerialtronics, Draganfly Innovations, SkySpecs, Secom

Companies that implement drones in infrastructure: BT, Facebook, Balfour Beauty, easyJet BT experimented with drones to provide temporary access to the Internet on battlefields, disaster zones and hard-to-reach areas.

If the networks are ever destroyed by floods, the drones will be able to first assess the damage, and then provide access to the Internet in the area through site-bound devices and balloons. Facebook is working on a similar project.

Using the Aquila drone equipped with solar panels, Mark Zuckerberg plans to provide about 4 billion people with Internet access who do not have access to the network.

Drons are also used to monitor the existing infrastructure. For example, last year the company Balfour Beauty conducted an inspection of bridges in the English county of Sussex with the help of drone. The use of the new technology enabled the company to reduce the cost of inspecting one bridge by an average of £ 4,000. Loukoster easyJet began to conduct safety inspections of its aircraft using drones.

After a successful test at the British airport of Luton, the airline plans to introduce the technology at other airports.

Japanese company Secom created a drone for security inspection, which automatically turns on when an intruder is detected, follows it and sends video in real time to the post of guard for further response.

Building Applications: aerial photography and tracking progress Manufacturers: DJI, Kespry

Companies implementing drones in construction: Brasfield & Gorrie, 3D Robotics, Airwave

The American startup Kespry recently introduced a drone that uses NVIDIA's machine learning technologies to recognize building materials, machinery and other structures. Access to a large amount of information in real time allows developers to optimize business processes and detect construction errors at an early stage, when they are easier and faster to fix. Thus, the use of drones for additional inspections can save developers a lot of money.

Development company Brassfield and Gorrie started using drones to monitor construction sites several years ago. Models built with the help of data collected by drones, allow you to monitor the work of counterparties and the overall progress of construction.

Utilities: monitoring of mining systems Producing companies: Kespry, Insitu, senseFly

Companies using drones in mining operations: Pix Processing, Avision Robotics Shell uses drones at some of Europe's largest power plants and sends them to oil and gas facilities in hard-to-reach places for example, high towers or the lower parts of an offshore oil rig), because it is safer and more efficient than sending people.

At the beginning of the year, it became known that the drones of the Kalashnikov concern (part of the Rostekh state corporation) would be used to monitor the pipeline systems of Rosneft, Gazprom, Gazprom Neft, LUKOIL, Tatneft and Transneft.

Also, drones can be used to monitor other resource objects, including power lines and wind turbines. Research agency Research and Markets believes that in the period from 2017 to 2025, the drones market in the energy sector (including sales of drones, software and services) will expand to $ 4.47 billion.

Video shooting Usage: commercial video shooting - concerts, films, advertising, surveying, cartography and others

Manufacturers: DJI, Kespry, Autel Robotics, Insitu, Aeryon Labs, Inc., Aerialtronics, Draganfly Innovations

Companies using drones for video: BBC, Columbia Pictures Industries, Paramount Pictures

The market has a whole segment of professional drones equipped with specialized video equipment.

To install the video camera, the drone has special suspensions, which are mobile mechanisms of hinged type. Such mechanisms make it possible to secure a reliable fixation of the video camera and almost completely free it from vibration.

The images received by the camera with the help of special technology FPV (literal translation - "first-person view") are broadcasted to the control panel - smartphone, tablet or other output device.

A radio-controlled drone equipped with a video camera allows using FPV to control the shooting process not blindly, as is usually done, but focusing on the resulting picture.

In addition, the drones are so firmly entrenched in the film industry that festivals of films shot with the help of drones are held annually around the world

The sphere of application of drones is not limited to already established large industries. High mobility of drone can also be used in narrow niches. Below we give the most vivid examples.

First Aid: Scientists from Delft University of Technology have developed a flying defibrillator, which is designed to deliver the equipment necessary for first aid in the shortest possible time.

Delivery of organs for transplantation: above solutions in this area are Spanish Dronelife and Indian Fortis Healthcare.

Nature Conservation: drones are used to detect poaching activity, monitor animal populations, and collect environmental data. Forest restoration: British startup BioCarbon Engineering plans to use drones to create detailed maps and dot planting of trees.

2.0 Chapter 2. Features of drones using in the oil and gas industry

2.1 Features and benefits of unmanned technology

The growing use of unmanned aerial vehicles (UAVs, drones) radically changes the business models of oil companies and creates new operating conditions in various areas of their presence.

The use of solutions based on unmanned technologies provides great opportunities for oil and gas enterprises, for example in the field of geological exploration - from the analysis of perspective areas to geodetic surveys for the design and preparation of seismic surveys.

By 2020, the global market for UAV applications that complement and, in some cases, crowd out existing operating processes, according to PwC estimates, will be $ 127 billion (with the market of devices themselves in 2015 being only $ 1.4 billion). Cost of devices is relatively low and gradually decreases, so their application will grow both in the whole world and in Norway.

Potential for the use of drones in the oil and gas industry is truly enormous. Many of the safety and reliability issues that oil and gas companies traditionally spend significant funds can effectively be handled using unmanned aerial vehicles. It is important to understand that the value of UAV in the oil and gas industry is not so much in the "turntable" itself, which can be purchased by any philistine at the nearest electronics store, but in innovative programs for recognizing and processing data from UAVs. It is the ability to quickly and accurately process the data received from UAVs and, more importantly, the ability to integrate these data into existing information systems and business processes in the enterprise gives companies in today's conditions significant competitive advantages and qualitatively improves their ability to adapt to new conditions. WideBeaching Technologies The growing use of unmanned aerial vehicles (UAVs, drones) fundamentally changes the business models of oil companies and creates new conditions for activities and in various areas of their presence. The use of solutions based on unmanned technologies gives great advantages to oil and gas enterprises, for example in the field of geological exploration - from preliminary analysis of perspective areas to geodetic surveys for the design and preparation of seismic surveys.

To help oil and gas companies with practical solutions to these complex issues, PwC has created a center for innovative technologies in the field of unmanned aerial vehicles. Among the world's largest oil and gas companies, leading in the introduction of unmanned technologies in production processes, are BP and Shell. BP has already established remote control centers using drones and sensor technologies, Shell plans to provide the entire production process with "smart" technologies, including the technology of drones and sensors, by 2019.

Among Norwegian oil companies implementing unmanned technologies, we can mention Gazprom Neft and Rosneft. "Rosneft" plans with the help of unmanned vehicles to survey the terrain with the ability to obtain high-definition photos to create orthophotos. In Gazprom Neft, a special technopark was created to develop such projects. According to PwC experts, in the very near future more and more companies will be engaged in the transformation of their operational processes using unmanned aerial vehicles. This will include the oil and gas industry, where both mobility and high quality of information are needed. Today, China, the United States, France, Germany, and Poland in Eastern Europe have made significant progress in the development of commercial technologies for the application of UAVs. In Norway, unmanned technologies are used, but the effectiveness of their application relative to other countries is still low. Norwegian companies most often use UAVs to inspect oil and gas installations. Meanwhile, UAV solutions can be of great use in almost all key production processes in the oil and gas industry and help to cope with serious problems.

In the oil and gas industry, unmanned aerial vehicles are used to solve the following problems [1]:

- systematic monitoring of pipelines;
- pipeline monitoring
- regular control of industrial production at each stage of the work process;
- timely detection of oil spills;
- detection of pipeline exit areas and deviations from the calculated position;

- detection of violations of requirements for protecting pipeline sections, monitoring of near-tubular space and ground facilities;
- prospecting and exploration of deposits
- environmental monitoring of atmospheric emissions
- remote control of surveys and contract work
- operative control over unauthorized actions and stay at the protected objects of unauthorized persons, as well as detection of illegal pipeline closures, illegal activities, theft.

For this purpose, unmanned aerial vehicles are equipped with equipment for photo and video recording. The shooting is performed using a camera mounted on the UAV. The camera is used for a more rapid visual inspection of the territory along the main oil pipeline route. Unlike video shooting, photography has the advantage in terms of higher resolution. In addition to photo and video, there is also thermal imaging. Such a survey allows monitoring in conditions of reduced visibility (for example, fog) or at night. Combining different types of shooting allows you to more accurately assess the state of the object. In this case, the operator can manually change the trajectory of the unmanned aerial vehicle, return it to the desired point and photograph the object again.

In the future, unmanned aerial vehicles can be used not only for the purpose of monitoring industrial facilities, but also for the immediate elimination of malfunctions. For example, at the competition "Drones for Good", held in the United Arab Emirates, the first place was occupied by the development, which is intended for use in industrial facilities, in particular, for monitoring of surface pipelines. However, this function does not end with the device. The uniqueness of the development lies in the fact that it performs work to eliminate the identified problems, for example, sealing the damage in the pipe of a gas or oil pipeline. The patches are made of liquid polyurethane foam. The device applies the material to the depressurization site, within 5 minutes it freezes and closes the gap [2].

To date, more and more interest is attracted by unmanned heavy vehicles. Such unmanned aerial vehicles are used to perform a variety of operations [5]:

- in the oil and gas industry (for monitoring purposes);

- in construction (for the delivery of parts and observation);

- in the development of quarries (in order to control the levels of slices and monitoring);

- in emergency situations (for reconnaissance, fire fighting, rescue operations in hard-to-reach areas);

- in agriculture (for spraying and control of crops);

- in the field of medicine (delivery of medicines and transportation of equipment);

- in science (during research and delivery of goods);

- for railway companies (protection and overflight of roads at night);

- with aerial photography (in particular, 3D-survey and panorama) [5].

Let us dwell on the prospects of using unmanned heavy vehicles in the oil and gas industry. Such developments can be used in solving logistics tasks at the field. At the same time, the issue of transferring light weights from production bases in fields to drilling rigs for short distances in off-road conditions is being solved, besides, the need for high-traffic vehicles and additional labor force, which is economically viable, disappears.

A couple of years ago, the maximum carrying capacity of unmanned aerial vehicles was in the range of 5-10 kg. However, now there are devices that can lift cargo up to 70-100 kg. And in early 2017, one of the Norwegian companies reported the creation of an unmanned aerial vehicle with a payload capacity of 300 kg. And the aircraft itself weighs only 75 kg and is equipped with eight engines with propellers. The flight time of such a device varies within 30-45 minutes depending on the weight of the cargo. And as reported by the developers [3], in the near future they will be engaged in the creation of an unmanned aerial vehicle with a carrying capacity of 800 kg.

Considering the speed with which progress is progressing in the field of unmanned aerial vehicles with large payloads, in the near future they will completely replace traditional transport and labor.

Most of the petroleum companies in Norway are already using unmanned aerial vehicles to conduct regular monitoring of oil and gas rigs. Taking into account the specific characteristics of the place on which oil and gas companies are engaged in their activities, it can be concluded that the use of unmanned aerial vehicles makes it possible to monitor much more quickly and also to detect malfunctions in the operation of industrial facilities.

In Norway there are several developers and manufacturers of unmanned aerial vehicles. The products of these companies are successfully used by many oil corporations.

These are:

- **Griff Aviation** which produces big scale drones, that can carry upto 200 kg. Is a unique heavy carrier in the world. And can be utilized for logistic purpose in oil and gas industry. Currently, they are working on a project with several Norwegian instutions to solve transport related issues in offshore petroleum.

- **Blueye** is a underwater drone producer, was established in Centre for Autonomous Marine Operations and Systems (AMOS) at NTNU and located in Trondheim. Can be used for undersea inspections in Norwegian Continental Shelf.

- **Maritime Robotics**, as well as Blueye located in Trondheim and produces various technology for offshore but the scope is a bit different. Currently, they produce Moored Balloon System (MBS), Unmanned Surface Vehicle (USV) and Unmanned Aircraft System (UAS). Their USV is a potential cargo carrier for vessel substitution.

- Nordic Unmanned

Based on the above data, it can be concluded that the existing Norwegian unmanned aerial vehicles are adapted for use in various regions. have a wide temperature range and the possibility of use in conditions of poor visibility, for example, in rainy weather, fog.

2.2 The use of drones in geological exploration and production

The introduction of unmanned technologies into geological exploration processes will help to solve a number of tasks, such as a tangible reduction in the cost of primary exploration, a reduction in the work period, and in some cases, drones help to obtain more complete and qualitative data. During the inspection, carried out with the help of the drone, it is possible to obtain accurate topographic data on the prospective area with the help of technical tools (digital terrain model, orthophotomaps, 3D models).

Data acquisition using unmanned devices is applicable for initial (preliminary) geological exploration. Solutions using UAVs provide accurate information that simplifies the process of assessing and modeling the pool's potential. Online and automatic access to results ensures efficient further processing of data, integration with GIS / CAD data. With the help of drones, it is possible to effectively monitor hydrocarbon production facilities, monitor the current status of construction sites in the fields and prevent serious damage during operation due to the planned operation of unmanned devices (scheduled flights).

Monitoring of oil deposits can be supplemented with the use of various methods of collecting information to expand the possibilities for obtaining accurate data and preventing losses (for example, infrared cameras), and applied environmental monitoring technology is applicable for better monitoring of environmental impacts.

The use of technologies such as monitoring of vegetation index, allows to identify areas of increased environmental impact. Continuous monitoring of the activities of contractors and compilation of clear documentation throughout the investment site provide sufficient evidence in the event of claims.

With the help of the UAV, topographic maps for investment purposes are effectively compiled, as well as a thorough and automated process for supervising the implementation of capital construction projects.

2.3 The use of drones in monitoring

Solutions using UAV can be successfully applied for monitoring in the field of oil refining. With the help of drones, it is possible to control the quantity and quality of stocks, for example the location of supports, the determination of the parameters of the pipelines.

The use of unmanned devices is possible on inspected sites to confirm the correctness of the work performed. In addition, drones, which can be launched remotely from the control center, effectively carry out daily monitoring of the territory and patrolling in the framework of planned and unplanned flights. In the process of monitoring UAVs for oil refining processes, a detailed image and description of entire infrastructure segments can be obtained, which minimizes the risk of malfunctions and reduces possible damage.

With the help of drone, it is possible to accelerate the inventory procedure (inventory check), as well as early detection of problems with infrastructure facilities in remote areas and planning for necessary repairs. Drones with thermal imaging and optical systems are able to detect virtually all defects prior to putting the plant into operation.

Thanks to an effective monitoring process, the protection of the territory, protection from violators invading the site, as well as the collection of facts that indicate the presence of threats. Reducing the time to respond to calls and increase safety when eliminating emergencies can quickly make accurate decisions in emergency situations. In the company "Gazprom Neft" for the development of such projects, there is a technopark of industrial automation, which operates in cooperation with scientific and educational and innovation centers in Russia.

As reported in the company's corporate magazine, as part of R & D, Omsk State Technical University specialists are developing an unmanned flying robot scanner to monitor the construction of refinery facilities. The complex consists of a quadrocopter equipped with a video camera and the corresponding software allowing to accumulate and analyze the information collected by the aircraft and automatically generate a report. This tandem will be able to monitor in real time all phases of construction at the processing facilities of Gazprom Neft refineries. The complex can not only show the general picture, but also reveal deviations in the construction process of the object from the design characteristics. There are no analogues of such a complex in the world yet.

2.4 Transportation and storage

Very soon, drones will become an integral part of the logistics industry both as a new delivery method and as a service accompanying transport services. Industry companies will turn to unmanned aerial vehicles, as compared to other modes of transport, involving human participation, unmanned devices can be more efficient, and also tend to have lower operating costs.

According to our estimates, the total capacity of the market available for deploying solutions using unmanned devices in the transport industry is $ 13 billion.

The use of solutions based on unmanned technologies increases the efficiency of investing in transport networks and controlling oil and gas storage facilities. With the help of drones, the state of the infrastructure is assessed using unmanned technologies. The use of a UAV with a fixed wing (with a range of up to 100 km) significantly improves and speeds up the process of data collection. Visualization of the entire linear infrastructure gives a more complete picture of the state of the infrastructure and the necessary measures for its maintenance. The effectiveness of the use of drones is evidenced by the results of pilot operation of UAVs at the facilities of the Rosneft subsidiary RN-Krasnodarneftegaz. Specialists of RN-Krasnodarneftegaz use domestic UAVs equipped with equipment for round-the-clock photo and video shooting, including in the infrared range. The received data is broadcast in real time, and also recorded on a memory card. The operator can manually change the trajectory of the drone's motion, return it to the desired point to repeat the survey of the object. In one hour, the device is capable of flying more than 70 km of pipeline corridors. We add that drone can be used in a wide temperature range. Based on the results of the tests carried out at RN-Krasnodarneftegaz and completed by the beginning of this year, it was decided in 2017 to increase the number of overflights by 20% and expand the scope of their use. Trial operation of drones has shown that the efficiency of establishing the causes of deviations in technological regimes in pipeline transport has increased by 45%, control over oil and gas production facilities has increased, including the appearance of unauthorized persons. The tests were carried out on the deposits located in the Slavic and Akhtyrko-Black Sea regions. The total length of the route was over 1 thousand km.

2.5 Inspection with drones

One of the most obvious and established uses for drones in an offshore context is to make inspections on facilities – oil and gas platforms, wind turbines etc. UAVs can inspect high areas such as cranes, “crawler” robots can enter tanks and traverse hull structures.

Experts assure this is not only more efficient in terms of costs and time, but also safer than humans carrying out the same work. Aerial drones can access areas that would require humans to use ropes and harnesses, crawlers can enter spaces that would be inaccessible or extremely dangerous for humans, while UUVs can carry out work that previously required the use of trained divers.

With the help of UAVs it is possible to inspect:

- **Liveflare inspection**. This method expels the requirement for a shutdown to review the flare and gives the data required to decrease, postponement or better arrangement a turnaround.
- **Underdeck inspection**. Pilots, can zoom in on zones of interest, annihilating the requirement for extensive scaffolding, rope access to work scopes, over side work and stanby vessels.
- **Vents tack and exhaust inspection.** Give a creative solution to inspect onshore and offshore vent stacks and exhausts while they are live which highly decreases costs by removing the need to shut down during inspections and reducing the need for working at height.
- **Internal tank inspection.** Is able to perform internal inspections on large tanks on operational vessels such as FPSOs, bulk carriers, tankers and onshore oil storage tanks. ROAVs decrese the need for working at height and in limited spaces, enabling the pilot to undertake a safe first audit of the tank so that further inspection and maintenance can be prioritised.
- **Chimney and cooling tower inspection.** It is possible to capture a series of individual aerial photos to cover the full surface of the structure, by deploying ROAVs. Advanced photogrammetry software afterwards will help to create exact 3D models and highly detailed orthophoto mosaics of the chimney or cooling tower. Final results are sent in software also as traditional formats, that helps the user to visually see the full height and 360° model with defects correctly measured and categorised.
- **Structural inspection.** The method used by ROAV for inspection gives structural inspections of high or difficult to reach structures, that are quicker and more secure than traditional access methods. It lessen costs by evacuating the requirement for extensive areas of scaffolding and improve safety by decreasing the requirement for working at height and overside work.
- **Aerial survey.** Fixed wing and rotary ROAVs used to acquire high resolution aerial pictures. By using advanced photogrammetry software to create orthophotos, digital elevation models and panoramic images of a site, the imagery is processed. This kind of imagery is commonly utilized for site design, health and safety inductions,

evacuation plans, tendering information and as-built photography. All of this can be exhibited in an online 360 degree virtual tour.

The inpection is usually performed by two persons. One of them is a pilot, who flies the craft, another is an operator who takes controls over the camera fitted to the drone.

3.0 Chapter 3. Economic efficiency of drones application in oil and gas logistics

3.1 Drones using in oil and gas logistics as the most effective solution at the present stage

The introduction of innovations is an integral part of any enterprise and the headache of any entrepreneur who wants to retain existing customers and attract new ones. Logistics is a particularly important area of activity, as the logistics approach can be seen in everything from the way information is submitted to the simple delivery to the end user. By definition, logistics is the methodology for optimizing and managing flows in systems.

So far, only giant companies can afford to experiment and look for new solutions to problems, optimization and automation. UAV, of course, have their pluses, and their shortcomings, presented in Table 2 [3].

Table 2

Advantages and disadvantages of UAV

Advantages	Disclosure of parameter	Disadvantages	Parameter expansion
Cost Savings	The cost of shipping UAV cargo, weighing no more than 2kg, was valued at $ 0.1 versus $ 2-8 by land transport.	Confidentiality and safety UAV - originally military facilities, which is an important factor for his psychological perception.	UAVs are the main threat to information security not only for citizens, but for companies.
Ecologicality	Electricity is the only resource	Bills	In the legislation of many countries, there are a

	that is necessary for the operation of the drone, which largely "landscapes" it.		number of bills that somehow limit the flight of drones in airspace. And also UAVs are subject to mandatory registration, which also complicates their use, although there are drones released from registration due to their characteristics.
Exclusion of the "human factor"	This factor	"Problems in the air"	Birds also deliver a number of problems. For example, in the event of a collision with them, we will get 3 problems at once: a broken UAV, a damaged cargo and a dead bird.
Autonomy, flexibility Flexibility manifests itself in a very high response rate.	Autonomy allows you to adjust courses if necessary or force majeure.	Weather conditions	UAV, depending on other vehicles used in logistics, is sensitive to the slightest weather conditions, which makes it very difficult to use them.

Summing up, we can say that the main factors, one way or another, keeping logistics companies from using PBLA are "problems in the air" and sensitivity to weather conditions. Moreover, drones can be used in the logistics process inside the warehouse or other enclosed spaces for additional automation of some important functions.

For a long time, satellites, airplanes and helicopters used topographic surveying and geospatial data collection. Technologies for photogrammetric data processing and geospatial data collection are part of a broader scientific discipline known as geoinformatics, which deals with the structure and nature of spatial information used for urban development, agriculture, infrastructure development, mining, and many other applications. Photogrammetric and geospatial analysis provides companies with access to valuable information on topography, hydrography, vegetation cover, soil type, land development level and other characteristics that allows to increase the efficiency of their activities.

At the same time, aerial photographs obtained in the traditional way are still quite expensive and do not necessarily provide the necessary detail, since the quality of the images is usually low. Drones are more cost-effective and guarantee better data quality. That is why the growth in demand for data will lead to an ever-increasing use of drones for commercial purposes. Drones enter into direct competition with manned aircraft and satellites. According to PwC, due to the lower costs of collecting high-quality data and greater versatility, unmanned aerial vehicles can become the main tool for photogrammetric and geospatial analysis in the business processes of many companies.

The data obtained with the use of drones must be subjected to additional processing. Only after that they will be of particular value to the business. Analytical information and recommendations developed on the basis of this data should be provided as soon as possible and at the same time be clear, logical and detailed. Customers expect to receive this data on any type of device (mobile or desktop) at any time and in any place. That's why, according to PwC, the availability of data will be one of the key factors contributing to the further distribution of unmanned technologies for business purposes. There is also a link to the trend of simplifying and automating the use of drones, for example, by implementing the control capabilities of these devices from mobile devices, particularly smartphones or tablet computers, rather than through special control devices, as is done today.

Another example may be the development of flight control systems that ensure the safe operation of the drones park when performing various flight missions. These trends will contribute to the active introduction of unmanned technologies in companies of various sectors. New technical capabilities Drones consist of a number of technologically advanced components on which their performance, safety and reliability depend. In the conditions of continuous improvement of hardware solutions and reduction of their cost, the scope of application of drones will expand, and the investment attractiveness of this new, more innovative and affordable technology will increase. In the near future, a powerful push to develop solutions using unmanned devices will give technological breakthroughs, especially in the field of hardware, software and data processing technologies. The impact on the potential of the dron market will be the emergence of new types of power supplies, engines and materials. So, for example, manufacturers are already working on the creation of hydrogen fuel cells, which are more efficient than used now batteries. This technology will reduce the weight of vehicles and increase the flight time. The technology of programming and data processing will be improved.

Drones manufacturers are working on the introduction of stand-alone collision avoidance systems that process the data received from the sensors installed on the drone and help to prevent a collision or automatically take off and land in an automatic mode. This technology is already used on a small number of devices and is constantly being improved.

3.2 Development of methodological approaches to the evaluation of the economic efficiency of drones using when making managerial decisions

3.2.1 Valuation models for assessing the effectiveness of information reports

It is advisable to consider the effectiveness of digital technologies in the oil industry as a whole and its modifications in the form of digital deposits (CM) in the context of general principles and methods used in the implementation of information technologies. Therefore, below, the methodological framework for assessing the effectiveness of IT, developed and used in Russian and foreign practice, is described in more detail.

At the same time, IT technologies are understood as a set of operations related to the collection, storage, processing, interpretation, issuing of conclusions and making decisions based on this information. Therefore, in what follows, for simplicity, we shall use the term "information conclusions" referring to the result of the complex of the operations listed above, which increase the reliability of the management decisions taken. Reliability in a broad sense will be characterized by the risk of making erroneous decisions, and the concept of "information value" (VOI) considered below is interpreted as the concept of "cost of increasing the reliability of information" (for simplicity - the cost of reliability of information (SNI) and propose methods of economic evaluation.

Obviously, it is not enough to estimate the costs for the purchase and maintenance of drones: it is necessary to justify them from the standpoint of value. Consider IT assessment models that represent the most common approaches to assessing IT in foreign theory and practice.

Methods for establishing the value of the reliability of introducing innovative information technologies

The generally accepted definition of information reliability (ID) of conclusions ("softwareassurance") is formulated as a level of reliability in which the information system (IS) at any moment of its life cycle is not vulnerable, and in which the software functions operate in the established mode. There are several general models for estimating the cost of investments in IT. The main factors considered in these models can be taken as a basis for deciding on the appropriate level of investments channeled into IT systems to ensure a given level of reliability. The goal is to summarize the concepts and principles underlying these models and describe their common characteristics.

The initial principles used in the models can be divided into four groups:

1. Investment-based models (IOM)
2. Cost-oriented models (ZOM)
3. Models reflecting environmental factors (IOPS)
4. Quantitative assessment models (MCOs)

The Total Value of Opportunities (TVO) is the standard indicator developed by Gartner Group in developing the TCO method to better reflect the economic results of IT use. Its purpose is to assess the potential effectiveness of given investments in IT in time. This indicator focuses on risk assessment and 46 allows you to quantify the degree of flexibility that this alternative provides for each level of risk. (Flexibility is defined as the ability to create value under the conditions of a given alternative ("options").

The indicator of the total value of the alternative, SCA, is based on the following four methods. "Cost-benefit analysis"

• Future uncertainty
• Organizational diagnostics
• Best practice measurement.
• Cost-benefit analysis.

To characterize the total cost of operations, the indicator "Total Cost of Ownership" (TCO) is usually used.

As the evaluation criteria, this indicator uses the cost of acquisition, installation, technical support, maintenance, modernization, forced downtime, and other costs of operating the system. Using a wide range of indicators of organizational effectiveness, you can estimate the amount of profit.

A recommended approach for profit analysis is described in Gartner's Business Performance Framework. The TCO method gives good results when calculating current cost characteristics, on its basis it is possible to fairly objectively analyze the costs of IT operation. But this does not take into account the risks and there is no possibility to compare IT with strategic goals and business results. The "cost-benefit" analysis should be multidimensional, consistent with the situation in question and describing the business situation in terms understandable to non-IT professionals.

Since investments in innovative IT, particularly in drones, rarely provide immediate profit, quantifying the expected future effects of the investments under consideration is needed to measure the total value of the alternative, SCA. This aspect is particularly attractive for estimating the information reliability indicator (the total value of an alternative option to achieve information reliability), since many investments in improving the reliability of information are designed to provide future benefits by preventing undesirable outcomes. These benefits should be measured quantitatively, based on reliable assumptionsю

It is the basis of the SCA method. Any changes in practice cause some kinds of meaningful changes, and organizational diagnostic methods test the organization's ability to adapt to these changes.

Three types of risks are associated with such changes:

1) business risks,

2) management risks, and

3) technological risks, which are evaluated according to the following five factors: Strategic Alignment, Risk, Payback, Architecture of the system (Architecture) and its influence on business processes (Business Process Impact).

Best practice measurement.

This factor requires the use of a generally accepted methodology for obtaining an estimate that characterizes future uncertainty. The purpose of the measurement process is to provide a traditional business analysis capable of assessing the cost of an information proposal for stakeholders. The key here is the choice of a small number of agreed indicators.

Using common metrics provides insight among participants, so developing such metrics is a critical process.

Total Economic Impact (TEI)

By analogy with the total value of the alternative (SCA), the method of calculating the total economic contribution (effect) serves to support decision-making, reduce risks and provide flexibility, that is, expected benefits, not which are taken into account when using the method (cost-benefit analysis).

The CMEA indicator is designed to integrate risks and flexibility into a single model that is capable of providing reasonable solutions for IT investments. The CMEA indicator is the development of the company GigaGroup; it enables the organization to express analytically the benefits of an intangible nature for various areas of organizational functioning: flexibility, costs, profits.

Flexibility. This characteristic is a function of the cost of investment opportunities and can be described in terms of increasing financial value or growth of communication potential or potential growth of business value.

The CMEA indicator quantifies these factors using another, more explicit methodology, such as the Real Options Valuation (ROV) method, which can describe the actual cost of the options (options) available at the time of decision making, or the value of the option realized in later periods (assuming that the future market value of the share may increase due to the growth of certainty.)

Costs - In analyzing costs, along with the initial investment, the current operating costs are considered. It allows you to determine how the IT budget is allocated to the overall structure of organizational control during the evaluation

Profits - They are directly expressed in the growth of business value

This expression includes any added value that can be identified as an IT function, and any value generated outside IT.

Thus, the profit estimate is interpreted as the cost of business projects and their strategic contribution; it characterizes how much these investments correspond to the objectives of the business unit.

Risk assessments are expressed in the form of uncertainty or an estimate of the odds that take into account the potential economic consequences of the underlying assumptions. In essence, the decision-maker (decision maker) should quantify both the consequences of all assumptions and the likelihood of outcomes.

At the same time, a confidence interval should be provided for the estimates under consideration.

The CMEA indicator is most useful in the case when the purpose of the organization is to bring investments into technologies into line with the goals of the business.

The main goal of CMEA is to justify business solutions for a given set of alternatives. This is achieved by communicating the full cost of each alternative in terms of business. This method is considered very attractive.

The amount of profit is usually calculated based on an estimate of the hypothetical increase in costs that would have occurred if the corresponding functions or services were not available. For example, when using a FWS, they are asked what would be the costs of the organization if the system failed or caused accidents? Further, the FAR considers these costs as a profit derived from the possibility of avoiding risks. With this method of estimating the cost of a "malfunction" (failure), the ZVS provides a good current benchmark ("benchmark") to determine the cost of the overall risk reduction program (information security growth).

The FID can be used to monitor the cumulative effectiveness of any reliability enhancement program by comparing the current costs of maintaining a given level of reliability with information on the costs of preventing accidents.

Since the value of the FID is strictly cost-oriented, it is better to use it to estimate costs rather than the value that is received. But the criterion of the ZVS also works well in conjunction with methods such as Balanced Scorecard, making it easier to understand the full picture of the costs of the proposal in question. Of the remaining methods for assessing information value in the third group (Models reflecting environmental factors (IEFS), the most known are: Balanced Scorecard (BSC), proposed by Norton and Kaplan) A balanced scorecard (SSP) unites traditional financial indicators from the reporting with operational parameters that allows to estimate intangible assets: corporate innovations, degree of satisfaction of employees, etc. These parameters are considered from different points of view - financial and customer needs, internal processes, development of the professional level of employees.

The leaders of the organization have the opportunity to compare the prospects of each of these areas with the overall business development strategy.-

The consumer index proposed by Andersen Consulting, Information economy methods introduced in the practice of BetaGroup, IT (IT Performance Management Group) to the fourth group (Quantitative Assessment Models (MCOs) include such tools as:

-Information Economics (IE),

- Quantitative Estimation Models,
- Real Options Valuation (ROV),
- Applied Information Economics (AIE)

-Hubbard Methods.

Table 4 presents some general characteristics of these indicators and their systematization

Although the models considered cover a whole range of different approaches, they have some common elements.

Table 3

Models for assessing the effectiveness of drones using

Investment-oriented models (IOM) ("InvestmentOriented Models")	Cost-oriented models (CostOrientedModels)	Models reflecting environmental factors (OIE) ("Environmental / ContextualOriented Models")	Quantitative assessment models
1. The total value of the alternative (SCA) 2. "Cost-benefit analysis" 3. Future uncertainty 4. Organizational diagnostics: Three types of risks: 1) business risks, 2) management risks and 3) technological risks,	1.Economic value added, emf 2. Source of economic value, IET 3. Total costs of owning property (EAF)	1. The method of balanced indicators (NortonandKaplan) 2. Consumer index (AndersenConsulting) 3. Information Economy (Beta Group) 4. IT performance tables (IT Performance Management Group)	1. Real Options Valuation (ROV) 2. Applied Information Economics of the Hubbard (Applied Information Economics (AIE)) - Hubbard

5. Best practice measurement 6. Total economic contribution (CMEA): - Flexibility - Expenses - Arrived			

Economic science has developed a certain set of tools that help to identify the components of the cost of economic decisions based on the theory of marginal utility, i.e. by determining the value of an additional unit of output. At the same time, the oil companies consider the profitability of invested capital (ROIC) as one of the key performance indicators (KPI). From these two prerequisites, the following one-period (for one fiscal year) model can be constructed to estimate the effectiveness of the information received and used:

EP = IC x (ROIC - WACC),

where:

EP = Economic profit (benefits from IT);

IC = Invested capital (working capital + net residual value of fixed assets + other assets),

ROIC = Return on invested capital (net operating profit, net of tax adjustments, divided by invested capital or, NOPLAT / IC),

WACC = weighted average cost of capital (own and borrowed).

The return on invested capital (ROIC) is a more appropriate analytical tool for measuring efficiency than the traditional industry-wide return on assets (ROA), since it focuses on the company's actual operating performance.

Other variables are easily measurable and take into account a number of micro and macroeconomic factors - both controlled and not controlled by management. Based on the theory of marginal utility, it is possible to derive a new indicator - the value of the marginal cost (value) of information, EVMI, as the sum of probabilistic estimates associated with the uncertain outcome of the solution: EVMI = The expected value of the best solution, taking into account NEW information (excluding the cost of obtaining it) , minus the expected value of the best solution WITHOUT NEW INFORMATION.

The EVMI indicator is a probabilistic estimate of the maximum value of new information in decision making. Until then, as long as the real costs of obtaining new information do not exceed EVMI, it provides added economic value to the company. In other words, this value defines the threshold (limiting) value of the cost of supplying new information, for which NPV = 0.

Also, as criteria for the financial effectiveness of the application of innovations (in our case - drones) in logistics are considered:

- The flow of real money
- Net Income from Innovation
- Indicators, the correlation of results and costs for this innovation
- The indicator of the ratio of total additional production by the program as a whole to the total costs for their implementation

3.2.2 Estimation of effects from the use of drones in oil and gas logistics

Cost structure from the introduction of drones

Successful operations to introduce unmanned technologies can increase the profitability of oil and gas companies, increase labor safety and provide income to society by reducing harmful emissions and water consumption, and to provide benefits to consumers. To quantify the impact of drones on the oil and gas industry and society as a whole, a detailed model was developed, the main elements of which are shown in the figure:

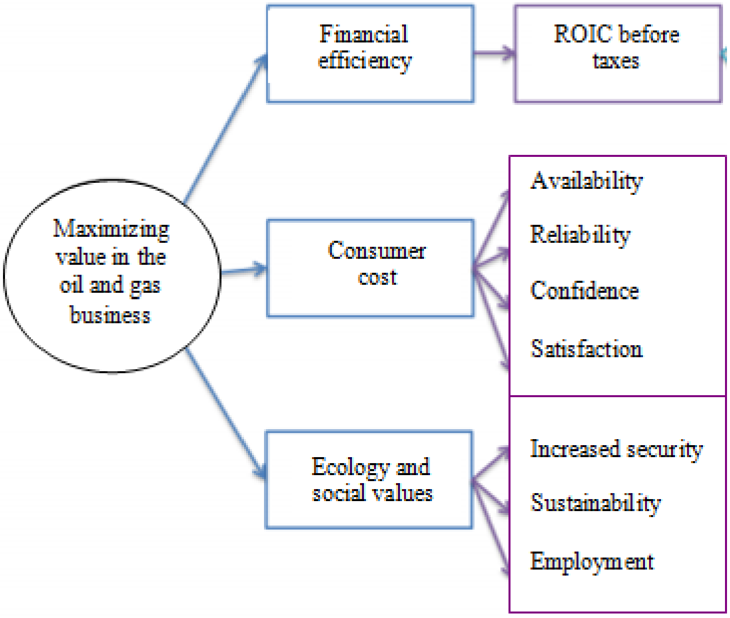

Figure 3. Cost maximization in oil and gas production[2]

Here: ROIC = Return on invested capital (before taxes)

The main problems affecting the management of changes (UPI) are related to the structure of company management, project development and the course of processes. Consider them sequentially.

The main activity of the company determines the units, executors, methods, instruments aimed at management implementation of pilot programs and the CM corporate strategy of the company.

At the same time, the functions of the executive committee, the operational committee, and the pilot project manager must be clearly defined and interrelated. The main activities related to the management of deviations during the implementation of the pilot project include phases:

- conceptual,
- definition of characteristics of the project,
- development and deployment of the project,
- operating.

To determine the degree of influence of the revealed deviations from their desired dynamics, it is necessary to have clear ideas about the economic consequences of such

[2] Source: World Economic Forum / Accenture analysis

deviations, that is, to establish the main benefits achieved due to the corrective effects of the CM.

Quantitative assessments of benefits

The expected benefits are grouped into two categories:

Allowing to make quantitative estimates ("quantifiable"):

- Increased production
- Cost reduction
- Growth of CIN

Profit of non-material nature (quantitatively invaluable):

- Better access to operational data
- Improved security
- Improvement of ecology.

Quantified profits

To assess the profits for all pilot projects, general criteria are established.

As for quantified profits, they can be estimated by the following scheme: reducing losses, optimizing production volumes, reducing costs, increasing CIN.

Usually, the goal of the digital technology program is to justify the introduction of a new technology or to achieve an increase in the performance of operations with the current technology. The advantages of using the CM are associated with changes in the management of organizational and production processes and in the emphasis on the most significant business assets.

Let us clarify the nature of the benefits obtained as a result of such a transformation.

Under the usual approach, profit is determined on the basis of a simple formula:

Profit = Gross revenue - costs

Or more:

Profit = (volume of oil (gas) production x price (oil (gas)) - taxes) - (operating costs + general production costs + (depreciation, depletion, depreciation) Let's determine the differences in the nature of the benefits associated with the use of drones.

Currently, when introducing drones in the logistics of oil and gas companies, the question is whether they, combined with integrated operations, can make a business profitable in the long period of low HC prices? To answer it, it is advisable to consider a new definition of profitability, which takes into account the possibility of a comprehensive and deeper view of operations, supply chains and work processes; this will allow more accurate determination of the benefits that these data bring.

Profit generating data = ((product evaluation * product flexibility) - taxes) - (operational evaluation + supply chain evaluation + automation + productivity gain + portfolio valuation); Here, the term "evaluation" refers to a more adequate and complete (close to real conditions) measurement of the relevant parameter.

Let's characterize these new variables:

Product Evaluation: In the production of oil (gas), the volume of production is measured, but the interpretation of profit and loss reporting for each well or completing operations at close intervals is essentially a "transformation". Indeed, an increase in production with negative margins due to high operating costs, low market value or high environmental costs does not lead to an increase in profits. A more objective assessment of the products is to justify the correct ("correct") evaluation of the deposits, wells and market conditions, and in the decision to postpone other operational opportunities ("options") until market conditions are favorable for the integration of operations in favor of the company solutions.

"Flexibility" of the product (the ability to adapt to changing conditions): most of the current products usually have a single route to the market. Stages of transportation and primary processing are usually considered as providing links that do not add value. However, flexibility in production decisions regarding what to produce (for example, gas or LMC), to which market to supply and when it is more profitable to sell on the spot market, can provide an additional margin that can bring profit at low prices.

Best Operational Evaluation: The field's control and measurement operations provide a more accurate view of the existing equipment and the rational flow of processes that help take proactive actions to maintain oilfield equipment, energy costs and other operational decisions. Timely use of this information not only saves costs, but also increases the reliability of the most important part of assets.

The best assessment of the supply chain: few operators provide all the operations themselves or most of them on the field themselves. Collaboration and effective planning of logistics and operations, together with oilfield services companies and external contractors, contribute to greater efficiency and more complete use of the capabilities of all participants. Correct division of information between them contributes to the formation of "proactive" links in the oil supply chain. The absence or limitation of information from supplier companies leads to less efficient solutions and increased costs.

The best estimation of automation: in the world practice of many commercial objects of land and sea oil fields the "manufactory" concept of production of operations has been adopted. Many operations can be evaluated using metering systems that provide partial or complete automation. Removing personnel from certain operations can improve the reliability and predictability of such operations. Currently, the most complete automated production system is planned, including the decommissioning of equipment at deepwater offshore installations.

Productivity: the goal of management is to produce more products at a lower cost; but at the present time, a more effective strategy may be to reduce production for the whole set of objects (with the "right" choice). Adding a new technology does not always help increase productivity. You should start with the correct definition of the problem and connect the technology at reasonable stages (steps), and only after training the personnel and changes in management.

A more complete portfolio assessment: operators usually limit options by considering a single asset. But the use of various asset portfolios allows the company to move from oil to gas, from dry gas to fatty gas and ultimately from low-income to high-yield products and operations. Well-designed portfolio planning provides advantages for short-term opportunities and increases profitability of production.

3.3 Unrealized potential of drones

Current market conditions create problems for oil companies, but at the same time can mobilize significant innovative potential. Millions of intelligent elements generate real-time information 24/7 in huge volumes. One rig can generate up to 1 terabyte of data per day, as a result, the total amount of data passing through the oil field can potentially be more than 1 petabyte; and this information is compared and evaluated with an accurate representation of the virtual deposit and all its components.

According to experts, a large-scale digital transformation in the oil and gas industry will be facilitated by the solution of the following five problems (Table 4).

Table 4

Five major problems in the implementation of drones in oil and gas production

Market	Engines Market
	* Enhance operational information capabilities in the development of predictive analysis * Decrease in the cost of digitization * Problems of ownership and access to data (key data "in the cloud")
	* Search by operators for ready-made solutions * Reduction of risks due to reduction of mergers and acquisitions (M & A) and growth of oilfield service services * The aspiration of alliance members to make greater use of the E2E solutions
	* Cost of MRO * Standardization of processes and equipment
	* The desire of contractors to optimize through new technologies and platforms for cost management * Reducing risks by eliminating disparate data interfaces
	* Efforts to reduce costs and allocate risks * OFS companies invest in exploration and development to reduce the expected risks

Companies need to approach innovations such as drones, and how to create new opportunities by using innovative technologies in key aspects of the value chain (analytical process and modeling allows operators to predict the impact of changes in the system).

Ultimately, in order to maximize profits, companies are looking for opportunities to manage individual assets throughout the life cycle. At the same time, according to experts, the biggest obstacle to full-scale success and adaptation to digital operations is the time required to fully deploy the system.

In addition, specialists engaged in the development and adaptation of digital technologies (drones) must take into account a number of factors that are characteristic of the "Internet of material objects":

- coordination of proposals for the growth of value with the strengths of the company, the requirements for its management and implementation methods.
- the formation of service proposals that maximize the cost of operations.
- providing a complete life-cycle presentation, including confidential company data, for rapid adaptation and improved decision-making.
- ensuring cost monitoring throughout the life cycle of the project, allowing to improve and correct the observed processes in real time.
- careful consideration of the ecosystem across the enterprise

4.0 Prospects for the development of the drone market

The sphere of application of drones is expanding rapidly: analysts of Interact Analysis believe that by 2022 the market will grow more than 10 times, to $ 15 billion.

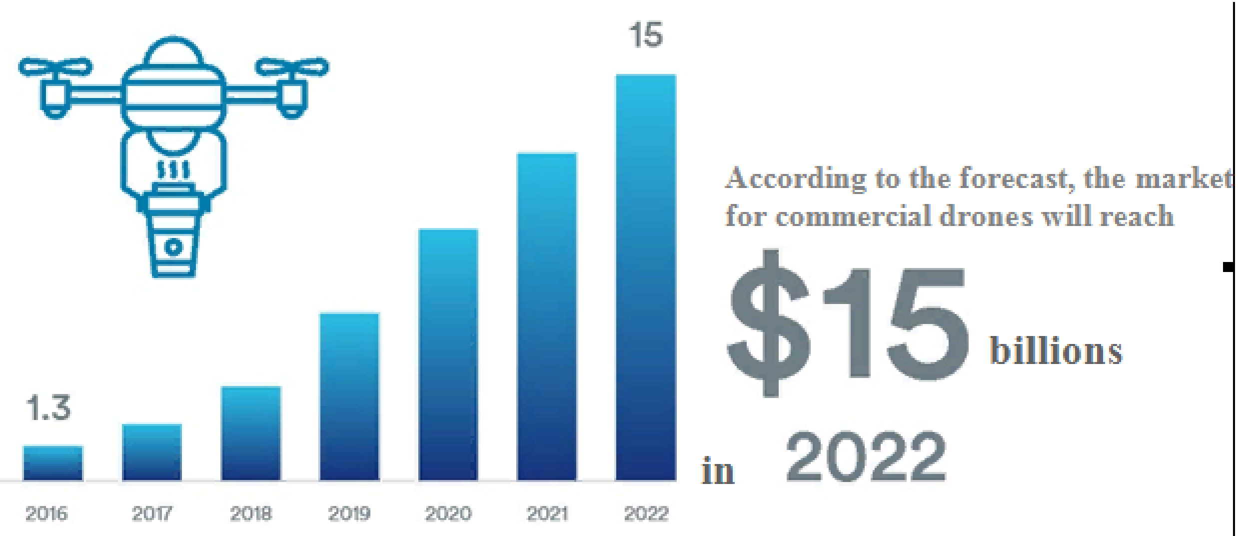

Figure 2. The forecast of development of the market of drones

In this case, the main markets will remain the US and China, the main producer - DJI, and two-thirds of the sold drones will cost less than $ 2,000. However, now on the way of development of drones there are a number of problems, both technological and legislative.

Unmanned aircraft can be divided into 3 types: with a fixed wing, rotorcraft and with several rotors (quadrocopters, etc.).

So far the most popular model is the quadrocopter. Although it is less efficient and often less stable than standard helicopter models, its design is much simpler and therefore cheaper to manufacture.

Apparatus with a large number of engines (8 in octopters, 10, etc.) require a lot of energy, and any battery on them quickly discharges. In addition, as the number of engines increases, the cost of the drone increases.

Example: the famous Yamaha Rmax with a carrying capacity of 28 kg costs from $ 86,000 to $ 230,000 (a version for air traffic with autopilot). There are also drones with a fixed wing: they can carry more equipment on longer distances with less energy. However, they can not hang over one place and, accordingly, can not provide an accurate position of the camera.

The drones of vertical takeoff and landing (capable of taking off and landing at zero horizontal speed) have become most widespread due to their accuracy. However, they have limitations on scaling.

The difficulty of adaptation for carrying heavy loads. The reason is that they require a lot of energy and lift only small masses, and if one of the rotors breaks, they inevitably lose weight. One solution to the problem of load capacity is the aerodynamic scheme with the separation of the functions of the lifting and steering screws. Such a system allows to increase the efficiency of the drone and reduce its cost.

The problem of sources and energy storage. Batteries allow load-lifting drones to stay in the air for 20-30 minutes. The solution to this problem can be the development of fundamentally different systems for drones. For example, innovations in the field of hydrogen fuel cells will significantly increase the flight time of heavy drones, but these systems still have insufficient power and even in the future will be more expensive alternative to energy with gasoline. The German company e-Volo is now using lithium-ion batteries, but in the future plans to switch to a hybrid hybrid scheme, in which electricity is produced on board using a gasoline engine.

Moreover, speaking about the future development of the drones market, it should be noted that legislators from different countries have several issues to solve:

- What qualifications should a person have for admission to piloting drones?
- How to regulate airspace to minimize the risk of collision with aircraft?
- How to protect people from falling on them drones and who will be responsible for this?
- The complexity of the answer to these questions lies also in the fact that excessive regulation will suffocate the developing industry and will not allow drones to realize their economic potential.

4.1 Safer and more efficient logistics with drones. Future project of four Norwegian companies

Presently four Norwegian innovation organizations are working together to utilize UAVs to convey cargo between vessels and platform. The objective of the "More secure Logistics from Unmanned Logistics Helicopter" explore venture is to create frameworks for utilizing drones.

One of the involved companied is **Griff Aviation**, that was mentioned begore They create and make manufacture UAVs that have the ability to convey substantial cargo. Should drones be an option in contrast to traditional crane lift, the logistics drone must have the capacity to work securely under severe climate conditions.

The second participant is **Norut**, which leads the project and has enormous experience in developing autonomous control systems for UAVs, as well as operating them in harsh weather conditions in northern waters. When departure, landing, and delivery of cargo can take place on a vessel at sea, the offshore logistics drone must have a high level of automation. The project draws upon expertise from the research community at the Faculty of Engineering and Technology at The Arctic University of Norway in Narvik, which has extensive experience in automated UAV operations.

The third company is **STABLE** – will make the control system, which will help drones start and operate from a moving platform, it is one of the main challenges of the research project. The company delivers advanced stabilization technology. Organization's job in the venture is to build up a steady platform for take-off and landing the logistics UAV. The platform is to be put in a container on the vessels deck, which also acts as the drone’s hangar between the flight missions.

Olympic Subsea is the last company-participant, situated in Fosnavåg, operates a fleet of 11 offshore construction vessels, and has a history of being an innovator in the offshore vessel market. The organization participates as an active development partner in "Safer logistics from vessels with unmanned logistics helicopter".

I contacted to one of the members of the project, who is the representative from Norut. And he informed me that the project is still on beginning level and no further infrusormation is available.

5.0 Conclusions

Modern technologies using digital and information systems, in our case - drones, represent the future of the oil and gas industry; they can be used much more efficiently to improve current processes and information flows in the exploration and production sector. The active use of drones at all stages of the value chain and management levels forms the image of the company - the leader of the XXI century.

The generalization of the basic methods for assessing the effectiveness of the use of drones, which can serve as a fundamental basis for methodological approaches in assessing the effectiveness of CM, allows us to distinguish four groups of models:

investment-oriented models (IOM)

- cost-oriented models (ZOM)
- models reflecting environmental factors (IOPS)
- Quantitative assessment models (MCOs)

The advantages of new IT technologies, in particular drones, and their specific implementation in oil production and oil and gas logistics are that they provide: - increased efficiency and lower production costs achieved through rational operations, faster and safer methods communication, which guarantee the necessary flow of information. - increase of efficiency due to rational and timely actions, with emphasis on the creation of value and isdrons are specified on the basis of generalization of the main factors of IT economy in operations related to the logistics of the oil business.

The logical methodological basis used in assessing the effectiveness of the use of drones in oil and gas logistics is the theory of decision-making. The main tools and procedure for selecting solutions include 4 steps - the formation of a decision-making structure, information collection, decision-making and training based on experience gained. It is expedient to allocate material and non-material factors of using drones in logistics. The resulting value of the technology under consideration for the whole life cycle is calculated as the sum of the material and non-material values of the components.

6.0 Bibliography

1. 4K gopro. (n.d.). Retrieved 01 2018, from http://4kgopro.com/the-best-4k-drone-companies/
2. Abdul-Karim, A., Overview of Saudi Aramco's Intelligent Field Program //Al-Dhubaib, T.A., ElrafiE. and Alamoudi, M.O.,// SPE paper 129706, presented at the SPE Intelligent Energy Conference and Exhibition, Utrecht, The Netherlands. – March 23- 25, 2010, p. 15.
3. Accenture, The 2016 Upstream Oil and Gas Digital Trends Survey, https://www.accenture.com/ch-en/insight-2016-upstream-oil-gas-digital-trendssurvey
4. Alberto F. Marsala, Metrics for economic evaluation of innovative technologies in the oil industry // Saudi Aramco, SPE 111996, 2008
5. Al-Dhubaib, T.A. Intelligent Fields: Industry's Frontier and Opportunities // SPE paper 141874, presented at the SPE Middle East Oil and Gas Show Conference, Manama, Bahrain – September 25-28, 2011, c.12
6. Apfel, Audrey. The Total Value of Opportunity Approach. // CIO – January 15, 2003.
7. AUTOMATED DRONE SOLUTION FOR OIL & GAS SECTOR // https://www.airoboticsdrones.com/oil-and-gas/
8. Bardley T. H., Moffitt B. A., Fuller T. F., Mavris D., Parekh D. Design studies for hydrogen fuel cell powered unmanned aerial vehicles. American Institute of Aeronautics and Astronautics.
9. Committee on National Security Systems (CNSS) // National Information Assurance (IA) Glossary – Instruction № 4009, 2006.
10. CURRENT DEVELOPMENTS IN THE DRONE INDUSTRY? (n.d.). Retrieved 01 2018, from http://www.businessinsider.de/commercial-uavmarket-analysis-2017-8?r=UK&IR=T
11. DHL. (n.d.). Retrieved from Logistics Insights: http://www.dhl.com/content/dam/downloads/g0/abo ut_us/logistics_insights/DHL_TrendRe port_UAV.pdf

12. Digital Oilfield Ten Years On: A Literature Review. Progress and Pain //Energysys – 2016, c.17
13. Digital Transformation Initiative Oil and Gas Industry // In collaboration with Accenture // World economic Forum, January 2017 – c.33
14. Drone Applications in Oil and Gas // http://grinddrone.com/applications/drone-applications-in-oil-and-gas
15. Edwards, T. The Art of Intelligent Energy(iE) - Insights and Lessons Learned from the application of IE //T. Edwards, O. Mydland, A. Henriquez // SPE 128669, paper presented at the SPE Intelligent Energy Conference and Exhibition. Utrecht, The Netherlands – 2010.
16. Ella R., The Central Role and Challenges of Integrated Production Operations // R. Ella, L. Reid, D. Russell, D. Johnson, S. Davidson // SPE Paper 99807-MS, Presented at the Intelligent Energy Conference and Exhibition, Amsterdam, The Netherlands, 11-13 April 2006 –p. 16
17. 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.
18. 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 // https://www.gminsights.com/industry-analysis/unmanned-aerial-vehicles-UAVcommercial-dronemarket?utm_source=globenewswire.com&utm_medium=referral&utm_campaign=Paid_Globnewswire
19. Gonzalez-Aguilera, D. & Rodriguez-Gonzalvez, P. (2017). Drones An Open Access Journal, Drones, Vol 1(1), p. 1-5.
20. grade GPS receivers. Ph.D. dissertation, University of Arizona. // http://www.casa.arizona.edu/data/abigail/Abigail_Rosenberg_Final_Dissertation.pd
21. Green J.K. Lethal unmanned air vehicle feasibility study. Praca dyplomowa, 1995.

22. Higher Standards: How Automated Drones Are Improving Oil and Gas Inspections // https://www.iotworldtoday.com/2018/07/25/higher-standards-how-automated-drones-are-improving-oil-and-gas-inspections/
23. http://www.oliverwyman.com/insights/publications/2016/jun/new-digital-ideas/new-drone-data-wave.html#.V4eXPdJf2M8
24. Intelligent Drones Push The Boundaries Of Oil And Gas Inspection // https://www.forbes.com/sites/markvenables/2018/07/24/intelligent-drones-push-the-boundaries-of-oil-and-gas-inspection/#6de034d466df
25. Ito, Y., (2016). Insights for logistical realization of unmanned vertical take-off and
26. Jadoo fuel cells powers Mako unmanned aerial vehicle. Fuel Cells Bulletin, 4, 2009.
27. Jamal M., Effective well management in Sabriyah intelligent digital Oilfield // M. Jamal [and others] // Paper SPE 167273 prepared for presentation at the SPE Kuwait Oil and Gas Show and Conference held in Mishref, Kuwait, 7-10 October 2013. –p. 12
28. Kelek, B. S. (2015). Blue Sky Birds Come to the World, Journal of International Trade, Logistics and Law, Vol. 1(1), p. 41-49.
29. Lejon, K. Multi-asset production support centre-generating values, // K. Lejon, K. J. Hersvik, A. Boe //SPE 127730, paper presented at the SPE Intelligent Energy Conference and Exhibition held in Utrecht, The Netherlands, 23–25 March 2010
30. Logistics Business Process: Case of Pharmaceutical Industry, International Journal - Vol. 5 (2016)
31. Moov Logistics News. (n.d.). Retrieved Jan 15, 2018, from How Drones Were Used To Deliver Life Saving Medical Supplies In Africa: http://news.moov.com.ng/how-drones-were-usedtodeliver-life-saving-medical-supplies-in-africa/
32. Record flight UAV using Protonex fuel cell system. Fuel Cells Bulletin, 4, 2009.
33. Rhoads G. D., Wagner N. A., Taylor B., Keen D. Design and flight test results for a 24 hour fuel cell unmanned aerial vehicle. 5thAnnual International Energy Conversion Engineering Conference, AIAA 2010-6690.
34. Rosenberg, A. S. (2009). An evaluation of a UAV guidance system with consumer landing aircrafts (UVTOLAs), Japan Marketing Academy Conference Proceeding of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, Vol. 10(12), p. 3948-3953.
35. Ross J.A. Computer vision and target localization algorithms for autonomous unmasnned aerial vehicles. Uniwersytet Stanowy Pensylwania, 2008.

36. Slabinac, M. (2015). European Experience, 15th international scientific conference Business Logistics in Modern Management, Trauzettel, V. (ed.) Faculty of Economics in Osijek, Osijek, 15 October 2015, p. 117-129.
37. Smith, J., Mazur, M. & Wisniewski, A. (2017). Clarity from above: transport infrastructure, PricewaterhouseCoopers // http://www.pwc.pl/en/publikacje/2016/clarity-from-above-transportinfrastructure.
38. Supplychain247. (n.d.). Retrieved Jan 20, 2018, from Solving a $45 Billion-Dollar Per Annum Retail Problem with RFID-Reading Warehouse Drones: http://www.supplychain247.com/article/mit_rfid_readi ng_drones/Drones.
39. The 3 Biggest Uses of Drone Data in the Oil & Gas Industry // https://www.simulyze.com/blog/the-3-biggest-uses-of-drone-data-in-the-oil-gas-industry
40. Top 3 Drone Applications in Oil and Gas Industry in 2020 // http://info.industrialskyworks.com/blog/top-3-drone-applications-in-oil-and-gas-industry-in-2020
41. Using Drones To Improve Manufacturing And Supply Chain Capabilities // https://www.forbes.com/sites/stevebanker/2016/09/06/using-drones-to-improve-manufacturing-and-supply-chain-capabilities/#19e024ba5b01
42. CAA Norway, Regulation of drones // https://luftfartstilsynet.no/en/drones/commercial-use-of-drones/about-dronesrpas/regulations-of-drones/
43. Norut, Drones can provide safer and more efficient logistics offshore // https://norut.no/en/news/drones-can-provide-safer-and-more-efficient-logistics-offshore