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Using Unmanned Aerial Vehicle in the Energy Sector

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Abstract:

Purpose: *The article presents areas in the energy industry where drones are being used and presents the results of a study of drone use in the activities of energy service employees.*
Design/Methodology/Approach: *Accordingly, a pilot project was conducted at the company under study, which lasted from March 2022 to April 2023. During this period, 22 employees of the company used four UAVs to carry out their daily work duties. Within the project, drones were mainly used to support the performance of visual inspections, and other work requiring support, such as the condition assessment process, which are fundamentally carried out by the Electricity Emergency Service employees from ground level. The research work carried out as part of the pilot included three stages - testing the effectiveness of using drones in detecting faults on the power grid, surveying the opinions of power service employees on the appropriateness or effectiveness of using drones in carrying out daily duties, and presenting the time differences in doing line inspections using different technologies (including drones).*
Findings: *The results of the pilot project clearly indicated the positive aspects associated with the use of UAVs in the operations of the analyzed energy company. The use of drones in field work was characterized by high efficiency of fault identification during the realized inspection of the energy grid. In addition, a research survey carried out among the employees of the analyzed enterprise highlighted the high value of using UAVs like an everyday working tool. The research within the pilot project also showed that the use of drones also translates into certain time savings, which can then be translated into financial benefits for enterprises. Thoughtful use of drones to inspect energy grid can significantly improve the quality of their service and even allow failure prediction.*
Practical Implications: *Therefore, the results of the research work carried out as part of the pilot project have been used by the company to implement the UAV on a full scale. At the same time, the conclusions in the article can serve other energy companies to promote drone technology and implement the solution in business operations.*
Originality/Value: *Benefits can be obtained in improving the efficiency of energy infrastructure and successively reducing the failure rate through preventive removal of perceived risks.*

Keywords: *Unmanned Aerial Vehicle (UAV), energy sector, renewable energy, drones.*

JEL codes: *Q42, O33, L94, C61.*

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1. Introduction

There is increasing demand for the use of drone technology in business operations. Energy sector is one area where unmanned aerial vehicles (UAVs), may find particular use. Around the world, many energy companies are using drones for power grid surveillance tasks, as outlined in numerous available articles or reports.

However, there seems to be a research gap relating to the presentation of detailed data on the measurable time or financial benefits of using UAVs for power line inspection or the attitude of employees towards this technology. The article presents areas in the energy industry where UAVs are being used, and presents the results of a study on the use of drones for energy service workers' activities, carried out as part of a pilot project at one of the energy companies.

The results of the research work are aimed at answering the question of the effectiveness of drone use in detecting faults on a power line, presenting the opinion of power service employees regarding the validity or effectiveness of UAV use in performing their daily duties, and presenting the time differences in doing line inspections using different technologies (including drone).

2. Literature Review

There is a noticeable ever-increasing demand for drone services. Unmanned aerial vehicles (UAVs) are defined as unmanned aircraft capable of flying without a pilot-commander on board, either autonomously or in a controlled manner from another location within its range (ICAO, 2005). They can be used for surveying work, transportation and searching for missing persons, among other things. Drones make it possible to reach places that until recently were inaccessible to other aircraft.

These small flying devices present before us a huge range of possibilities, eagerly used when inspecting hard-to-reach areas, inspecting a specific area, or locating

foreign troops. helping them in their ongoing operations. The potential for their application is also found in the field of energy. Drones can be used for reconnaissance, surveillance and many other purposes in the energy sector (Major, 2017).

Until recently, liberal aviation regulations supported the development of the drone industry, enabling a variety of operations and knowledge accumulation, which laid the groundwork for the development of market segments such as medical transportation, agriculture, forest monitoring, construction, emergency services support or energy industry inspections (Instytut Micromacro i Łukasiewicz – Instytut Lotnictwa, 2024).

The use of UAV has the potential to be used in the energy field, which can reduce the time of performing specific tasks on the energy infrastructure, increase work safety, improve the accuracy of the measurement methods used, provide faster access to information, and improve the efficiency of energy equipment. UAVs can also be used in DSOs to control technical acceptance, supervise projects, support property management (verification of the technical condition of buildings and other property elements) or for marketing and promotional tasks.

All the equipment installed and used in drone operations can transmit in real time the data they have collected on anomalies and emergency conditions occurring at the monitored facilities, both linear and stationary. The efficiency of drone use in the power industry also lies in the much faster collection of data and its automatic recording. The ability to hover stably in the air and the drones' small size allow for a thorough visual inspection of poles, power lines, insulators, wind turbines or photovoltaic farms.

By flying along the corridors of high-, medium- and low-voltage lines, it is possible to verify the condition of the route's tree cover or the distance of poles from the edge of the forest. Inspections can be in the form of periodic inspections of the infrastructure or intervention activities, which allow immediate assessment of the situation and taking necessary corrective and repair actions. All of the above-mentioned examples can transform into tangible economic benefits.

With the data collected using the UAV, it will be possible to determine the technical condition of the electric power infrastructure, which will make it possible to support decision-making processes for investment or operation, as well as to respond quickly to possible failures. The capabilities of drones and their simple control allow inspection of high, medium and low voltage lines, wind farms, photovoltaic installations, as well as industrial facilities, towers, chimneys and water reservoirs. The necessity to quickly obtain information about the condition of infrastructure means that the technology of drone use will develop rapidly in the near future.

Inspection of energy infrastructure with UAV eliminates or minimizes the shutdown time of the installation under inspection, and allows for an increase in the number and quality of inspections. Their key advantage is the ability to quickly reach hard-to-reach and dangerous areas and check each component of the installation from a short distance. During routine maintenance, a lineman sees a potential issue with a tower. A utility company that has trained and outitted their ground patrol teams with drones can direct that lineman to get a better look at the possible defect without climbing or using bucket trucks.

When a team member visually identiies a possible defect, they can quickly deploy a drone to get a higher level of detail, better classify the problem, and determine the best course of action, all while avoiding hazardous man-hours (Measure, 2018). Moreover, the development of drone technology in the 21st century, provides additional options for energy grid inspection.

In this context, autonomic flights combined with the use of artificial intelligence (AI) are becoming particularly important. In this mode of operation, our aerial vehicle performs its flighttask independently, under the supervision of a remote pilot, based on the pre-programmedroute, while providing real-time data on the system component to be inspected using sensorsmounted on the drone deck (Kiss, Palik, and Major, 2017).

An example of the use of drones in the energy industry is Power South Energy Cooperative in the US state of Alabama (southeast coast of the US), which manages energy lines totaling more than 2,200 miles (Czapaj-Atłas and Dudek, 2016). The company uses drones for inspections conducted both from the ground and from the air. The areas where the lines under the company's authority are located are characterized by significant mountainous, forested and, in many places, wetlands. Drones are particularly useful for identifying overgrown tree branches that threaten to get too close to energy line wires.

Another global example of drone deployment in the energy industry is China Southern Power Grid, which is responsible for a base of more than 254 million residents and 87.4 million households (https://enterprise.dilectro.pl/drony-w-inspekcji-linii-energetycznych). From 2012, the company began testing the potential of UAV, which were used to inspect energy lines. Drones delivered high quality results at a much lower cost.

UAVs were easier for workers to inspect and to fly to remote areas, while providing detailed inspection results of the same quality as helicopters. The significantly lower cost compared to helicopters allowed more inspectors to use drones as a regular work tool. Satisfactory results have translated into project development - by 2019 the company had 6,000 drone units and 900 certified pilots, and thanks to new developments in drone technology there are more opportunities for exploration, experimentation and use on a larger scale.

According to the authors of the study "Drones in the Global Power and Utilities Industry, Forecast to 2030" (Frost & Sullivan, 2020), continued trends of digital transformation in the power and utilities sectors and an increase in the rate of drone use to ensure security of energy supply in today's challenging environment will keep demand for UAVs growing worldwide.

3. Research Methodology

The purpose of the research work was to demonstrate the effectiveness of the operational use of drones in an energy company. Accordingly, a pilot project was conducted at the company under study, which lasted from March 2022 to April 2023. During this period, 22 employees of the company used four UAVs to carry out their daily work duties.

Within the project, drones were mainly used to support the performance of visual inspections, and other work requiring support, such as the condition assessment process, which are fundamentally carried out by the Electricity Emergency Service employees from ground level.

The research work carried out under the pilot project included three stages:

- The first stage of the research work was to see how the number of operations performed with the UAV translated into the number of defects detected. To this aim, two parameters were compared - the number of flights and the number of detected defects.
- As part of the next stage of the work, a survey was conducted among employees who used UAVs as part of their job duties. The survey was voluntary and anonymous, and the survey questionnaire consisted of three closed questions. Twenty-two employees who used drones during the pilot project participated in the survey.
- The final stage of the research work was to present the time savings resulting from the use of drones in the work of power emergency services, using the example of a real operational activity of inspecting power poles. Accordingly, the time of doing field work using existing, traditional methods (entering the pole by a worker/using specialized equipment) and using a UAV was compared. It was assumed that during a standard eight-hour work day, workers spent six hours on visual inspection (the remaining two hours were for transportation and completion of formal and administrative issues). In addition, the analysis did not take into account situations where inspection could not be carried out by the traditional method and situations where the owner's permission had to be obtained to enter the property. The indicated time parameters were measured based on real activities performed during the pilot project.

4. Research Results and Discussion

Below is a summary of the basic data collected during the pilot project (Table 1). During the 12 months, the employees of the analyzed company, in the context of their work activities, carried out 166 flight operations with the use of UAV, with a duration of 78 hours. During this time, 143 faults were detected on the energy infrastructure.

Table 1. *Summary data on flight operations and identified defects using drones*

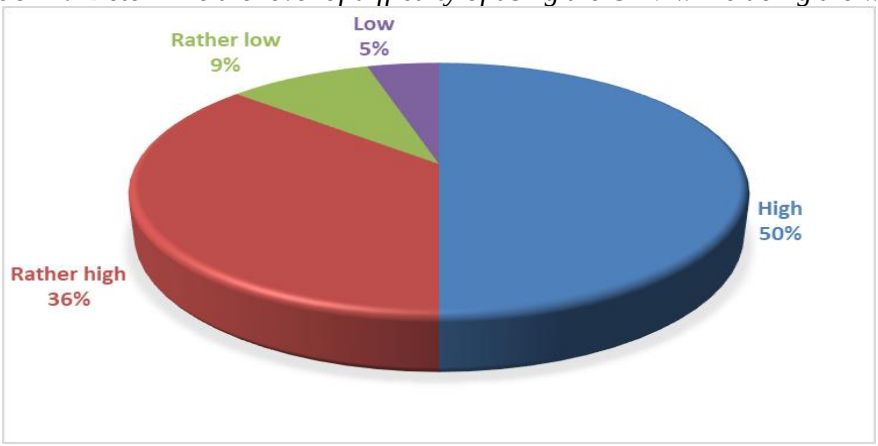
Number of operations - flights	**Duration of flights (hours)**	**Number of defects identified**	**Effectiveness of defect identification**
166	78	143	86%

Source: *Authors' calculations on the results of the pilot project*

Comparing the number of flights performed with the number of identified defects, it is possible to note the high effectiveness of the use of drones to locate tasks that need to be performed on the energy infrastructure at the analyzed company (more than 86% defect detection rate using UAV). Most of the performed flights were characterized by the detection of at least one defect.

In order to confirm the effectiveness of drone use in the operations of energy companies, the below are the results of a survey of employees who used UAVs as part of the pilot project.

Question 1. *Determine the level of difficulty of using the UAV while doing the work?*

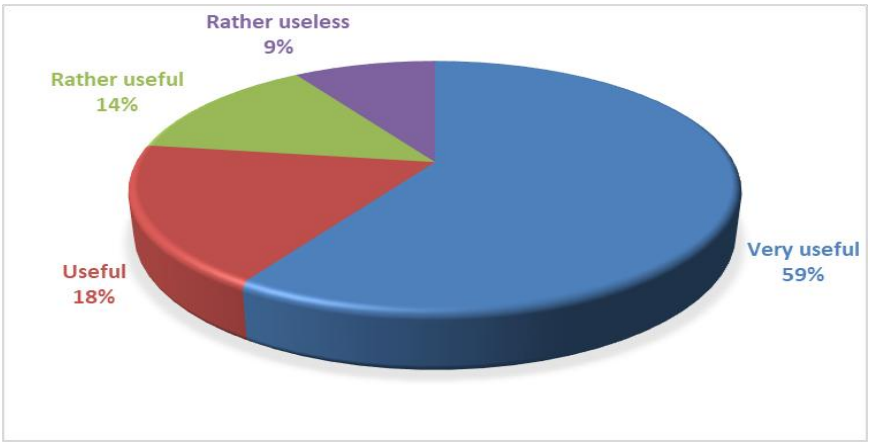


Source: *Own study.*

An analysis of the chart shows that the vast majority of employees (more than 80%) consider it very easy and easy to operate UAVs to perform daily work activities. Only one employee who participated in the survey indicated that using drones is

very difficult.

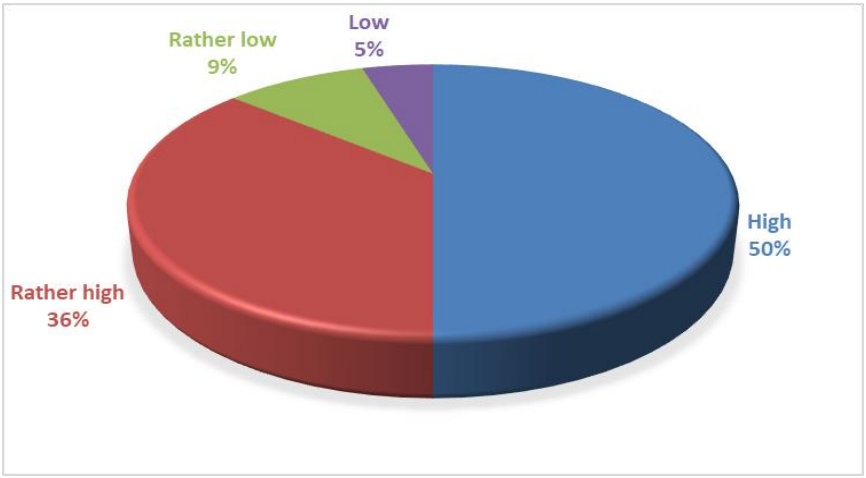
Question 2. *Evaluate the usefulness of purchasing a UAV as a work tool for energy service workers?*



Source: *Own study.*

Responses to the next question indicate that 77% of employees found UAVs very useful or useful as a tool to help them perform their work activities. Another 14% indicated that drones are rather useful. Only less than 10% of respondents said it was not a useful work tool.

Question 3. *Evaluate the effectiveness of using UAVs in the work duties of an energy service worker?*



Source: *Own study.*

The results of the responses to the third questions asked show that as many as 86% of those surveyed believe that the use of UAVs to carry out daily work duties has high or rather high effectiveness. The remaining 14% of employees, on the other

hand, indicated the opposite, a low effectiveness of drone use.
Below are the results of the final stage of the study - a comparison of the average inspection time for power poles using the existing traditional inspection methods - pole entry/use of specialized equipment and using a UAV (Table 2).

Table 2. *Comparison of task completion time using different inspection methods*

Actions	**Traditional methods**	**Use of UAVs**
Number of poles inspected per 1 hour	5	30
Number of poles inspected per 1 day	30	180

Source: *Author's calculations on the results of the pilot project.*

The data presented shows that one day of inspection using the UAV effectively means 150 more poles checked, which would have taken 30 man-hours to check using the traditional method. The above figures translate into concrete financial benefits in the form of saved work-hours of the company's employees. Frequent inspections using the UAV enable early detection of irregularities, giving power companies the opportunity to significantly reduce operating costs and keep the facility in good working order.

The economic effect is not only financial savings, but also time savings - time spent on maintenance work or troubleshooting, time spent shutting down equipment, and time spent on hazard analysis. This time is transformed into tangible financial benefits for the company. The use of drone makes a significant contribution to the minimisation of timerequired for failure detection, as the drone can be directed to altitudes of up to hundredmeters in a matter of seconds, while the worker would spend at least an hour doing this job (Zsolt Jurás, 2021).

5. Conclusions

The results of the pilot project clearly indicated the positive aspects associated with the use of UAVs in the operations of the analyzed energy company. The use of drones in field work was characterized by high efficiency of fault identification during the realized inspection of the energy grid. In addition, a research survey carried out among the employees of the analyzed enterprise highlighted the high value of using UAVs like an everyday working tool. The research within the pilot project also showed that the use of drones also translates into certain time savings, which can then be translated into financial benefits for enterprises.

The implementation of the pilot project at the analyzed power company allowed access to photos and videos for employees, which made it possible to refine the assessment of technical condition, based on a detailed close-up inspection of electrified components, without the need to take equipment out of service. The inspections carried out using drones allowed access to elements of infrastructure that

are difficult or even impossible to visually inspect today, due to, among other things, the enclosure of private land, location in wetlands or floodplains, or in forested areas.

The use of drones in the conducted research made it possible not only to increase the quality of the visual inspection, but also to significantly reduce the time of its implementation. Real-time visual inspection using UAVs made it possible in many cases to eliminate the need to shut down facilities and energy lines.

Thoughtful use of drones to inspect energy grid can significantly improve the quality of their service and even allow failure prediction. Benefits can be obtained in improving the efficiency of energy infrastructure and successively reducing the failure rate through preventive removal of perceived risks.

Drones are one example of modern and innovative technologies, the use of which will certainly contribute to increased safety in the energy industry. The use of drones in the energy industry to inspect infrastructure could be a milestone, as with their development it will be possible to bring about virtually complete automation of the monitoring process of many energy installations.

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