Major Influencing Factors of Decision About Alternative Technical Means in Selected Aviation Services

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Abstract The paper presents general assumptions and continued results of the studies on theoretical and practical aspects of providing selected services with alternative technical means. The study purpose was based on SWOT analyses and research within customers and suppliers. The specificity of the assumptions in the selected areas was illustrated on the basis of examples of completed undertakings. Additionally, the article contains a list of examined factors influencing the adaptation of Unmanned Aircraft Systems as components of the model of conversion of services that could have an impact on decision-making in terms of applications of alternative air platforms. Specific conditions for the chosen area induce the building of the base of rules and the base of knowledge in the range of applying the alternative technical means. It will be essential to preparation of the standards of the approximate inference leaning on insecure or incomplete knowledge. The article bring forward the preliminary results of research and development in this area.

Keywords Aviation · Service provision effectiveness · Unmanned aircraft services · Air services · Remotely piloted aircraft systems

1 Introduction

Constantly and dynamically growing market for unmanned aircraft is estimated at over 120 billion US dollars. According to approximate calculations by the among others PWC circa 30% of the commercial use of unmanned aerial vehicles flying platforms belong to infrastructure sector. The technical means used in the physical movement of products as well as in the logistics information process also directions

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of their utilisation and their application systems creating some kind of infrastructure of logistics processes (Skowronek and Sarjusz-Wolski 1999).

Rapidly growing set of revolutionary solutions, shaping and affecting, for example, the space in which we live. Open the question remains, how many participants indicated above "e-revolution" are ready to function in the created by the revolution conditions. Somebody could also ask, how e-revolution is accepted by final customers, but it seems a reasonable treatment of the listed above processes as objectively existing elements of our surroundings ("technosphere") conceived as an area of human intervention in nature or the area affected by such activities. (EoN https://www.researchgate.net/publication/308076826).

The needs meeting model assumes among others that result of use (technology or product) is set of observations, which are an important element to identify new or significantly alerted needs. This is the starting point for the development of the "new product or the process. Here you can see the relationship with the concepts of "innovation" as process or "innovation" as the technical and technological aspect in this case (Kaźmierczak 2009).

The author presented the assumptions of research at the Conference EPPM 2017. Essential point of the research was to establish, that one of the possible ways to improve efficiency of the provision of the category of services can be use in activities related to such services by alternative technological means. Alternative technical means author understands as substitutional product to actually used. The expected result of the research was the emergence of the model, to assist the overall tasks related to conversion services provided by MAV to UAV. The model development and verification, to supporting a comparative assessment of the selected processes to provide services using alternative technical means, should lead to the development of tools (a set of tools) to facilitation in decision taking concerning the application of the alternative air services platform (Piechoczek and Kaźmierczak 2016). The following article describes the successive stages of the research and preliminary results.

2 Preliminary Research

Research issued within Polish companies only. Selected companies were divided for three groups. Supplier who deliver products or service, they have interest of delivery. Ordered is company who order product or service and pay for that. Third group are researchers or observers who has neutral relations with alternate service. Author delivered questionnaire to companies in the phase of recognition needs associated with the observations of the previous generation's products users effects: information on the extent and how to take into account the data from existing users in the formulation of the description of the new for may be relevant to the decision of the base type—to take or failure to next steps in the cycle (Kaźmierczak 2012). The author of the paper has prepared a questionnaire with questions of SWOT analysis. He expected answer if customer need alternate solution pushed by the market. What is valuation by three different side of the business.

The analysis includes the following areas and subareas:

(1) Benefits of application

- support for protection of critical infrastructure,
- diagnostic of the long distance linear objects (networks),
- monitoring state of power lines preservation,
- costs reduction of maintenance high tension and medium tension power line,
- ability to perform a visual inspection and measurements in populated areas,
- safety of the measurement team.

(2) Unique characteristics

- quick response,
- noise reduction in urban areas and protected,
- possibility of taking administrative decisions on the basis of data,
- choice of platform to a specific task,
- possibility of panoramic observation of linear object and its environment,
- possibility of monitoring and diagnostics of the object from different angles and angular elevation,
- ability to quickly locate anomalies and locations failure,
- possibility of using different measurement methods in minimum time unit,
- ability to apply the new technology (introduction of new diagnostic methods, introduction of new network management tools,
- automation of analysis the collected material,
- ability to reduce staff involved in maintenance process,
- experience and knowledge,
- the international exchange of experiences,
- cyclic training operators.

Rating scale for each question between -10 and $+10$. Survey questionnaires were sent to the selected service providers, recipients of services and research centers. Selection criterion is based on the research of representation referred to as a provider of services, customer services and researchers and reviewers so neutral. Survey were directly addressed to the selected institutions and in the analysis have been used as survey. The scaling method used in the surveys with scaling forced for a nominal scale, which allows only the conclusion of goodies or equality measured characteristics; the basis of allocation are qualitative characteristics of phenomena. You have selected the audience side of the company responsible for the handling of linear objects of critical infrastructure including gas and transmission and distribution of electricity. As vendors were recommended in the market of alternative equipment suppliers and service providers. Neutral it's research institutions and observers of alternative technical means. Selected results of preliminary research presents diagrams below:

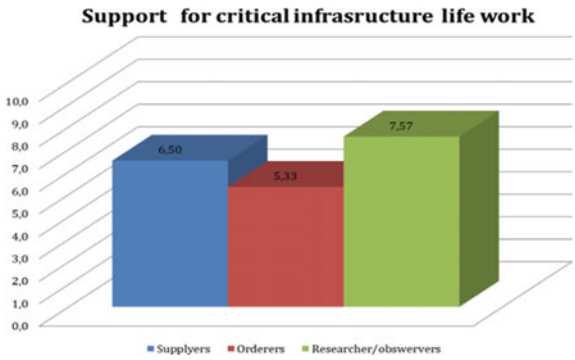

Fig. 1 Support for critical infrastructure

Summary of issue:

- support for safety of critical infrastructure is top rated by a group of observers and researchers. The difference between respond within inquiry groups exceeds 10% (Fig. 1)
- cost reduction of service share responders. We observe large disparity between the assessment of suppliers and customers (Fig. 2)
- sceptical judgement of orderer in the relationship with suppliers and researchers (Fig. 3)
- surprise is pessimism observed within providers in area of long distance monitoring. These capabilities highly evaluate recipient and researchers (Fig. 4)
- the differences in the application of the multidirecton diagnostic methods express responded group. The recipient does not approve the point of views providers and researchers (Fig. 5)
- another surprise is pessimism of suppliers in the immediate location of the anomaly. Optimists are the recipient and researchers (Fig. 6)
- reduction of staff involved in the operation was not accepted by the public. Studies have found big disparities between the opinion of customers and vendors (Fig. 7)
- innovation is accepted by all groups (Fig. 8).

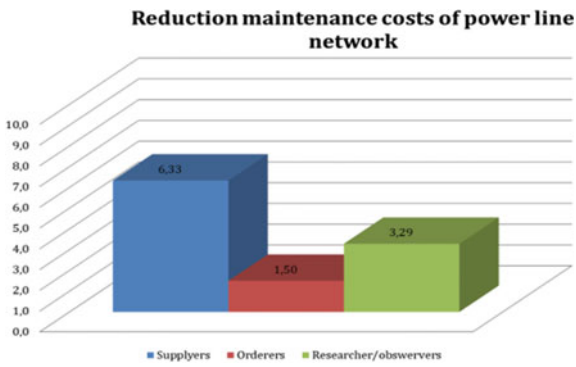

Fig. 2 Decreasing maintenance costs

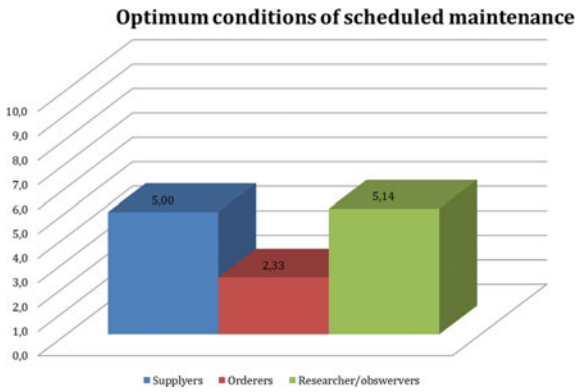

Fig. 3 Optimum conditions of maintenance

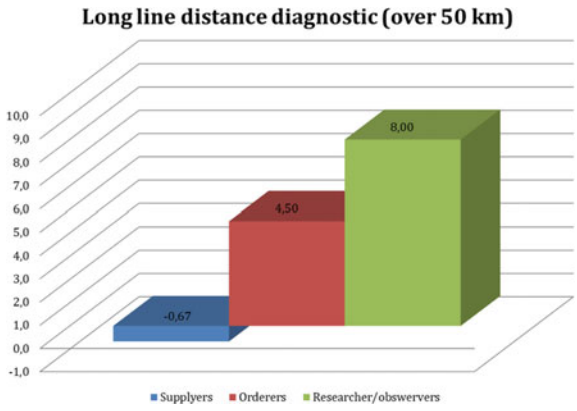

Fig. 4 Long line distance diagnostic

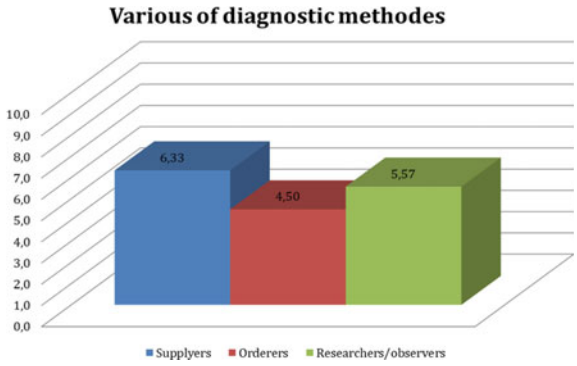

Fig. 5 Various of diagnostic methods

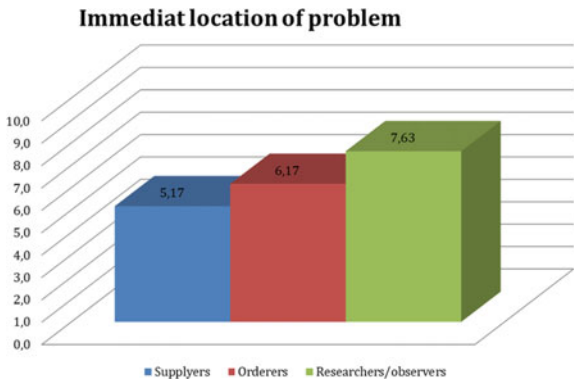

Fig. 6 Snap access mechanism location of problem

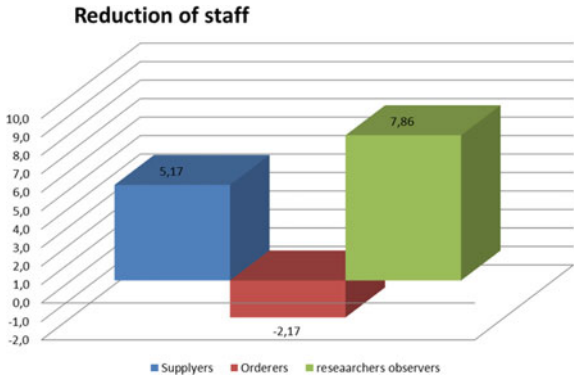

Fig. 7 Reduction of staff engaged

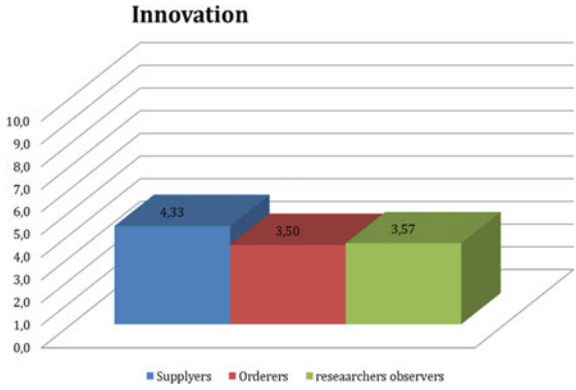

Fig. 8 Innovation

The initial investigation presents acceptance of usage alternative technical means. Therefore, study on new tools supporting their application are appropriate. The results of the preliminary tests confirm the necessity of support the decision-making process by including multi factors tool determining used platform type (Fig. 9).

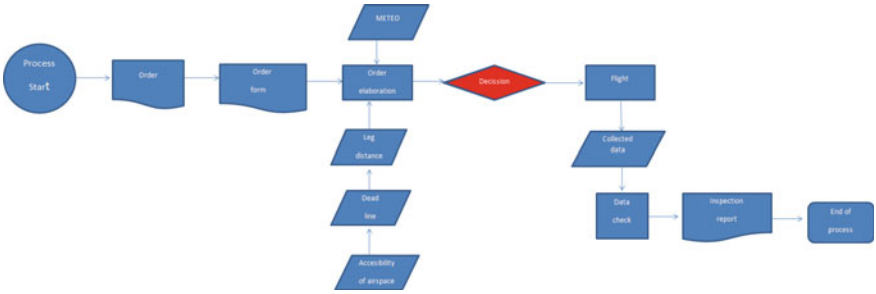

Fig. 9 Decision process model

The model will be placed in decision point marked red. Due to range of network decision point should be transferred to lower level. Lower level of decision required tool to take proper decision. The preliminary model has to fulfil that requirements.

3 State of Knowledge Analyzed

Remotely Piloted Aircraft Systems/Unnamed Aircraft Vehicles should be integrated into the existing aviation system in a safe and proportionate manner and this integration should foster an innovative and competitive European drone industry, creating jobs and growth, in particular for SMEs.

The proposed regulatory framework should set a level of safety and of environmental protection acceptable to the society and offer enough flexibility for the new industry to evolve, innovate and mature. Therefore the exercise is not simply transposing the system put in place for manned aviation but creating one that is proportionate, progressive, risk based and the rules must express objectives that will be complemented by industry standards (EASA 2019).

Machine learning has become an increasingly important artificial intelligence approach for UAVs to operate autonomously. Applying advanced machine learning algorithms (e.g., deep learning algorithm) could help the UAV system to draw better conclusions. For example, due to its improved data processing models, deep learning algorithms could help to obtain new findings from existing data and to get more concise and reliable analysis results (Shakhatreh et al. 2018). One of the necessary information for the flight is the careful evaluation of the weather conditions. Weather conditions are ideal for safe drone operation. Sunny days with calm or weak wind offer less risk to the safety of the operations of this type of equipment. However, it may be necessary to operate a RPAS in weather conditions that do not always fit the ideal operating profile. In this situation, care must be taken not to compromise the safety of the operation and to avoid damaging the equipment and, in particular, the risk of collision with objects, persons and aircraft (ANAC 2019 Doc-1009).

The GNSS satellite technology is an indispensable part of the aircraft's technical infrastructure. In particular, the GNSS satellite technology is used in precise air navigation. The primary products of GNSS applications in aviation are position, time, orientation, and velocity. The position parameter is determined by means of the aircraft coordinates in the XYZ geocentric system, the BLh ellipsoidal system, or the ENU local system. The time parameter allows for precise definition of the moment of determining the aircraft position during the ongoing air operation. The orientation parameter makes it possible to reflect the position of the aircraft in terms of HPR (Heading, Pitch, Roll) angles in 3D space. This system is very useful for UAVs ground station as well. Thanks to it the UAVs parameters delivered for UAV operator can be characterized as highly precise and timely delivered as well. It is very from the point of view safety of the mission conducted by UAVs and its fulfilment (Kozuba and Krasuski 2018).

In recent years, the high demand for UAVs has resulted in quest for technological advancements expected from these systems. Air vehicle, data link, payload, ground control station and other sub-systems require different technologic areas of expertise on their own. System design therefore became an important factor since all these sub-systems, which effect the operational mission directly, require different disciplines of expertise (Torun 1999).

4 Assumption of Direct Research

Shape based on the known data base, verified elements of the decision-making process. Groundwork model project is known data base of the author assessment as expert and his experiences in this regard. Model project contains the following groups of factors influencing decision making, as independent variables:

- current meteorological conditions (wind direction and velocity, precipitation, humidity, temperature, pressure, visibility, cloud base and clouds type
- weather forecast as above
- ambient conditions (village, town, densely populated areas, mountains, plains, forests)
- availability of airspace (limited traffic zone ATZ (Air Traffic Zone), CTR, MATZ (Military Air Traffic Zone), danger areas, prohibited zones etc.)
- the probability of loss of control of BSP-weight-drive type,

dependent variables as well:

- the type of alternate device
- experience the operator.

Source of knowledge acquisition will be current weather information and forecasts, NOTAM (Notice to Air Men) information of ATC (Air Traffic Control) and maps, alternative technical data technical means, the data of the customer.

According to method Value Streaming Map (VSM) created number of alternative scenarios. Generated on about 44,000 scenarios includes factors has influence on the decision-making process.

The decision making process follow heuristic or soft computing methods and tools such as Decision Trees (DT), Fuzzy Interference System (FIS), Belief Networks (BN). The concept of a linguistic variable in the case of FIS provides a means of approximate characterization of phenomena which are too complex or too ill-defined to be amenable to description in conventional quantitative terms. In particular, treating Truth as a linguistic variable with values such as true, very true, completely true, not very true, untrue, etc., leads to what is called fuzzy logic. By providing a basis for approximate reasoning, that is, a mode of reasoning which is not exact nor very inexact, such logic may offer a more realistic framework for human reasoning than the traditional two-valued logic (Kołodziejczyk 2011)

FIS (Fuzzy Interference System) is trying to formalize human reasoning process using natural language using fuzzy logic (that is, through the construction of fuzzy IF-THEN rules).

Fuzzy inference system consists four modules:

- Fuzzification: Converts the entry system, which are acute values (numeric) to fuzzy. This is done by applying a function belonging.
- Knowledge Base: stores a set of IF-THEN rules provided by the experts, which is a formalized, understanding of the addressed problem.
- Mechanism of inference: simulates the human reasoning by fuzzy inference process inputs in, accordance with the logic of the stored in the IF-THEN rules.
- Defuzzification: Converts a set of fuzzy inference resulting from the sharp values (Zadeh 1975).

In the case of uncertain knowledge we are dealing with statements, which in the general case, you can't say with certainty that they are real or fake. A method of characterization of the degree of belief about the veracity of statements is needed for this purpose. Both belonging to the initial knowledge base, as well as obtained in the result of the vote.

The coefficient of adequacy (likelihood of sufficiency-LS), is a measure of belief, that hypothesis (H) will occur if the condition occurs E. Factor of having (likelihood of necessity-LN), is a measure of belief an expert as far as the condition is necessary for the occurrence of hypothesis H. These measures can be given by an expert or derived from conditional probabilities according to designs. In this project the author relied on measures provided by an expert (Marszałek 2018).

To build the model uses probabilistic inference based on Bayes conditional probability given the logic. Independent variables are specified on input. They specify the numeric intervals derived from meteorological information or categories described in AIP (Aeronautical Information Publication). Selected rules that combine harvest limits and sets of numeric values and their mutual relationships.

On the basis of the data from the expert you have created a collection of teaching data. Divided into data on learning and testing. The data-sharing was made at random 70% of teaching and 30% of the testing data. Test data trimming model parameters

random data and they are used for verification of the model. In this model, instead defuzzification is created category or module category.

5 Conclusions

Consideration presented above an next stage of research objectives and presented research tools and methods describe present status of investigation. Results of scientific research will be the instrument for decision making and management remotely piloted aircraft systems (RPAS/UAV). Those scientific research determine preparation to doctor thesis "THE STUDY AND VERIFICATION of SUBVENTION MODEL THE COMPARATIVE ESTIMATION of CHOSEN AIR-SERVICE PROCESSES WITH UTILIZATION of THE ALTERNATIVE TECHNICAL MEANS" follow the resolution of Faculty Organization and Management Council branch production engineering. Authors estimate to present progress of research and future results. Research intention is to review if the created model will be an adequate tool for middle level decision point in maintenance system of line critical infrastructure.

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