Exploiting security, safety and situational related services by using Remotely Piloted Aircrafts

ILKKA TIKANMÄKI AND JYRI RAJAMÄKI
Laurea SID Leppävaara
Laurea University of Applied Sciences
Vanha Maantie 9, FI-02650 Espoo
FINLAND
Ilkka.Tikanmaki@gmail.com http://www.laurea.fi

Abstract: - The purpose of this study is to find out what kind of services can be designed by utilizing Unmanned Aircraft Systems (UAS). This study provides an understanding of the current obstacles for producing these services. The legal UAS issues in public and private organizations are examined. The biggest challenge in using Unmanned Aircraft Vehicles (UAVs) is that legislation does not recognise enough a UAV as an aircraft. Training and other requirements for the operator and the actual flyer are unspecified for UAS-operations. UAVs development is waiting for standardization. The aim of this research is to analyze and assemble summary about this issue by using data triangulation. From the research perspective there are needs for UAS and also social general ignorance how UAS can be exploit in civilian use. Challenge for cooperation in this particular case is to reconcile the needs of different actors - public and private - under common interests. The market has a huge economic promise for different UAS classes. By other means than utilizing UAS, the same benefits are difficult to be achieved; therefore societal benefits are particularly high. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

Key-Words: - Legislation, public, private, unmanned aircraft system, unmanned aerial vehicle, service provider

1 Introduction

This paper converses on designing new applications and services in the field of Remotely Piloted Aircraft (RPA) and objectives to make a service innovation with RPA systems. Prior studies have revealed a need for networking between different authorities with regard to cooperation of implementation of Unmanned Aircraft System (UAS).

Utilizing UAS for routine missions has several obstacles; 1) the aviation laws do not recognize UAS, so there is not sufficient guidance for the use of UAS, 2) UAS is a relatively new "phenomenon", so the potential it generates is not yet been understood, 3) governmental cooperation environment is not sufficiently innovative and forward looking, cooperation should always and in all circumstance be possible and 4) the limited resources of public organisations restrict the introduction of new concepts [1].

Table 1 shows many current applications which can be operated by UAS.

Table 1. Current UAS Applications and Quantity in EU [2]

	MTOM< 150 kg			MTOM > 150 kg		
	VLOS	BLOS	Total	VLOS	BLOS	Total
Security related	6	8	14	5	6	11
Safety related	6	1	7	1	1	2
Scientific & Research related	14	2	16	1	1	2
Contractor Supplied Flight Services	25	4	29	1	1	2
Civil/Military Cooperation	1	0	1	0	5	5

BLOS= Beyond Line-of-Sight, VLOS= Visual Line-of-Sight, MTOM= Maximum take-off mass

Non-military UAS applications are divided into five categories: security (39 sub-categories), safety (35 sub-categories) and scientific & research (31 sub-categories) related applications and contractor supplied flight services (38 sub-categories) as well as civil/military cooperation (34 sub-categories). Civil/military cooperation is also known as 'mutualisation'.

The European Commission allocates UAS into two categories according to their weight: maximum take-off mass (MTOM) under 150 kg and MTOM above 150 kg. UAS' usage is growing in Europe with regard to different security, safety and scientific & research related missions as well as contractor supplied flight services and civil/military cooperation. Table 2 presents the summary of UAS related project applications in EU.

With regard to UAS-systems utilization, Finnish aerospace and aviation technology professionals' visions and objectives are to create the ability to develop and maintain these systems. Also, a profitable international business potential is seen. Co-operating intensity is depending on an interaction between private sector strategies and public sector policies and institutions. The public and private sectors together promote a favourable environment for this matter [3].

Table 2. Overview of projected UAS applications in EU [2]

	MTOM< 150 kg			MTOM > 150 kg		
	VLOS	BLOS	Total	VLOS	BLOS	Total
Security related	23	26	49	5	27	33
Safety related	30	27	57	2	29	31
Scientific & Research related	20	20	40	0	21	21
Contractor Supplied Flight Services	35	15	45	0	13	13
Civil/Military Cooperation	1	24	25	0	33	33

Estimates of the forecasted market are done by comparing results and conclusions from several sources. Potential UAS applications are base on the assumption that the regulatory problems are solved.

European Commissions' (EC) Seventh Framework Program for Research and Technological Development (FP7) includes several UAS projects; Airborne Information for Emergency Situation Awareness and Monitoring (AIRBEAM) being one of them. AIRBEAM proposes a situational awareness toolbox for crisis management over a wide area applying UAVs, UAS and satellite systems. Many UAVs and space-based platforms are available. These system-related sensors pose new challenges for end-users with an effective emergency management and law enforcement to maintain. AIRBEAM's aim is to provide all authority organisations in each EU Member State to define their own needs and evaluate technical solutions that should be offered by unmanned aerial platforms. AIRBEAM's ambitious goal is to establish close cooperation between industry partners, stakeholders and end users with a realistic workable concept [4].

2 Problem Formulation

2.1 Theoretical framework

The importance of cooperation between authorities discovers an important subject to be developed. Finnish Government's Security and Defence Policy state that close cooperation between the authorities create cluster synergy effects by cutting overlapping functions and support functions, thus enabling an efficient use of resources [5].

Prior studies reveal a need for networking between the authorities with regard to the cooperation of implementation of UAS [6]. Networking benefits of government activities are emphasized, because the authorities do not need a duplication of resources. None of the authority is solely responsible for certain activities, because there is an exemplary cooperation between public authorities. When something happens, it is decided the responsible litigant who is responsible for operations, but which receives support from other public authorities.

The importance of cooperation in UAS usage is highlighted because a number of different actors, such as police, rescue service, customs and border control authorities need a same kind of services. The service provider must be familiar with the various actors' needs to be able to meet the demand of the

right way. Selecting a product for many different needs of operators must therefore give a special attention.

Interagency cooperation is essential that various actors have sufficient knowledge of other's concepts, measures, resources and plans. Interagency co-operation aims at the cost savings to increase the efficiency. Good collaborative practices are a prerequisite for proper functioning [6]. Networking is a process where the knowledge, values and skills of corporate combine the added value of productive activity, aiming at the promotion of competitiveness in the longer term [7]. Different levels of networking means that cooperation between organizations is needed; performing a similar task teams to cooperate, or individual experts formed a collaborative network. UAS-cooperation with the authorities will act in all of the above mentioned areas.

For example, large public events have temporary command centres for general and field management, where liaison officers of different actors allow coordination of actions. Command centres usually have representatives from the police, the event organizer, rescue services, border guards, customs and military. Depending of the nature of the event design and operation there may also be other public authorities [6].

With regard to the development of UAS services, networking is very important, especially for a small country with limited resources. One player is unable to cope on its own for systems implementation and use of it. That is why network creation is a vitally important and obtains synergies from a wide-scale deployment of the UAS.

2.2 Research method and process

This case study research finds out how services can be produced by applying Unmanned Aircraft Systems and what legal obstacles there are when using UAS in public organizations. The study has attempted to generate a new theory on the basis of existing theoretical constructs to meet organizational needs. As noted in the literature review, this study's specific research aim is a relatively new one. Therefore, our research approach is a case study that is generally recommended for theory-building [8], [9]. The researchers should understand the implications of their research perspective, and act in ways that reflect that knowledge [10]. The first author of this paper has a long experience in an organization where the needs of UAS can be utilized.

In a case study, the usage of a variety of sources is recommended, including interviews and written materials [11], [12]. The evidence collection phase contains many different modes and methods. None of them is unique to a case study and techniques differ greatly [12]. The material collected for this study is based on interviews, international and national aviation regulations, scientific publications, collected articles and literary material. One prominent data collecting method used is focus interviews. The focus interviewees were designated based on their expertise on aviation laws and aviation industry. The interviewees operate in the preparation of aerial legislation as training providers or service providers. This case study uses triangulation of data sources to ensure the credibility and validity of the results

Analysing case study data is the heart of theory building. At the same time, it is the most difficult and the least codified part of the process [9]. The focus of the analysis is the obstacles in the current legislation with regard to UAS. National Aviation Acts differ widely from each other; hence we focus on preparation of international aviation laws. Case study researchers should pay attention to three areas; design issues, data collection and data analysis [13], [14]. During the research process we paid special attention to above-mentioned points.

2.3 Empirical context and target

The biggest challenge for operationally use of UAVs is that legislation does not recognise well enough UAV as an aircraft. Training and other requirements are not specified for UAS-operations. Especially, the development of large UAVs is waiting for standardization.

Main obstacles for Light (small) UAS (25 - 150 kg) are varying national certification standards and rules. Norway and UK have basic standards and rules, Czech Republic, the Netherlands and France have nearly ready rules which, however, are not harmonized in European level. 'Sense and avoid' binding funded research is not ongoing or upcoming at the moment [2].

International Civil Aviation Organization (ICAO) has defined 'a pilotless aircraft flight at airspace' as follows [15]: "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to

civil aircraft shall be so controlled as to obviate danger to civil aircraft".

ICAO is also defined 'non-segregated' and 'segregated' airspaces. Non-segregated airspace means "airspace where all traffic, including civil traffic is authorised to fly and where both manned and unmanned traffic will be integrated according to established procedures". Segregated airspace means "airspace that is segregated for exclusive use and into which other traffic is not permitted." [15]

An Unmanned Aircraft Systems Study Group (UASSG) state in their Training Course of Regional Officers on November 2009 that UASSG is the focal point to all issues concerning UAS's within ICAO. In order to prevent UAS issues they should assist the Secretariat in coordinating the development of ICAO Standards and Recommended Practices (SARPS), procedures and guidance material for civil unmanned aircraft systems (UAS), to support a safe, secure and efficient integration of UAS into non-segregated airspace and aerodromes [16].

Currently, most military UAV operations in Europe are restricted to run only in the reserved airspace, where UAVs' flying area is separate from other air traffic, or UAVs are flying above the sea, applying special arrangements. If action takes place outside the segregated airspace, there will be various constraints in order to protect other aircrafts using the same airspace [15].

To take full advantage of current and future UAV platforms' capabilities, a training program has to accomplish the safe UAV operations. Military authorities in Europe insist that UAVs can be used in all classes of airspace. Also, they should operate across national borders. This means that UAVs should be used outside of segregated airspace. Furthermore, national level regulations are not conducive to routine operations.

In addition, taking into account the obvious interest, and a lack of similar in the rest of the world, non-European countries could decide to accept the specifications. Specifications may provide a basis for future Air Traffic Management (ATM) for civil UAVs. Aspects outside the jurisdiction of Eurocontrol must be dealt with appropriate bodies. These aspects are e.g. airworthiness, certification, system safety, training and licensing of personnel.

If we look training from economical point of view, even though UAV is flying in non-segregated airspace, the pilot-in-command does not need to be classified crew member. The pilot-in-command is required adequate training so that he can interact with Air Traffic Control (ATC) and other airspace users. For example, IFR flight requires an instrument flight rating. Training costs are less expensive than manned aircraft's pilots, but more than the basic requirements for UAV operators. As the specifications require, the air traffic services provided to UAVs should be equal to manned aircraft. Hence, only the controllers would need additional training, primarily in emergency situations, which are unique to UAVs. Air traffic controllers need to familiarize with UAV performance insofar as it relates to control in the rest of the traffic integration. The cost of controller training would be relatively insignificant.

To implement ATM integration of UAS operations, UAS needs: 1) to respond to and communicate with ATC, 2) to navigate, and to monitor air space and air to operate, 3) to sense and avoid collisions, and 4) predict the actions for ATC and pilots. Integration of airworthiness certification requires certification for unmanned aircraft, control station and the command and control links. Operator's certification has to be same as for manned aircraft and operator's documentation has to include manuals and charts. Pilot in charge has to be a licensed pilot [16].

ICAO's ongoing UAS-related tasks are

- to analyze the issues of existing Standard and Recommended Practice (SARPs),
- determine the gaps of unmanned aviation and to explore solutions developed by the individual countries/regions,
- participation to essential panels, workgroups/study groups and Secretariat

to modify an existing SARPS which have unique features to UAS.

Conclusions from the Study Group were the basis for the development of SARPS, Procedures for Air Navigation Services (PANS) and development of guidance material. The working group decisions are also a holistic approach to UAS relevant, the partner countries and industry associations and technical specifications performing bodies and multi-year commitment to UAS-tested social matters [16].

The Study Group's development concepts in terminology are; RPA + Remote-controlled Pilot Station + Command and Control links (C2) form the RPAS. According to [17], RPAS evolved concepts are; a) RPAS is a part UAS, b) RPA requires a registration and Certification of Airworthless (CofA), c) CofA considers the whole system, d) State of RPA design includes a remote pilot station type certificate data sheets, e) Remote pilot station's state monitoring is essential, f) Defining Quality of Service (QoS) and Required Communications

Performance (RPC) for Command and Control links, and g) UAS operator's certificate details must be accurate.

Remote pilot's licensing is one of the pending issues according to [17]; should remote pilot licensing qualify by type of the RPA or by remote pilot station? License should anyhow specify both the type of RPA and the remotely piloted station. Remote pilot in any case requires new arrangements [17]. Chicago Convention Article 32 determines Licenses of personnel; Convention incorporates 'pilot' and 'other members of the operating crew' but not remote pilot [14]. CAP 722 guidance gives criteria as airworthiness, determinations to flying devices, for risk assessment during the flight as well as the flight safety determinations. Instructions can be used to control the UAS systems safety use comprehensive.

In the point of view of technology's economic estimate, the economic challenges are the development and dissemination costs. Even if there is some R & D funding, most of the industrial R & D expenses will direct to UAS operators. Sense and avoid is likely to be highly significant cost factor. Progressing technology extends to all the parts of the UA system, both in the air and on the ground. Data-linking and related needs for the spectrum are other aspects that pose a significant cost, even though it is impossible to estimate how much [15].

5 Discussion and Conclusions

The starting point of this study was to find out how services can be produced by using Unmanned Aircraft Systems and what obstacles are there in the operational point of view. The research was started by a desire to explore is it possible and how it can be done by using UAS. The theoretical part focused on theory building of case study research and how it can exploit in this study. The scientific publications concentrate on the building, planning and on the technical properties of UAS. Unmanned aircrafts are currently used mainly for various military purposes. This study is limited to civilian use of UAS's, which is restricted by the various lacks of legislations. Government activities and the civilian side of the UAS could be used for many different purposes of use.

The aim of this research was to analyze and assemble a clear summary about this issue by using different kind of data. The study also succeeded to clarify the implications for different organisations when UAS is used in the future. Research objectives were successfully and the research questions were received answers. This study shows the needs for UASs but also a social general ignorance how UASs can exploit in civilian use. Challenge for cooperation in this particular case is to reconcile the needs of different actors - both in public and private - under common interests.

The research reported here attempted to generate new theory on the basis of existing theoretical constructs to meet organizational needs. As noted in the literature review, specific research aim is a relatively new one. Therefore, this study used a case study approach, which is generally recommended as a suitable research design for theory-building [8, 9]. Design knowledge applies people who have received formal education in that field [19]. Require is that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge [10].

Cooperation between public and private sector for using UAS need strengthening since services are needed widely. Common service providers in the use of UAS to the needs of public administration should seriously consider because of the economic and practical reasons. We believe it has not been paid enough attention to cooperation and networking between different authorities and experts concerning UA Systems' use in public safety duties. The importance of networks and networking in today's world cannot overstate. A smooth and seamless cooperation between different spheres of actors contributes UAS's implementation for public and private needs for improving and speeding up preparation and inception of legislation of UAS.

Based on the results of this study, the market has clearly a huge economic promise for all UAS MTOM classes and services utilizing them. By other means, as applying UAS, the same benefits cannot be achieved, so the societal benefits are particularly high. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

These markets are a catalyst for the development of technology in many areas, which have significant spin-off potential. The significant use of new air services' increase is expected to be available in the near future. UAS joint use, both civilian and military, is a key condition for non-military government applications. Applications for UAS may be applications where the airplane's or helicopter's use is too expensive to perform a task or there is a risk for human life.

The European Commission's AIRBEAM project is an excellent possibility to the EU level co-operation aimed at improving situational awareness

by using opportunities of Unmanned Aerial Vehicles.

References:

[1] Association of Finnish Defence and Aerospace Industries Aviation Group, Aviation Industry and Aviation Technology Program Criteria, 2010, pp. 6-8.
[2] European Commission. 2011. Strategy for unmanned aircraft systems in the European Union. Available: http://ec.europa.eu/
[3] Porter, M.E. Stern, S. 2001. National Innovative Capacity. The global competitiveness report. Available: http://www.isc.hbs.edu/
[4] European Commission. Seventh Framework Programme. Available: http://cordis.europa.eu/fp7/
[5] Prime Minister's Office Publications. 2009. *Finnish Security and Defense Policy 2009*. ISBN 978-952-5807-31-8. 5.2.2009.
[6] Taitto et al. 2007. Pelastusopisto. *Viranomaisyhteistyö – hyvät käytännöt*. Pelastusopiston julkaisu 1/2007. ISBN 978-952-5515-37-4.
[7] Toivola, T. 2006. *Verkostoituva yrittäjyys. Strategiana kumppanuus.* Helsinki: Edita
[8] Yin, R. 2009. *Case Study Research. Design and Methods.* Fourth Edition, London: SAGE Publications.
[9] Eisenhardt, K.M. 1989. Building Theories from Case Study Research. *The Academy of Management Review*, Oct 1989; 14, 4; ABI/INFORM Global pp. 532 – 550.
[10] Orlikowski, W.J. Baroudi, J.J. 1991. Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, 2(1), pp. 1-28.
[11] Eriksson, P. & Koistinen, K. 2005. *Monenlainen tapaustutkimus.* Kuluttajatutkimuskeskus. Julkaisuja 4:2005. Kerava: Savion Kirjapaino.
[12] Koskinen, I., Alasuutari, P. & Peltonen, T. 2005. *Laadulliset menetelmät kauppatieteissä*. Jyväskylä: Gummerus Kirjapaino.
[13] Gerring, J. 2007. *Case study research. Principles and practises.* Cambridge: Cambridge University Press.
[14] Dubé, L. and Paré, G. 2003. Rigor in Information Systems Positivist Care Research: Current Practices, Trends and Recommendations. *MIS Quarterly*, (27) 4, pp. 597 – 635.
[15] ICAO (International Civil Aviation Organization). Ninth Edition 2006. Convention on International Civil Aviation. Doc 7300/9. Available: http://www.icao.int/icaonet/dcs/7300.html
[16] Eurocontrol. 2007. EUROCONTROL Specifications for the Use of Military Unmanned Aerial Vehicles as Operational Air Traffic Outside Segregated Airspace. Available: http://www.eurocontrol.int/
[17] ICAO (International Civil Aviation Organization). 2009. ICAO Training Course of Regional Officers. Available: http://www2.icao.int/
[18] ICAO (International Civil Aviation Organization). 2010. Workshop on the development of National Performance Framework for Air Navigation Systems, December 2010. Available: http://www.icao.int/
[19] CAA (UK Civil Aviation Authority). 2010. CAP 722. Unmanned Aircraft System Operations in UK Airspace – Guidance. Available: http://www.caa.co.uk/docs/33/CAP722.pdf
[20] Van Aken, J.E. 2004. Management research based on the paradigm of design sciences: The quest for field-tested and grounded technological rules. *Journal of Management Studies*, 41(2), pp. 219-246.