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Possibilities to operational use of Remotely Piloted Aircrafts in Finland

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Possibilities to operational use of Remotely Piloted Aircrafts in Finland

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Miehittämättömien ilma-alusjärjestelmien operatiivisen käytön mahdollistaminen Suomessa

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Tämä opinnäytetyö koostuu viidestä kansainvälistä tieteellisestä julkaisusta. Opinnäytetyössäni käsittelen tilannetietoisuuden parantamista, reaaliaikaisen tilannekuvan käyttöä ja haasteita julkisissa organisaatioissa edellä mainituissa tilanteissa. Verkottumisen merkitys yhteistoiminnassa viranomaisten välillä on yhtenä aiheena. Lainsäädännön näkökohdat suunniteltaessa uusia palveluita ja sovelluksia miehittämättömien ilma-alusten (Unmanned Aerial Vehicle, UAV) käyttöön sekä esteet palveluinnovaatioiden toteuttamiseksi UAV:lla on tämän opinnäytetyön päätutkimuksen aihe.

Teknologian kehitys mm. langattomassa viestinnässä sekä sensoreiden ja ohjainjärjestelmien nopea kehittyminen mahdollistavat edistyneen tekniikan käytön myös miehittämättömissä ilma-alusjärjestelmissä (Unmanned Aircraft System, UAS). Viime vuosien aikana UAS -teollisuus on kasvanut nopeasti siviilitarkoituksiin kehitettävien sovellusten ansiosta. Rajoitukset lainsäädännössä kuitenkin hidastavat uusien teknologioiden käyttöönottoa. Lainsäädäntöön odotetaan tulevan merkittäviä muutoksia Euroopan tasolla vuoteen 2015 mennessä. Tämän opinnäytetyön tarkoituksena on tutkia, mitä hyötyjä saavutetaan UAS –palveluilla.

UAS luokitusprosessi on meneillään Euroopassa, mutta se on keskeneräinen. Euroopan viranomaiset luokittelevat UAV:t kahteen luokkaan. UAV, jonka suurin lentoonlähtömassa on yli 150 kg, säädetään Euroopan ilmailuviranomaisen, EASA:n, toimesta ja UAV, jonka suurin sallittu lentoonlähtömassa on alle 150 kg sääntelystä vastaa kansallinen siviili-ilmailuviranomainen. Keskusteltaessa tilannetietoisuudesta ja reaaliaikaisesta tilannekuvasta, on huomioitava, että monet osapuolet tarvitsevat reaaliaikaista tilannekuvaa työssään. Erityisesti päättäjien ja heidän avustajiensa on tiedettävä, mitä kentällä tapahtuu.

Viranomaisten välisen yhteistyön merkitys on tärkeää ja sitä on edelleen kehitettävä: tiivis yhteistyö viranomaisten välillä tuottaa synergiaetuja päällekkäisten toimintojen ja tukitoimien leikkaamisella sekä mahdollistaa resurssien tehokkaan käytön. UAV:n suuri haaste on lainsäädännön puuttuminen. Koulutus ja muut vaatimukset niin operaattorin kuin varsinaisen lentolaitteenkin osalta ovat määrittelemättä. Tämän opinnäytetyön tavoitteena on analysoida ja koota yhteenveto tästä asiasta. Tutkimus osoitti tarpeen hyödyntää UAS:ä siviilikäyttöön. Haasteena yhteistyölle tässä tapauksessa on sovittaa eri toimijoiden – julkisen ja yksityisen sektorin - tarpeet yhteisten etujen mukaisiksi. UAS:n käyttö parantaisi merkittävissä määrin turvallisuus- ja ympäristökysymyksiä.

Opinnäytetyössä selvitettiin myös UAS:n tulevaisuuden käyttömahdollisuuksia julkisella sektorilla. Opinnäytetyö osoitti UAS:n tarpeellisuuden, mutta myös yleisen tietämättömyyden UAS:n kaupallisesta hyödyntämisestä. Miehittämätön ilmailu tulee osaksi kokonaisilmailua, mutta miehitetyt lennot eivät ole poistumassa kokonaan. Tulevaisuudessa UAS -järjestelmillä voidaan kustannustehokkaasti suorittaa tehtäviä ja toimintoja, joihin tarvitaan tänä päivänä raskaampaa, miehitettyä laitteistoa.

Avainsanat: Miehittämätön ilma-alus, viranomaisyhteistyö, ilmailulainsäädäntö, tilannetietoisuus

Laurea University of Applied Sciences **Abstract**
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Possibilities to Operational Use of Remotely Piloted Aircrafts in Finland

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This thesis consists of five international scientific publications as well as this summary, which brings together those publications. This thesis converses on improving situational awareness and real-time picture, challenges of strategic management in public organizations in above mentioned situations. Importance of networking for co-operating is also discussed. Legislation aspects in the provision of designing new applications and services in the field of Remotely Piloted Aircraft (RPA) and objectives to make a service innovation with RPA systems is one of the outputs of this thesis.

Scientific and technological developments in mobile communications, sensors, drive systems and other areas are rapidly making possible to develop UAVs with advanced technology. There has seen rapid growth in UAS industry during last years. That has happen not least because of civilian applications are growing. However, the limits of regulations and technologies restrict to allow 'file-and-fly' permissions equally for unmanned as for manned aircrafts. The objective of this thesis is to research what benefit is achieved by UAS services.

UAS classification process is ongoing in Europe and it's not completed. European authorities use unmanned aircraft's classifying into two categories: UA with the maximum take-off mass of more than 150 kg, regulated by EASA and UA with a maximum take-off mass less than 150 kg, regulated by the national civil aviation authority. When discussing about situational awareness and real time picture, we should remember that many parties need these issues when they are working. Especially decision makers and their assistants need to know what is happening in the field.

The importance of cooperation between authorities has discovered an important subject to be developed. Close cooperation between the authorities achieves synergies between overlap functions by cutting and support functions to enable efficient use of. The biggest challenge in using Unmanned Aircraft Vehicles (UAVs) is that legislation doesn't recognise enough UAV as an aircraft. Training and other requirements for the operator and the actual flyer aren't specified for UAS-operations. UAVs development is waiting for standardization. The aim of this research is to analyze and assemble summary about this issue. 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. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

Keywords: Unmanned Aerial Vehicle, Unmanned Aircraft System, Aerial Legislation, Co-operation

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List of Publications

P [1] I. Tikanmäki, T. Tuohimaa, How real time picture and situational awareness can be improved by using Unmanned Aircraft Systems (UAS)?, 10th WSEAS international conference on communications, electrical & computer engineering, Playa Meloneras, Spain, Mar 2011, ISBN: 978-960-474-286-8, pp. 28-33.

P [2] T. Tuohimaa, I. Tikanmäki, The Strategic Management Challenges of Developing Unmanned Aerial Vehicles in Public Safety Organizations, 10th WSEAS international conference on communications, electrical & computer engineering, Playa Meloneras, Spain, Mar 2011, ISBN: 978-960-474-286-8, pp. 34-39.

P [3] I. Tikanmäki, T. Tuohimaa, J. Rajamäki, How and why Unmanned Aircraft Vehicles can Improve Real-time awareness?, International Journal of Circuits, Systems and Signal Processing, Issue 5, Volume 5, 2011, pp. 469-477.

P [4] T. Tuohimaa, I. Tikanmäki, J. Rajamäki, Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS), International Journal of Systems Applications, Engineering and Development, Issue 5, Volume 5, 2011 pp. 610-617.

P [5] I.Tikanmäki, J. Rajamäki, Legislation aspects of service design and innovation utilizing Remotely Piloted Aircrafts. Submitted paper for Service Design and Innovation Conference 2012, Espoo 8-10 February 2012. October 2011.

List of Abbreviations & Symbols

ACAS	Airborne Collision Avoidance
AFDA	Association of Finnish Defence and Aerospace Industries
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
AUVSI	Association for Unmanned Vehicle Systems International's
BLOS	Beyond Line-of-Sight
BRIC	Brazil, Russia, India and China
C2	Command and Control
CAA	Civil Aviation Association
CAP	Civil Aviation Publication
CofA	Certification of Airworthless
CR	Close Range
CSR	Case Study Research
DOD	United States Department of Defence
EASA	European Aviation Safety Agency
ED	EUROCAE Documents
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
EuroUSC	European Unmanned Systems Centre
FAA	Federal Aviation Administration
FLIR	Forward Looking Infrared
HALE	High Altitude Long Endurance
IAF	Israeli Air Force
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technology
ILO	Finnish Aviation Industry and Aviation Technology Program
IS	Information System
IT	Information Technology
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
KNM	Key Network Management
LADP	Low Altitude Deep Penetration
LALE	Low Altitude Long Endurance
LAUREA	Laurea University of Applied Sciences
LOS	Line of Sight
LUAS	Light Unmanned Aircraft System Scheme
LUAS	Light Unmanned Aircraft System
MALE	Medium Altitude Long Endurance
MASPS	Minimum Aviation System Performance Standards
MAV	Micro Air Vehicle
MR	Medium Range
MRE	Medium Range Endurance
MTOM	Maximum Take off Mass
NAS	National Airspace System
NATO	North Atlantic Treaty Organization
NAUN	North Atlantic University Union
OECD	Organisation for Economic Co-operation and Development
OPA	Optionally Piloted Aircraft
OPV	Optionally Piloted Vehicle
PANS	Procedures for Air Navigation Services
PIA	Finnish Defence and Aviation Industry Association
QoS	Quality of Service
R&D	Research and Development
RPA	Remotely-piloted Aircraft
RPAS	Remotely-piloted Aircraft System

RPC	Required Communications Performance
RPV	Remotely Piloted Vehicle
RTCA	Radio Technical Commission for Aeronautics
SARPS	Standard and Recommended Practice
SME	Small and Medium Enterprise
SR	Short Range
STANAG	NATO Standardization Agreement
SWOT	Strengths, Weaknesses, Opportunities, Threats
TEKES	Finnish Funding Agency for Technology and Innovation
TRAFI	Finnish Transport Safety Agency
UK	United Kingdom
USA	United States of America
UAPO	Unmanned Aircraft Program Office
UAS	Unmanned Aircraft System
UASSG	Unmanned Aircraft Systems Study Group
UAV	Unmanned Aerial Vehicle
UAVS	Unmanned Aerial Vehicle Systems Association
UCAV	Unmanned Combat Aerial Vehicle
UK	United Kingdom
UN	United Nations
U.S.	United States
VLOS	Visual Line-of-Sight
VTOL	Vertical Takeoff and Landing
WG	Working Group
WSEAS	World Scientific and Engineering Academy and Society

1 Introduction

This thesis consists of five international scientific publications as well as this summary, which brings together those publications. This thesis converses on improving situational awareness and real-time picture, and challenges of strategic management in public organizations. Importance of networking for co-operating is also discussed. Legislation aspects in the provision of designing new applications and services in the field of Remotely Piloted Aircraft (RPA) and objectives to make a service innovation with RPA systems is one of the main outputs of this thesis.

The biggest challenge for operationally use of Unmanned Aerial Vehicles (UAVs) is that legislation does not know well enough UAVs as an aircraft. Training and other requirements are not specified for Unmanned Aircraft System (UAS) operations as well of the operator and the actual flyer. Especially for large UAV's development is waiting for standardization. Harmonized rules and standards are missing in European level for unmanned aircrafts. Furthermore, Light UAS (LUAS) certification and operational requirements are responsibility of National Aviation Authorities and European Aviation Safety Agency (EASA) is responsible for more than 150 kg weight unmanned aircrafts' regulations.

This thesis deals with unmanned aircraft system's (UAS) utilization for improving situational awareness and real-time picture in Finland. UAS's use of improving and reinforcing the real-time picture by the authorities is not utilized, i.e. for the following reasons; 1) the aviation laws in Finland do not recognize UAS, so there is not sufficient guidance for UAS, 2) UAS is a relatively new phenomenon, and its generated potential have not yet been understood, 3) governmental cooperation is not sufficiently innovative and forward looking, in order to co-operation should in all cases always be possible and 4) the limited resources in small countries restrict the introduction of new concepts.

UAVs have a century-old history in aviation. UAVs were tested During World War I in 1920. At that time UAVs were not used in combat. Germany used a simple but deadly V-1 "flying bomb" during World War II what made base for post-war UAV programs in United States (U.S.). In Vietnam War UAVs were first time used in surveillance tasks. However, same type of UAV was modified to carry payload and had its first test flight on December 2002. (Crouch 2005, 7.) The Israeli Air Force (IAF) had several UAVs in late 1970's and 1980's. It was noticed that Israel used UAVs successfully in Lebanon 1982. That encouraged U.S. Navy to acquire a UAV capability for the U.S. Navy (Crouch 2005, 7).

In the past years, UAVs have extensively been applied in such areas as reconnaissance, intelligence and border security. In those specified missions, UAVs are required to operate at a high accuracy. The dynamic modeling and especially the automatic control system design are playing very important roles (Turkoglu & Jafarov 2006). Scientific and technological developments in mobile communications, sensors, drive systems and other areas are rapidly making possible to develop UAVs with advanced technology (Lundell et al. 2006).

Unmanned air vehicles' role has recently received more attention and interest; uppermost the development of new technology, which was not available a few years ago (Austin 2010; Finn & Scheding 2010; Mueller et al. 2006). The absence of crises together with the paradigm change needed to happen before unmanned vehicles were adopted, and the UAV is an advanced technology and has become available (Crouch 2005, 6). In the past, UAVs might have received more attention, if crisis should be addressed by enforcement and intelligence during the conflict.

1.1 Definitions for Unmanned Aerial Systems

Unmanned Aerial Vehicles (UAVs) have been designated in many ways: remotely piloted vehicle (RPV), drone, robot plane, and pilotless aircraft are a few of those names. In most cases, they are called unmanned aerial vehicles. United States Department of Defence (DOD) defines unmanned aircraft as follows (DOD 2011, 361):

> "An aircraft or balloon that does not carry a human operator and is capable of flight under remote control or autonomous programming. Also called UA."

Definition for Unmanned Aircraft System according to DOD is:

> "That system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft. Also called UAS."

Unmanned Aerial Vehicles are defined by DOD (DOD 2009, 543):

> "A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semi ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles. Also called UAV."

As a terminology Unmanned Aircraft Systems Study Group (UASSG) propose to use terms ‘unmanned’ or ‘pilotless’ when there is no pilot on board. They also suggest using terms ‘aircraft’ instead of ‘vehicle’, and ‘Remotely-piloted aircraft (RPA)’ (system) instead of ‘Unmanned Aircraft’ (System). Other suggest for terminology according to Study Group are ‘Pilotless operation’ and ‘Pilot station’. (ICAO 2009.) United Kingdom’s (UK) Civil Aviation Authority (CAA) defines ‘Small Aircraft’ in Civil Aviation Publication (CAP) 658 as “Any unmanned aircraft, other than a balloon or kite, weighting not more than 20 kg without its fuel but including any articles or equipment installed in or attached to the aircraft at the commencement of its flight”. CAA uses term ‘small aircraft’ instead of term ‘model aircraft’ because UAVs and other flying machines are then captured. (Civil Aviation Authority 2007, Ch 2 p1).

CAA (Civil Aviation Authority 2010, 3) defines term UAS in CAP 722 as follows:

> “An Unmanned Aircraft System (UAS) comprises individual 'System elements' consisting of the unmanned aircraft (UA), the Pilot Station and any other System Elements necessary to enable flight, such as a Communication Link and Launch and Recovery Element. There may be multiple UAs, Pilot Stations or Launch and Recovery Elements within a UAS.”

For Unmanned Aircraft CAA has a definition: “An aircraft which is designed to operate with no human pilot on board, as part of a UAS. Moreover a UA: is capable of sustained flight by aerodynamic means; is remotely piloted or automatically flies a pre-programmed flight profile; is reusable; is not classified as a guided weapon or similar one-shot device designed for the delivery of munitions”. The acronyms RPA (Remotely Piloted Aircraft) and UAV may be used interchangeably, with the same meaning. (Civil Aviation Authority 2010, 3.)

CAA’s definition to Unmanned Air Vehicle System is: “A UAVS comprises individual UAV System elements consisting of the flight vehicle (UAV), the control station and any other UAV System elements necessary to enable flight, such as a launch and recovery element. There may be multiple UAVs, control stations, or launch and recovery elements within a UAV System”. (Civil Aviation Authority 2010, 3.) European Aviation Safety Agency (EASA) has same kind of definition for UAS: “An Unmanned Aircraft System (UAS) comprises individual system elements consisting of an ‘unmanned aircraft’, ‘the control station’ and any other system elements necessary to enable flight, i.e. ‘command and control link’ and ‘launch and recovery elements’. There may be multiple control stations, command & control links and launch and recovery elements within a UAS”. (EASA 2009a, 3.)

UVS International, in Hearing on Light Unmanned Aircraft System (LUAS) to European Commission (2009) define unmanned aircraft on the following way: “From a definition point, an unmanned aircraft (UA) is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous.” (UVS International 2009.)

UAS comprises the aircraft and the following elements: 1) control station, 2) software, 3) health monitoring, 4) communication link(s) (for command & control + data), 5) data terminal(s) (payload exploitation), 6) payload, 7) launch & recovery systems, 8) flight termination system(s), 9) support & maintenance equipment, 10) power generation, distribution & supply, 11) air traffic control communications equipment (voice & data), 12) handling, storage & transport equipment, and 13) all required documentation related to aforementioned. (van Blyenburgh 2008.)

1.2 UAS Categories

UASs have categorized many ways. According to van Blyenburgh (2008) UASs are categorized by size and altitude: a) Micro (μ), b) Mini, c) Mini; Lighter-Than-Air, d) Close Range (CR), e) Short Range (SR), f) Medium Range (MR), g) Medium Range Endurance (MRE), h) Low Altitude Deep Penetration (LADP), i) Low Altitude Long Endurance (LALE), j) Medium Altitude Long Endurance (MALE), k) High Altitude Long Endurance (HALE), l) Unmanned Combat Aerial Vehicle (UCAV), and m) Optionally Piloted Aircraft (OPA) & Converted Manned Aircraft.

Depending on the purpose of use, UAVs can divide into three categories; tactical, strategic and special purpose as Table 1 shows. UAVs are sometimes classified in following categories: a) Tactical, b) Endurance, c) Vertical Takeoff & Landing (VTOL), d) Man Portable (larger than micro air vehicles), e) Optionally Piloted Vehicle (OPV) (capable of manned or unmanned flight operations), f) Micro Air Vehicle (MAV), and g) Research (developed for specific investigations) (Bilbao et al. 2008). European authorities use unmanned aircraft’s classifying into two categories: UA with the maximum take-off mass of more than 150 kg, regulated by EASA and UA with a maximum take-off mass less than 150 kg, regulated by the national civil aviation authority.

UAV’s classification according to van Blyenburg (2011) is presented in the following Table 1.

UAS categories	Acronym	Range (km)	Flight Altitude (m)	Endurance (hours)	Max Mass (kg)
Tactical					
Nano	η	< 1	100	< 1	< 0,025
Micro	μ	< 10	250	1	< 5
Mini	Mini	< 10	150b 300a	< 2	< 30 (150b)
Close Range	CR	10 to 30	3000	2 to 4	150
Short Range	SR	30 to 70	3000	3 to 6	200
Medium Range	MR	70 to 200	5000	6 to 10	1250
Medium Range Endurance	MRE	> 500	8000	10 to 18	1250
Low Altitude Deep Penetration	LADP	> 250	50 to 9000	0,5 to 1	350
Low Altitude Long Endurance	LALE	> 500	3000	> 24	< 30
Medium Altitude Long Endurance	MALE	> 500	14000	24 to 48	1500
Strategic					
High Altitude Long Endurance	HALE	> 2000	20000	24 to 48	(4500c) 12000
Special Purpose					
Unmanned Com-bat Aerial Vehicle	UCAV	approx. 1500	10000	approx. 2	10000
Lethal	LETH	300	4000	3 to 4	250
Decoy	DEC	0 to 500	5000	< 4	250
Stratospheric	STRATO	> 2000	20000 to 30000	> 48	TBD
Exo-stratospheric	EXO	TBD	> 30000	TBD	TBD
Space	SPACE	TBD	TBD	TBD	TBD
TBD = To be defined a = according to national legislation b = in Japan c = Predator B					

Table 1: UAS categorization (modified from van Blyenburg 2011, 155).

UAS classification process is ongoing in Europe and it's not completed, anyhow CAA has adopted their classification from EUROCAE's Working Group 73, which is working a group system for UASs. Table 2 presents Civil Aviation Authority's UAS classification.

Weight Classification Group	Civil Category	Mass (kg)	Broad Military Equivalent	Civil Regulation
1	Small Unmanned Aircraft	20 or less	Micro (< 5kg)	National
			Mini (< 30 kg)	
2	Light UAS	More than 20 to 150		
			Tactical	
3	UAV	More than 150		EASA
			MALE	
			HALE	

Table 2: UAS Classification by weight (modified from Civil Aviation Authority 2010).

1.3 UAS Related Organisations

Organisations related to UAS are presented in Publication [P3]; however there are organisations that are significant to preparing and enforcement of legislation concerning UASs. EUROCONTROL, Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) are coordinating their UAS activities. International Civil Aviation Organization (ICAO) has also started an official UAS study Group which have 14 countries and 7 international organizations participating (van Blyenburgh 2008). The following provides an overview of the prominent players in the field of UAS.

The European Aviation Safety Agency (EASA), a bureau of the European Union, has specific regulatory and executive functions in civil aviation safety and environmental protection. EASA is an important factor in European aviation safety by promoting and developing common standards of safety and environmental protection in civil aviation as well as common rules at the European level. It monitors Members States' standards implementation and provide technical expertise, training and research for them. (EASA 2009b.)

The European Organisation for Civil Aviation Equipment, EUROCAE, is an organisation which formed at Lucerne (Switzerland) in 1963. EUROCAE's aim is to provide a European forum for resolving technical problems with electronic equipment for air transport. EUROCAE applies to aviation standards and related documents as required for use in the regulation of aviation equipment and systems. EUROCAE is an association composed of members who are specialized technical fields of Aeronautics and many of them are considered to be among world's leaders in their fields. Members of EUROCAE include Equipment and Airframe Manufacturers, Regulators, European and International Civil Aviation Authorities, Air Navigation Service Providers (ANSP), Airlines, Airports and other users. EUROCAE organises Working Groups (WG) in order to develop EUROCAE Documents (ED). WG members are experts working on a voluntary basis and they come from the association membership. EUROCAE has developed aviation standards over 43 years. (EUROCAE 2006.)

The European Organisation for the Safety of Air Navigation, EUROCONTROL, is an intergovernmental organisation with 39 member States; European Community is also member of organisation. EUROCONTROL was founded in 1960 as a civil-military organisation that is European repository of air traffic management (ATM). EUROCONTROL leads and supports ATM improvements across Europe and it is committed to build a single European Sky which delivers the ATM performance. EUROCONTROLs role in UAS aspects is to verify that ATM runs into requirements of justified airspace operators. EUROCONTROLs legality aspects include international (ICAO), regional (EASA) and national cooperation. (EUROCONTROL 2011.)

Legal aspects which EUROCONTROL is dealing include: a) Regulatory Framework, b) Certification, c) Airspace, d) Licensing, e) Liability/Insurance, f) Interoperability of systems, g) High Seas Airspace, h) Control: responsibility and authority, i) Communication: e.g. spectrum (Air-Ground, Ground-Ground), j) Cross-border operations, k) Civil/military cooperation, and l) Airborne Collision Avoidance (ACAS).

The European Unmanned Systems Centre (EuroUSC™) is independent Light UAS Approvals specialist. It's authorized to asses the airworthiness of Light UASs of maximum weight of 150 kgs. Safety is the main objective and the mission of EuroUSC™ is to make the light UAS revolution a reality. EuroUSC™ has background in military and civil aircraft operations; therefore it has understanding of the commercial realities of UAS as well as operations and training. EuroUSC™ works with organisations and companies which develops practical ways to operate UASs. (EuroUSC 2011.)

The Federal Aviation Administrator (FAA) regulates and oversees all civil aviation aspects in the U.S. and is that fore National Airworthiness Authority. FAA established the Unmanned Aircraft Program Office (UAPO) to combine the UAS safely and effectively into the National Airspace System (NAS). To achieve this goal, UAPO works closely with the UAS community trough RTCA SC-203 to determine Minimum Aviation System Performance Standards (MASPS). SC-203 recommendations are based on the assumption that UAS and their activity do not have a negative impact on existing NAS users. (RTCA 2010.)

International Civil Aviation Organization (ICAO) is the United Nations' (UN) specialized agency which was founded in 1944 in Chicago, United States. ICAO adopts international standards and recommended practices and integrates them as 18 Annexes into the Convention on International Civil Aviation which is commonly referred as the Chicago Convention. ICAO sets the standards for safety, regularity and efficiency of international civil aviation. "The Council and its subsidiary bodies set the continuing direction of the work of the Organization. The Council may act as an arbiter between Contracting States on matters concerning aviation and implementation of the Convention; it may investigate any situation which presents avoidable obstacles to the development of international air navigation; and, in general, it may take whatever steps are necessary to maintain the safety and regularity of operation of international air transport". (ICAO 2011.)

The Chicago Convention has 96 articles to regularize the privileges and restrictions for contract states and to regulate international air transport (ICAO 2011). ICAO focuses in UAS related issues to international operations including assuring safety, secure and efficiency. ICAO harmonizes all States, airspaces and aerodromes and focuses also on controlled airspace/aerodrome and mainly for civil aviation, hence, state aircrafts i.e. military, police and customs aircrafts does not belong to their focus. (ICAO 2010a.)

The Civil Aviation Authorities of Austria, Belgium, Czech Republic, France, Germany, Italy, the Netherlands, Spain and the United Kingdom have formed an organization named Joint Authorities for Rulemaking Unmanned Systems (JARUS). JARUS' active members are also EASA and EUROCONTROL. Organization's final purpose is a single set of draft airworthiness, both airspace and operational requirements for civilian UAS below 150 kg or which are for research purposes and are accepted by participating countries.

In United States RTCA, Inc. (known as Radio Technical Commission for Aeronautics until their re-incorporation in 1991 as a not-for-profit corporation) develops consensus-based recommendations among other issues for air traffic management systems. RTCA is a federal advisory committee, which organized in 1935 and includes more or less 400 government, industry and academic organizations around the world. Those member organizations stand for all sectors of the aviation, including government organizations, airlines, airspace users, airfield society and labour unions as well as aviation service providers and equipment suppliers. (RTCA 2011.)

RTCA's recommendations are used by the Federal Aviation Administration (FAA) based on policies, programs and legislative decisions and the basis for private sector development, investment and other business decisions. RTCA Inc. is a non-profit corporation founded to promote art and science of aviation and aviation electronic systems for the benefit of citizens. The organization operates as a Federal Advisory Committee and develops consensus-based recommendations for the modern aviation problems. (RTCA 2011.)

UAS Finland is a non-profit association and open community to private persons, associations and companies which are interested UAS operations in Finland. The aim of UAS Finland is to act as UAS activities' community, to gather and to disseminate knowledge of the field of UAS in Finland. UAS Finland provides a forum for UAS field operators, in which members can present their activities and share their knowledge and to promote the expansion of UAS activity in Finland. (UAS Finland 2011.)

World's oldest non-profit-making association The Unmanned Aerial Vehicle Systems Association (UAVS) focuses on the development of networks, increased cooperation and a safe, integrated and comprehensive utilization of unmanned aerial systems. UAVS is an information channel between the government and industry in the UK and represents the UAS industry, and provides information about what happens in the field of legislation, in particular in the UK.

UAVS regularly consults its members and even wider the industry for future UAS topics that focus on UAS's civilian use and commercialization. UAVS collect the information proposals to improve the CAP 722, 4th edition, the Unmanned Aircraft System Operations in the UK airspace -guidance. (UAVS 2011.)

UVS International is an association which operates in France. UVS International represents manufacturers of UAS, subsystems and critical components and associated equipment for UAS, as well as the research organizations and academia. UVS International has members in 34 countries on 5 continents. Focus area of UVS International is UAS related airworthiness, certification and air traffic management (ATM) issues. The UAS associated problems are global, hence UVS International puts effort to harmonise various national and international approaches at the easiest possible stage aim to inserting UAS into non-segregated airspace. (van Blyenburgh 2008.)

The above-mentioned organizations and associations are just examples of dozens of different entities, which operate in the field of unmanned aerial vehicles.

1.4 Purpose and rationale

This research process began by defining the topic and objectives as well as the theory of experience. Case study material was collected through interviews and by analyzing scientific publications, newspaper articles, reports, books and video clips. The scientific publications from the subject concentrate on the building, on the planning and on the technical properties of UAS (Mueller et al. 2006, Austin 2010, Finn & Schering 2010). The unmanned model planes are used mainly for different military purposes at the moment. Due to the character of the use it is difficult to get public written source material. Based on this, it was ensured that this is among the first researches in this issue in Finland (Järvinen & Järvinen 2004, 109).

According to Hirsjärvi et al. (2007), literature survey depends on the chosen scientific approach. Literature survey gathers information on existing studies and clarifies what is already written on this subject. Thus, for example can ensure that the research area has been written enough theories to which the research can be set up, and that the research will not try to solve the problem which has already been resolved. (Hirsjärvi et al. 2007, 253.)

There has seen rapid growth in UAS industry during last years. That has happen not least because of civilian applications are growing. However, the limits of regulations and technologies restrict to allow 'file-and-fly' permissions equally for unmanned as for manned aircrafts. The objective of this thesis is to research what benefit is achieved by UAS services and what they can take advantage of and what kind of services can be offered by UAS. The answers are presented in Publications.

1.5 Research Questions

The overall research questions in publications introduced and presented in this thesis are:

How UAS is understood in the point of view of legislation?

What are the main obstacles in development of UAS activity?

Sub questions in publications are:

What and why will be the biggest challenges, weaknesses and restrictions on the operation at this point in functionally, economically and legally both nationally and internationally?

How services can be produced by using Unmanned Aircraft Systems and what obstacles are there in the legality point of view?

How real time picture and situational awareness can be improved by using unmanned aircraft systems?

How and in what way UAV's can accelerate and improve maintaining of the real-time picture?

This thesis focuses to UAS generally and other systems like micro and mini aerial vehicles are delimited out. This research converses on the public use of UAS and delivers military UASs out.

1.6 Structure of the Thesis

The structure of this thesis is as follows: In Chapter 2 is presented the methodological issues and theoretical background of this study. This chapter explains the science, the scientific explanation and research and the definitions for terms innovation and artifact. Design science research paragraph contains review of design science. Case study has two viewpoints; what is a case study as a research method, a case study and the development or implementation of the system. However, even the focus is Yin's guidelines for case study research; it is examined pros and cons of a case study as well. Finally, at the end of the second chapter it is discussed factors affecting the choice of method and presented what methods have been used in publications.

Chapter 3 of this thesis focuses on results what have been found in this research, presents publications, and answers to research questions. UAS use cases and SWOT analysis is stated also in this chapter, as well as legal issues, both privacy perspective and aerial legislation are likewise stated. Chapter 4 contains discussion and finally chapter 5 sets out the conclusion of this study and suggestions for the further research.

2 Methods

This chapter deals with explanations for science and scientific explanation as well as definitions for innovation and artifact. In this chapter discuss is about design science research and case study research. Pros and cons of case study research and then choose of the research method are also conversed on at the end of the chapter.

2.1 Science and the Scientific Explanation

Niiniluoto (2002) describes the scientific meaning of nature, man and society of the information concerning the systematic whole and on the other hand these data, and the deliberate pursuit of a system model. The above-mentioned means, according to Niiniluoto, results of scientific research and the latter the scientific research process. In Finnish science policy it is commonly used the Organization for Economic Co-operation and Development (OECD) definitions, where the research and development means systematic action to increase the available information and thus reached on the use of new applications to find (Niiniluoto 2002, 13). The scientific as a term is merely descriptive, but it also has a normative component, unscientific, which means outside of science and scientific research against the rules of the game (Niiniluoto 2002, 15).

Science is a creative activity, which may be based on new ideas and good fortune, not just the mechanical problems to solve (Niiniluoto 2002, 63). Haaparanta & Niiniluoto (1998) in turn determine science as systematic and rational acquisition of new knowledge. Definition signifies activity which seeks and obtains information. Science can also refer to social institutions, with a social mission and own goals (Haaparanta & Niiniluoto 1998, 7.) Scientific knowledge can be defined according to Niiniluoto (2002), the results of a set that has been achieved through scientific research (Niiniluoto 2002, 15). The primary task of science is to produce new scientific knowledge (Niiniluoto 2002, 62). According to Niiniluoto (2002) scientific information includes reliable research results achieved by using best practices, which are acknowledged in the scientific community.

Scientific research seeks to achieve a variety of information about the phenomena of contingency and the development of forecasting and, consequently, their control of technology, as well as to explain and to understand nature, man and society on the facts and regularities (Niiniluoto 2002, 192). Hirsjärvi et al. (2007) present a scientific, acquired by research, information as which specify the issues related to research problems, and thus directs attention to the essential subjects. Traditional thinking habits and detachment of interests, the attraction of new issues, increase of discretion of own solutions, and getting systemically caught to the new issues are according to Hirsjärvi et al. (2007) benefits of scientific knowledge in everyday life.

In addition to creation of new concepts, perspectives of the world may recur (Hirsjärvi et al. 2007, 20). The role of science is a systematic and rational data acquisition. The results of science present the prevailing modes of argument in the world and these arguments will be similar to reality, resulting in that the truth is the essential goal of science (Haaparanta & Niiniluoto 1998, 9). Science is responsible for the acquisition of new knowledge, and such cases researcher is in a sense, truth seeker as Niskanen (2008) argues. According to Niskanen (2008) the results of the science support recommendations for action carried out by decision-making. In this sense, researcher's role is act with the decision-maker or an advisor. Science can be viewed in the light of the results of usability, and so a good study produces useful results. Science can also seek to acquire the reality of the information; the main objective is to find even the most informative truths as Niskanen (2008) prompts. (Niskanen 2008, 19.)

Individual researcher's point of view research is often a professional activity; a stimulus may be different personal goals. However, science is fundamentally a social activity and the progress of science presupposes the co-researchers, and its results, which are public and have general interest (Niiniluoto 2002, 61). The general objectives of science are theoretical effort to the truth and searching for applicable information (Niiniluoto 2002, 73).

The research meets the requirements of science, when research complies with the following demands made by Robert K. Merton (1968): (1) the criteria of universality, (2) knowledge of community, or communality, (3) impartiality and (4) systematic suspicion of principle (Hirsjärvi et al. 2007, 21). Haaparanta & Niiniluoto define scientific study as interaction between exploratory subject and research object (Haaparanta & Niiniluoto 1998, 15).

Research needs to be controlled by method in order to be scientific and thus acceptable to scientific community (Haaparanta & Niiniluoto 1998, 11.)

Deduction refers to an activity of thinking, which proceeds with assumptions' conclusions. Deduction consists of, 1) alleged statements contain assumptions and conclusions of theoretical reasoning, 2) the conduct or activity leader in reasoning, or practical reasoning, 3) the new arguments and hypotheses are invented, and 4) the arguments and hypotheses argument, testing, acceptance, adoption, and rejection (Niiniluoto 1983, 9; Niskanen, 2008, 34). Arguments relate to claims on the argument and the proof of chain construction. Often, the conclusion of the argument brought forth so that the first criteria is given, or premise, which is followed by a conclusion (Niskanen, 2008, 33.)

Scientific deduction can mean either the scientists in the actual operation, or logical deduction and method in accordance with the recommendations of doctrinal deduction activities. Generally, in scientific deduction, the researcher's premises are hypotheses, when considering how to invent and justify hypotheses (Niskanen, 2008, 36.) Scientific reasoning is a thinking activity that progress from assumptions to conclusion (Haaparanta & Niiniluoto 1998, 54). When examining a relationship between arguments of the deduction (premises) and the conclusions, a division is done between deductive and inductive deduction. Deductive deduction keeps the truth of premises in which reality is always followed by the conclusion, which is true. (Niskanen, 2008, 34.)

All non-deductive deduction is inductive one, where it is possible that the fact of premises in the conclusion can be false. The deduction form of deduction and induction is abduction. In case of abduction it is pursued by the consequences to guess the causes. (Niskanen, 2008, 34.) Niiniluoto, however, argues that in a broad sense, scientific deduction includes both theoretical and practical deduction. With theoretical deduction, Niiniluoto signifies deduction where assumptions and conclusions are argument theorems and with practical deduction, he points at that conclusion is an act or activity. (Niiniluoto 1983, 9.) The structure of the different phases of scientific deduction together corresponds to the original problem, which often includes why-question (Haaparanta & Niiniluoto 21998, 72).

Scientific means of explaining signifies the process, means or method, which gives a matter seeking to understand by finding answers to the questions why? what for? or whereupon? (Niskanen 2008, 40). Searching for the truth is related to theory building, which when realized, allows the explanation of the facts and regularities. Explaining is related to the need for a human to understand and analyze the world around us and to achieve truthful information (Niiniluoto 2002, 73).

2.2 Allocation of Scientific Research

Scientific research can be divided into basic and applied research in which scientific knowledge has a different role. According to Statistics Finland (2011a), the objective of the basic research is to search for new scientific knowledge without a priority effort to express the practical aims and applications. It is characterized by the properties, structures, cause and effect relationship analysis, with the aim of the new hypotheses, theories, and is indelibly linked with the formation, verification and explanation.

Statistics Finland (2011a) state that applied research is built on basic scientific research results on knowledge, which is aimed at a particular practical application. The goal may be, for example applications in search of basic research results or new methods and instruments for creating the problem. Research and development (R & D) is in turn an umbrella term, which refers to systematic activities to improve knowledge and information on the use of new applications to find. The criterion is that its objective is something fundamentally new. Research and development activities are included in the concept of basic research, applied research and development (Statistics Finland 2011a.)

Development work, i.e. product and process development refers to the study results and/or practical experience, the knowledge gained with the use of new products, services, production processes or methods to induce or existing substantial improvement (Statistics Finland 2011a). According to Järvinen & Järvinen (2004) the research provides new information that has both scientific interest and practical benefit. Basic research examines what is now considered the world, rather than applied research aims to build and evaluate new innovations based on the results of basic research (Järvinen & Järvinen 2004, 103.)

The traditional elements of the scientific research are research problem, research questions, and responding to them. Before selecting specific methods, the philosophy of science questions has to be explored. Questions are about the nature of reality (ontological), the nature of knowing (epistemological) and the attainment of knowledge tools (methodological) issues. Theoretical framework demonstrates on what scientific debate the research belongs and will it afford new information exactly to the specific scientific community. (Ojasalo et al. 2009, 18.)

According to Niiniluoto (2002), the main steps of the research process can be schematically and simply present as follows: (1) problem setting, (2) refinement of the problem and compiling the research strategy, (3) data collection, (4) material characterization; (5) data analysis, (6), drawing of conclusions, (7) preparation of the thesis or report, and (8) publication of research results (Niiniluoto 2002, 25). On the other hand, Hirsjärvi et al. (2007) state that the main steps of the overall research process is: (1) the choice of subject, (2) data collection, (3) evaluation of the material, (4) structuring of the ideas and notes as well as (5) research writing (Hirsjärvi et al. 2007, 63).

The choice of the topic includes according to Järvinen & Järvinen (2004), three factors: (1) the original research questions, describing what the subject wants to know; (2) study reasoning seeks to answer why we want to know; and (3) of the specified questions seek to find answers to the original questions. The purpose of the study is to clarify the items and the layout of the problem and to find out, for example, would it really produce new research findings (Järvinen & Järvinen, 2004, 5.)

Järvinen & Järvinen (2004) state that the idea of research is related to a problem or a question to which you want to get the answer. For example, design science research is based on an environmental object or problem of research. In working environment there can be a badly or poorly functioning artifact whose activity needs improving. The researcher may have an improvement suggestion which goodness can be explored by building a better artifact, and to analyze whether that solution was better than the old. (Järvinen & Järvinen, 2004, 103.) It can also build a whole new artifact, an innovation, to solve a working problem (Järvinen & Järvinen 2004, 107; Hevner et al. 2004, 77; March et al. 1995, 254.)

2.3 Definitions for Innovation and artifact

Business Dictionary (2011) defines innovation: “The process by which an idea or invention is translated into a good or service for which people will pay, or something that results from this process. To be called an innovation, an idea must be replicable at an economical cost and must satisfy a specific need. Innovation involves deliberate application of information, imagination, and initiative in deriving greater or different value from resources, and encompasses all processes by which new ideas are generated and converted into useful products”. (Business Dictionary 2011.)

Four types of innovation according to OECD are: product innovation; process innovation; marketing innovation and organizational innovation (OECD 2011) as seen In Table 3.

Innovation Field	Innovation Focus
Product Innovation	Related to new or significantly improved product or service. Includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
Process Innovation	Requires a new or significantly improved production or delivery method. Includes significant changes in techniques, equipment and / or software.
Marketing Innovation	Requires a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
Organizational Innovation	Associated with the use of a new organizational method in the company's business, workplace organization or external relations.

Table 3: Fields of Innovation (OECD 2011).

OECD states that these innovations can be new to the firm/educational institution, new to the market/sector or new to the world (OECD 2011).

Innovation is a new or significantly improved product (goods or services) which will be presented on the market or within the company to present a new or significantly improved process. Innovations base on new technological developments to improve existing technologies or the use of new knowledge acquired by company. An innovative company may develop innovations, or another enterprise can developed them. However, completely innovations developed by other companies are not considered innovations. Product innovation is a product (goods or services), which is either new or substantially improved relative to its basic features, specifications, software or other immaterial components, intended use, or the user-friendliness. Changes only the aesthetic quality of the innovation is not included in the definition. (European Commission 2005.)

Innovation is a new or significantly improved products (goods or services) launched by company, new or significantly improved process that company introduced, a new marketing method the company's introduced, or a new organizational method in business practices, workplace organization or external relations that company introduced. Innovation (product, process, marketing method or organizational method) must be new to the company's point of view. Developer of the innovation may be the company or other companies or organizations. (Statistics Finland 2011b.)

The innovations are considered to be created in the real world from the different people's needs. Meetings of the professionals of the different field are considered as situations which are valuable and produce many innovations. (Ojasalo et al. 2009, 71.) Santonen et al. (2007) argue that term innovation can be used to describe the invention or a novelty. Formulated in another way, according to Santonen et al. (2007), innovation can mean changeability. (Santonen et al. 2007, 8.)

Business Dictionary (2011) defines artefact as follows: “Hand-made object, or other result of human activity such as a design or document” and “Erroneous or extraneous data introduced either by the methodology used in data collection or by the process (such as scanning) used in data capture” (Business Dictionary 2011.)

An instantiation is to understand an artifact in its environment. Instantiations implement constructs, models and methods. According to Suomala et al (2005, 180) innovation is generally regarded as the invention, which has practical application value. The growing importance of innovation in the traditional understanding of innovation has received several extensions.

2.4 Design Science Research

Research is likely to be subject to design science, if the research question includes the use of verbs to construct, alter or improve (Järvinen & Järvinen, 2004, 103). Järvinen & Järvinen advise choosing the research method to examine the research question (Järvinen & Järvinen, 2004, 5). Choosing the right method could be derived from the research question, as Teräs (2008, 71) prompts for the basic guideline.

“The core mission of a design science, on the other hand, is to develop knowledge that can be used by professionals in the field in question to design solutions to their field problems. Understanding the nature and causes of problems can be very helpful when professionals are designing solutions. Design science develops knowledge on the advantages and disadvantages of alternative solutions”. (Van Aken 2005, 22.)

Function of a design science is to develop knowledge for the design and realization of artefacts or to solve improvement problems (Van Aken 2004, 224-225). A design science develops knowledge for the professionals in its field. Design knowledge is to be applied by people who have received formal education in that field. (Van Aken 2004, 225.) Interesting research topic in the information systems (IS) field is how to effectively develop new systems. This is important because information technology (IT) is developing and technical knowledge is growing. IT is applied to new areas which were not previously believed to need IT support. In this process, new kinds of systems and development methods are created. (Markus et al. 2002, 180.)

Järvinen & Järvinen (2004) on the other hand state that design science research is usefulness of innovation studies emphasizing transparency. The study is constructed and evaluated for innovation aimed at solving a problem in target environment. With design science research can create new innovations, or develop any existing innovation. Research may also produce new knowledge that professionals can take advantage of solving design and construction problems (Järvinen & Järvinen, 2004, 9-10.)

Hevner et al. (2004) created information systems research framework which is presented in Figure 1.

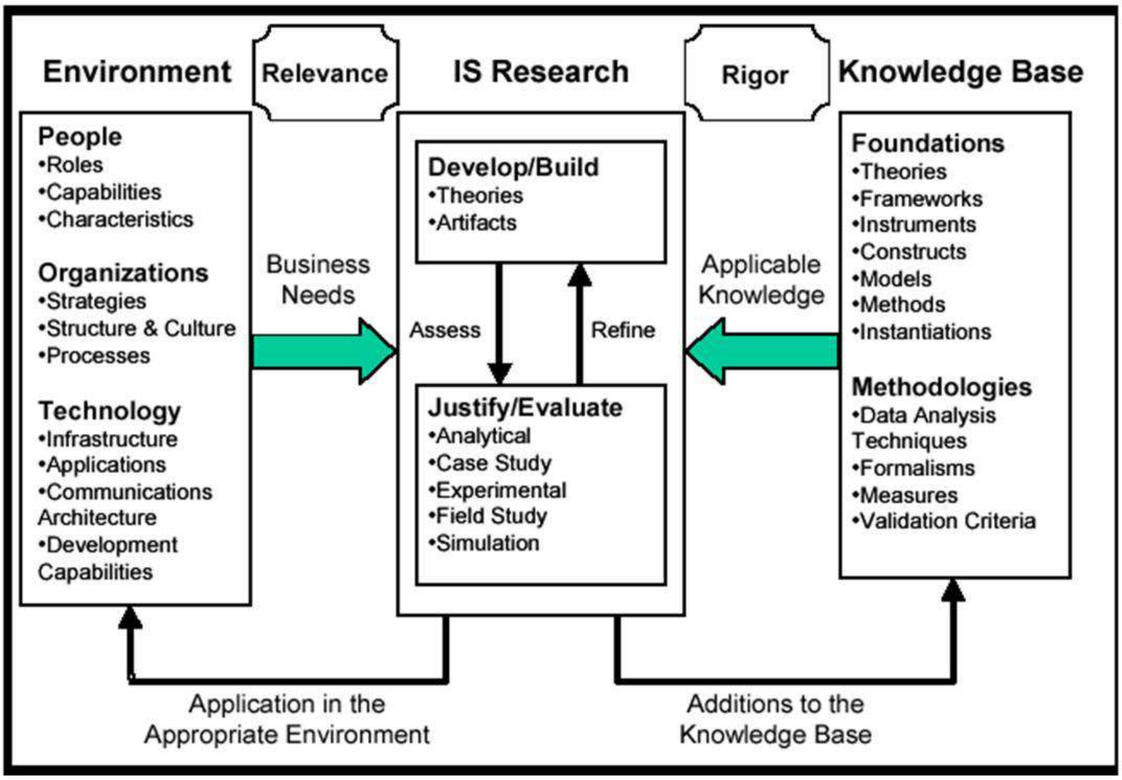


Figure 1: Information Systems Research Framework (Hevner et al. 2004, 80).

Hevner et al. (2004) consider as a basis for research the business environment which consists of people, business organization and technology. The targets of research in their view are human form of roles and competencies as well as the organization's strategies and processes, and technologies which support these. Hevner et al. (2004) and Järvinen & Järvinen (2004) state that investigators need to understand the target environment, its requirements, and also the subject to the investigation of the problem.

According to March & Smith (1995) “an instantiation is the realization of an artifact in its environment”. Instantiations implement constructs, models and methods. The Information Technology systems need to be instantiated using the experience and intuition. Only when it has been studied and used, we can formalize the constructs, models and methods, which it is based. (March & Smith 1995, 258.)

An object (artifact) is build to perform a specific task. Technology-oriented products are assessed by the value or usefulness - does it work? Is it an improvement? When something is built, it must be evaluated scientifically. (March & Smith 1995, 253.) The fundamental question of artifact is, how well does it work? March & Smith (1995, 251). Design science creates and evaluates IT artifacts intended to solve identified organizational problems (Hevner et al. 2004, 77).

Design science’s function is building and evaluating IT artifacts while natural science intents theorizing and justifying (March & Smith 1995, 251).

		Research Activities			
		Design Science		Natural Science	
		Build	Evaluate	Theorize	Justify
Research Outputs	Construct				
	Model				
	Method				
	Instantiation				

Table 4: A Research Framework (March, S.T, Smith, G.S 1995).

March & Smith (1995, 251) propose a framework to guide difference between research outputs and research activities as shown in Table 4. Research outputs; constructs, models, methods and instantiations are the first dimension of that framework. On the other hand the second dimension is based on design science and natural science research activities: build, evaluate, theorize and justify.

According to Lukka the constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world and to make a contribution to the theory of the discipline in which it is applied. Lukka states also, the central notion of this approach, the (novel) construction, is an abstract notion with great number of potential realizations. All human artefacts are constructions. Artefacts are invented and developed, not discovered. (Ojala & Hilmola 2003, 83-84.)

Task of design science is to produce design science knowledge to improve the activities of design and construction according to Pirinen (2009, 7). The purpose of design science is how to construct and evaluate innovations and artifacts. The method of design science research and design research is almost similar. Pirinen (2009, 6) explains design science following way:

> "Design Research consists of activities concerned with the construction and evaluation of technological artifacts to meet organizational needs as well as the development of their associated theories."

Hevner et al (2004, 82) describe design-science research as follow:

> "The principle of design-science research is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact".

Venable (2006) explains that theory building is a key activity which is related to various areas of research as shown in Figure 2.

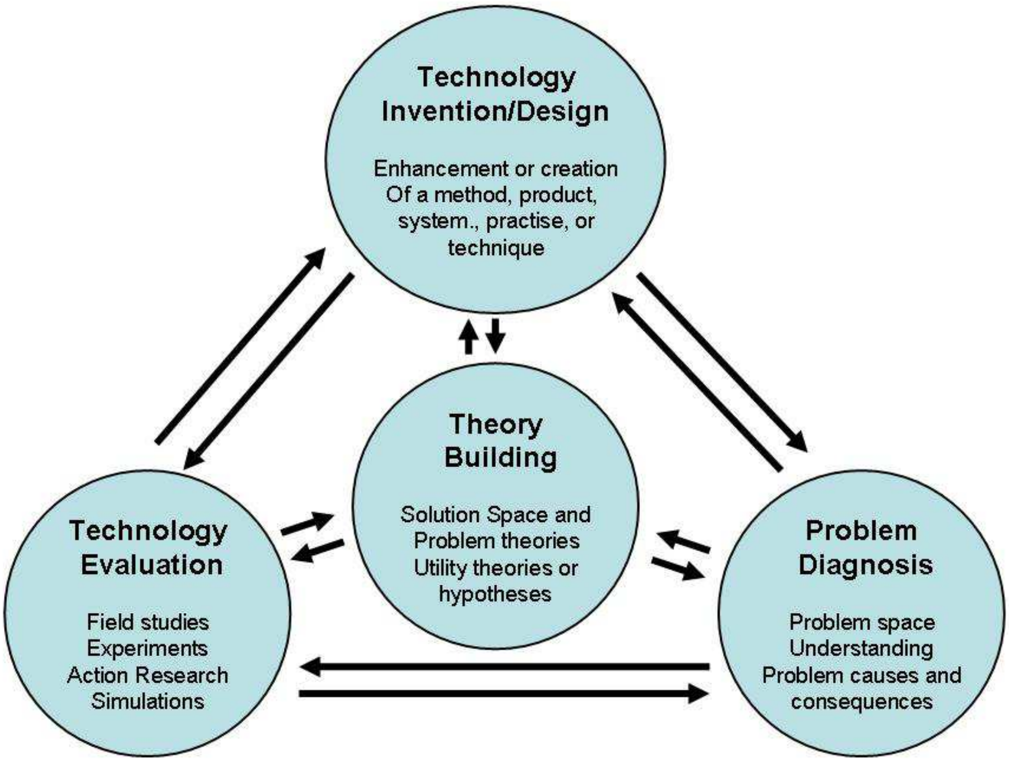


Figure 2: An Activity Framework for Design Science Research (modified from Venable 2006, 17).

Venable contends that the theory and theorizing should play a central role in the Design Science Research. Although, the theory can keep in touch with scientists and various research activities. As Venable (2006, 16) remarks:

> “Theories are proposed by someone, and analyzed, validated, refuted, modified, enhanced, evolved, and, hopefully, accepted and adopted over time by many”.

In fact, they can be changed many times in one Design Science research. Venable (2006, 16) continues:

> “Thus, theorizing, or theory-building is central to the work, which ties together various areas of research.”

Design Science researchers should be tied to theorizing - before, during, and the result of the work of Design Science Research according to Venable (2006). He also suggests that design theory is in the form of benefit theories related to the improvements expected from applying a specific type or types of technologies to certain type of problem. (Venable 2006, 17.)

2.5 Case Study Research

Case Study Research is one way of doing social science research among others. According to Barros case studies have been used in teaching and research since the early 1900`s and have become increasingly popular (Ojala & Hilmola 2003, 29). It has been used for exploratory, descriptive and explanatory purposes, depending on basic questions such as "what, who, where, how many, how and why?" (Ojala & Hilmola 2003, 32). As Barros states case studies are often assumed to be more holistic than other types of business analysis, for instance, by mixing quantifiable and qualitative data (Ojala & Hilmola 2003, 39).

As Järvinen & Järvinen state, case study can be descriptive in its nature but it can also test theories. Information can be obtained by survey, interview, observation and the use of archival material. Collected information may be either quantitative or qualitative. A case study will examine one case or multiple cases (Järvinen & Järvinen 2004, 75). Case study research is a research to study one or at most a few carefully selected cases. The essential thing is to examine the case. Case study research may be qualitative or quantitative, or both, depending upon the sort of within-case evidence that is available and relevant to the question at hand (Gerring 2007, 36). According to Eisenhardt (1989, 534) case study evidence may be qualitative (e.g. words) or quantitative (e.g. numbers), or it can be combination of both.

The case study is the most common qualitative research method in business economics. Subject to research in case of the company is usually a process, function or department. In the case study it is recommended to use a variety of sources, including interviews and written materials. All qualitative research is not a case study, but a case study may be greatly influenced by other trends in qualitative research. (Eriksson & Koistinen 2005; Koskinen et al. 2005, 154 – 157.) Evidence ("data") collecting has many ways and none of the methods is unique to the case study and techniques differ greatly (Gerring 2007, 69).

Case study research usually relies heavily on contextual evidence and deductive logic to reconstruct causality within a single case (Gerring 2007, 172). Ojasalo et al. (2009) contend that a typical case study is a feature of a wide range of methods to use to achieve a deep understanding of the case, and a diverse and comprehensive picture of the study to be investigated. Even though the case study can be used for both qualitative and quantitative research and they can also be combined. A case study, however, is often associated with qualitative research and methods. (Ojasalo et al. 2009, 55.)

Hevner et al. (2004, 86) guide to use design evaluation methods in case of case study. They guide that using observational method one has to study artifact in depth in business environment. Success is based on the researcher's skills; developing or constructing a theory or an object and the selection of appropriate means to justify the theory or to evaluate the item (Hevner et al. 2004, 88). As Yin (2009, 14) argues: “case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. Your goal will be to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization)”.

As following table shows three conditions affect to choice of research method: 1) type of research question, 2) the control of an investigator over the behavioral event, and 3) the amount of concentrations on contemporary compared to the historical events (Yin 2009, 8).

Method	Form of Research Question	Requires Control of Behavioral Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

Table 5: Situations for different research methods (Yin 2009, 8).

Yin (2009, 8) recommends, it is important when selecting a research method to be open-minded, because the different methods have overlaps among others. Thus, multiple methods may be suitable for a specific investigation as previous table summarizes.

Case study emphasizes the objectives of the customary investigation, that is, production of researched information on the target. A case study is well suited for use in development when it is wanted a deep understanding of the target of the study. With case study it is able to create development ideas, or a suggested solution to the problem, but it will not develop a concrete output in practice. The case study examines the items in its own environment in depth. Typical for case study research is to use several methods of data collection, which provide a comprehensive and in-depth picture of the object. (Ojasalo et al. 2009, 37-38.) Using case study research it is intended to clarify a lot of a restricted subject rather than a little from a wide subject. The case study can examine a single subject, but it is also possible to investigate several in comparison (Ojasalo et al. 2009, 53.) Case Study research improves thoughtful understanding.

Case study, as a method, has been criticized; inter alia, the lack of scientific rigor (Järvinen & Järvinen 2004, 79). Yin (2009, 14) points out that every researcher has to follow systematic procedures, reliable evidence and neutral perspective in case study research. The second point of criticism of case study method is that case study provides a little basis for scientific research (Järvinen & Järvinen 2004, 79). Case study has also been complained that it requires much of resources (Järvinen & Järvinen 2004, 79). Yin (2009, 15) acknowledges that it may be appropriate but guides future case study researchers to concern doing case study with modern instruments instead example observational evidence in the field. However, with other research methods there also appear mistakes (Yin 2009, 14).

The first strength of theory building according to Eisenhardt (1989, 546) is that it likely produces a new theory. A second strength is that the emergent theory may be tested with constructs which are measured during the theory building process. As the third strength Eisenhardt sees a result of the theory that could be empirically valid. Eisenhardt states: “The likelihood of valid theory is high because the theory-building process is so intimately tied with evidence that it is very likely that the resultant theory will be consistent with empirical observation. In well executed theory-building research, investigators answer to the data from the beginning of the research.” (Eisenhardt 1989, 547).

In theory building, some of the factors lead to the strengths, on the other hand they lead to a number of weaknesses in the use of case study. Efficient use of scientific evidence can lead to overly complex theory. The result can be a theory, which is very rich in detail, but poor from a holistic perspective. The second weakness is that building theory from cases may result in narrow and simple theory. “Case study theory building is a bottom up approach such that the specifics of data produce the generalizations of theory” as Eisenhardt states. Case study risks are theory’s describing in a very simple phenomenon, or that the theorist is unable to raise the general validity of the theory. (Eisenhardt 1989, 547.)

As Eisenhardt (1989) stresses a case study basis theory likely has significant strengths, such as novelty, testability and empirical validity, which create the close affiliation with the empirical evidence (Eisenhardt 1989, 548–549). Theory building approach is well-suited to new research areas or research areas where existing theory seems inadequate. Case study has mentioned to be one of the least systematic research methods methodologically (Dubé & Paré 2003, 597). Dubé & Paré (2003) point out three areas where case study researchers should pay attention to. These areas according to Dubé & Baré are; design issues, data collection and data analysis. They also highlight the apparent lack of rigor that is one area where qualitative, including case study, research should improve. (Dubé & Paré 2003, 627.)

According to Eisenhardt (1989) theory building in case study is particularly iterative, because the researcher can focus on one part of the process at a time, while the process itself requires constant iteration between steps (Eisenhardt 1989, 546). Data analysis in a case study is the most important part to build a theory, but it is both the hardest and least classified as part of the process (Eisenhardt 1989, 539). Eisenhardt states that conflicting literature represents an opportunity. The coexistence of conflicting results forces the researchers more creative and open-minded way of thinking than they otherwise might do. The result can be more profound vision of a new theory and contradictory literature as well as to sharpen of the limits to generalization of the relevant research. (Eisenhardt 1989, 544.)

Nunamaker et al. (1991) argued that the new artifact is always based on one concept. Järvinen & Järvinen (2004) consider that this means the concept of a resource, technical, human, or informational resource, or a combination thereof, recovery. Idea can also be based on a new theoretical invention.

2.6 Yin’s Guidelines to Case Study

The following figure 3 shows how Yin (2009) guides to do Case Study Research by linear but also iterative process (Yin 2009, 1).

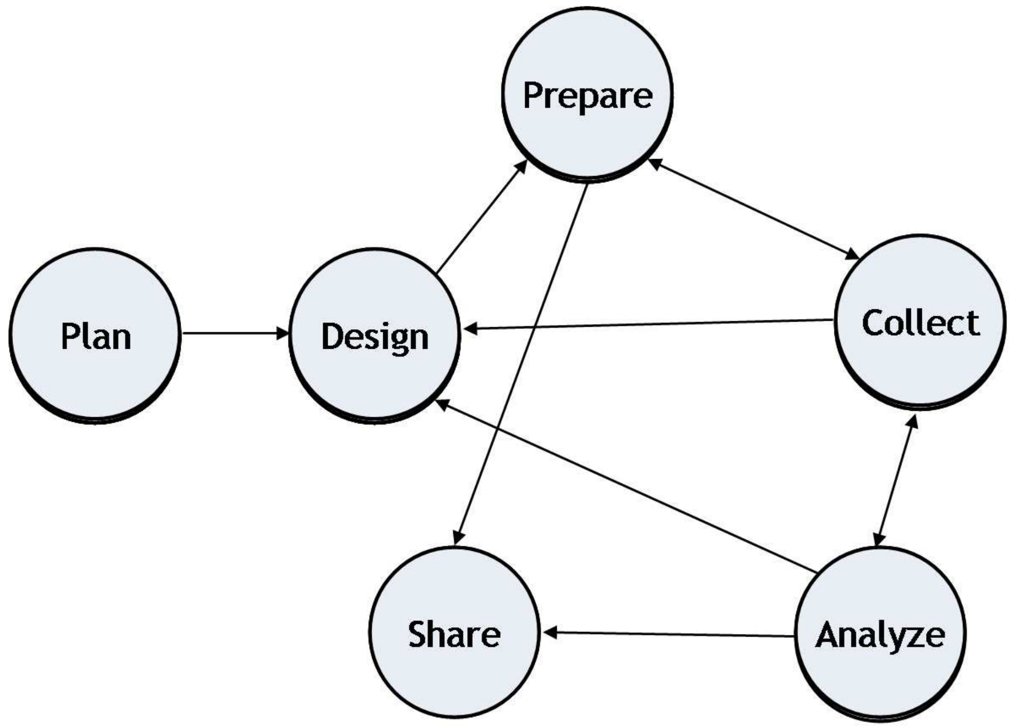


Figure 3: Doing Case Study Research: A linear but iterative process (Yin 2009).

Yin (2009) guides investigators when doing case study report to do case study rigorously. Yin divides research in to six steps which are explained in following sections.

2.6.1 Step 1: Research Plan

The first step in case study is to identify research questions or other basics for designating case study. Comparing case studies advantages and disadvantages to other methods strengths and limitations, help deciding what method you should use in research process. When research questions answers to questions “how?” and “why?” the case study method will be relevant because they are more explanatory than predictive (Yin 2009, 9). The more the research questions require in-depth and comprehensive description of a phenomenon, the more likely case study is suitable for a method. (Yin 2009, 4.) Case study has advantage in situations when the researcher has not at all or only little opportunity to influence the course of events (Yin 2009, 13).

The initial position of research in publication [P1] was to determine how real time picture and situational awareness can be improved. The other baseline for research was to investigate if it is possible and how, on the other hand, it can be done by using Unmanned Aircraft System (UAS). In publication [P3] which is extended version of publication [P1] is the same initial position but approach angle is different in a way that publication [P3] converse deeper backgrounds of UAS’s. Publication [P5] concentrates on legal aspects of service design and making innovation by utilizing RPAs.

2.6.2 Step 2: Research Design

It is important to emphasize the significance of five components of a research design in case study; question, propositions, unit(s) of analysis, the logic linking the data to propositions and the criteria for interpreting of the study (Yin 2009, 27). Study questions were descript in Step 1. By planning the development of the theory, suggestions and questions in the background expected in the study is essential (Yin 2009, 25). Design step includes also defining the unit of analysis and probably case to be studied (Yin 2009, 29). Designing case study means how to link collected data to research question, that is to say, develop a research design or plan (Yin 2009, 34). The last component of research design is criteria for interpreting a study’s findings. In case study as well as any other empirical social research, determination of the quality of research must be estimated, i.e. the quality and reliability of the research should pay adequate attention.

Unit of Analysis in publications [P1] and [P3] case study researches is expert’s best perceptions of the situation awareness and UAS’s role in it. In the other hand, experts give their own opinion not the organization's official position or vision. In submitted publication [P5] the unit of analysis is organizations that are preparing and/or proposing legal aspects of using UAS’s in European airspace.

2.6.3 Step 3: Preparing to Collect Research Evidence

It may be difficult and complex to prepare for data collection, because if it isn’t prepared well, the entire case study examination may be compromised. In the preparation of a case study four additional formal components are to be considered: (1) training for a certain case study, (2) developing a protocol for the study, (3) screening candidates for cases and (4) accomplishing a pilot case study. (Yin 2009, 67.) The case study protocol is an important way to increase the reliability of the case study (Yin 2009, 79) and it should have following sections: (1) an overview of the project where case study is introduced, (2) data collection procedure where data collection plan, contact persons and other field procedures are, (3) the specific case study questions, prospective information sources and (4) a guide for the case study. (Yin 2009, 81.)

Training for a study was, in publication [P1], particularly useful, because the original research question had to specify when it was noticed that research question gives much more when modified. A pilot case was also done by interviewing with test questions one interviewee. Publication [P3] base on [P1] and it had no further interviewee’s. Submitted publication [P5] has focus interviews and aerial legislation sources which deepens understanding of the legality aspects.

2.6.4 Step 4: Collecting Evidence

Researcher must mind to follow to case study protocol at each stage of research. It is important to use multiple sources when collecting data in order to maintain the reliability of the study. According to Yin (2009), there are six sources of evidence; documents, archival records, interviews, direct observation, participant-observation, and physical artefacts (Yin 2009, 98). All mentioned case study sources have their weaknesses and strengths. It is recommended by Yin (2009) to researchers to use multiple sources of evidence (triangulation) in case study (Yin 2009, 101). There may be explanatory, descriptive and exploratory case studies (Yin 2009, 40). Creating the database and keeping it throughout the study helps research work significantly. Figure 4 presents data triangulation

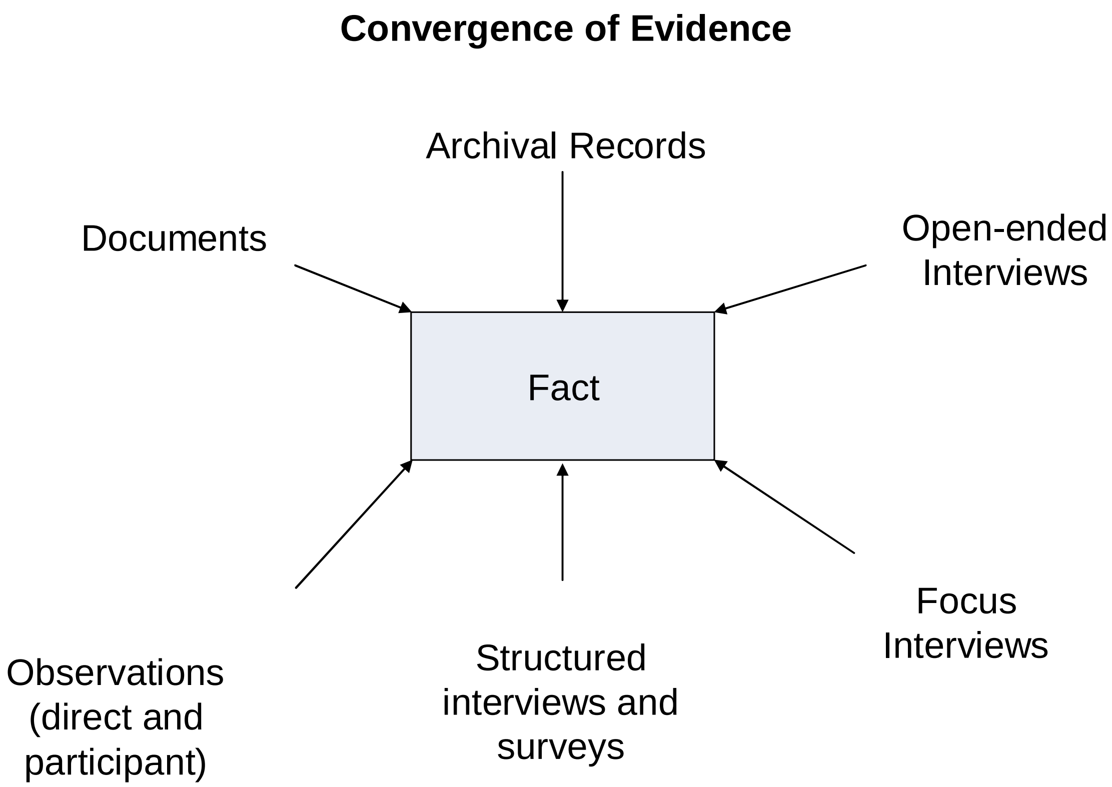


Figure 4: Convergences of Multiple Sources of Evidence (Yin 2009, 117).

When researcher is preparing to collect information of case study, Yin guides to screen the candidate "cases" for practicing the case study (Yin 2009, 91). Pilot case would help researcher to refine data collection plans and the procedures which to follow. Yin (2009) stresses the importance of the implementation of the pilot case, plan formulation and overall practicing. (Yin 2009, 92). Case study research can employ various data-collection processes such as participant observation, document analysis, surveys, questionnaires, interviews and others. The power of case study research is the ability to use all methodologies within the data-collection process and to compare within case and across case for research validity.

Bensabat et al. (1987) argue that a clear description of data sources and the way in which they promote the research results is an important part of the reliability and validity of the findings. Yin's recommendations to describe a case study protocol, and maintain a case study database should according to Bensabat et al. operate as an important guideline. (Bensabat et al. 1987, 381.)

In order to achieve triangulation, data were gathered from multiple sources. In Publication [P1] case study data was collected with interviews, from documents, collected articles and printed books. First interviews (after test case) were organized by e-mail. Before sending questions by e-mail, interviewees were called and assured they are willing to answer our survey. In extended version of [P1], publication's [P3] data deepens the knowledge acquired from additional literature and collected articles.

Sources of Evidence	Description
Documents	Newspaper articles, web site information Administrative proposals, internal reports, written reports on conferences and other meetings
Archival records	International and national aviation regulations Proposed aviational regulations and acts
Open-ended interviews	In depth interviews
Focus interviews	Interviews in Familiarisation course in East Lapland Vocational College
Observations	Direct and participant observations on UAS field tests during Familiarisation course in Kemijärvi aerodrome

Table 6: The Sources of evidence of this case study (modified from Teräs (2008, 78).

One prominent collecting method for data was focus interviews. Later on, when participating in UAS Familiarisation course in East Lapland Vocational College on April 2011 it was accomplished focus interviews concerning certain specific issues with student colleagues and teachers of the course. The results of these focus interviews were used for publication [P5]. In this way, it was attempted to get both an objective view of events and the subjective interpretations of participants.

2.6.5 Step 5: Analyzing Evidence

The case study evidence of data analysis consists of examining, classifying, tabulating, testing, or other evidence connecting, to make research-based conclusions. Case study evidence analyze is difficult due the undefined techniques (Yin 2009, 127). Therefore a four general analyze strategies should follow in case study. Those strategies rely on theoretical propositions, developing a case description, dual using of quantitative and qualitative data, and examine rival explanations (Yin 2009, 126). However, challenge is how to produce high-quality analysis, which requires attention to all the collected data, displaying and presenting the evidence separate from all the interpretations and deliberate alternative interpretations (Yin 2009, 126).

The analysis of documents and other sources of evidence create a deeper understanding of the subject. Document analysis reinforces information that is collected in a different ways. Focus interviews during UAS Familiarization Course in East Lapland Vocational College in Kemijärvi gave detailed information on the subject. The use of triangulation to increase reliability is essential. The focus of the analysis in publications [P1] and [P3] was doing SWOT-analysis on a basis of the interviews. Publications' [P2] and [P4] concentrated in cooperating challenges on the use of UASs and analysis was based on identifying various authorities' opportunities and means. Data analysis of publication [P5] primarily converse on current legislation obstacles when using UAS.

2.6.6 Step 6: Sharing

Case study composition phase means conclusion of its results and findings. Yin (2009) advises to compose portions of the case study during the writing process rather than at the end of data analysis phase. Comparing case study to other research methods, case study has more potential audience. Yin (2009) advices researcher to define a target group, to prepare a written and visual material and to present sufficient evidence to the readers, so readers can form their own opinions. Thereafter Yin (2009) suggests going through material once more and rewrite it. (Yin, 2009, 164.) The survey results have to present to the appropriate target audiences according to Hevner et al. (2004), as well as business-oriented community and technically-oriented community. Thus can be verified the felicity of the research and share research results for further benefit. (Hevner et al. 2004, 90.)

Publications in time schedule are presented in Figure 5.

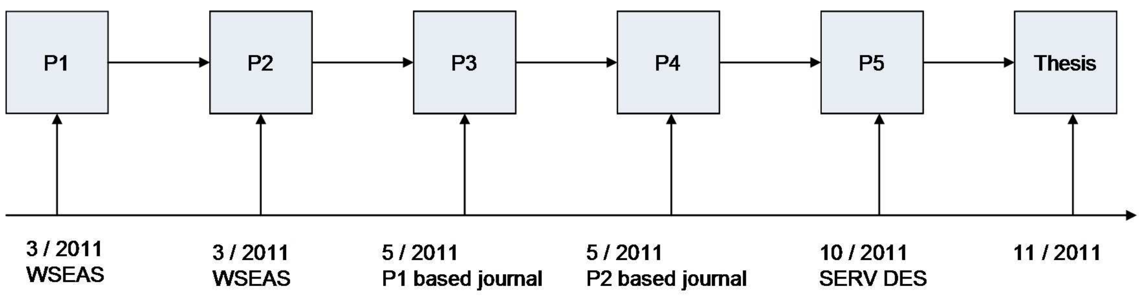


Figure 5: Research process time schedule.

Research findings in publications [P1] and [P2] are presented in international conference to academic audience and are also published. Publications [P3] and [P4] are published in international journals. During the studies findings are also presented to research colleagues.

Submitted publication [P5] is presented to lectures and co-students of Laurea University of Applied Sciences.

2.7 Choice of the Research Method

The selection of research method of the study should act research object and research question (Järvinen 2004, 3). In order to facilitate this Järvinen & Järvinen (2004) share the research extracts in two categories, according to research regarding the real world, or symbol systems. As an example of the symbol systems Järvinen & Järvinen (2004) designate the mathematical study extracts (Järvinen & Järvinen, 2004, 9). Real-world research on the extracts, either by what the real reality is, i.e. the way things are now, or research of usefulness of innovation, i.e. how things could be. Extracts from the real world of research can be divided into conceptual-theoretical statements and empirical statements, which is either testing existing theories or creating a new theory. Usefulness of the innovation can be examined as well as the implementation of innovation and its evaluation-assessment perspective. (Järvinen & Järvinen, 2004, 10.)

The mission of design science is to develop knowledge how to build and evaluate innovations and artifacts. The mission between design science research and design research is almost similar: it is construction and evaluation of technological artifacts to meet organizational needs as well as the development of their associated theories. By using last mile research can business value of artifact be estimate. Action research gives the answer to question how things are realized. When an artifact is placed in some environment, the significance of the expertise is emphasized. Expert knowledge of design science helps to implement appropriately designed artifacts and eliminate unwanted side effects. (Järvinen 2006.)

The information obtained by development process, can be integrated into case study. The case study describes the criteria, process and experiences learned in developing the system. Researchers who construct case study often participate in the development or implementation of the system they are researching (Nunamaker 1990, 92). Lukka states, the constructive research is one of the options currently available for a case researcher (Ojala & Hilmola 2003, 83).

In this thesis, it is used multiple methods; publications [P1], [P3] and [P5] are made by using case study research, and in publications [P2] and [P4] is used design research as a method to improve UAS's use in organisations.

3 Results

This chapter presents the research findings. In this study, triangulation of data sources is used to analyze the research findings. Results are based on the answers got from interviews, collected articles, literary material, international and national aviation regulations, and scientific publications. In a theoretical framework, scientific publications were investigated. The focus of the analysis in this study is obstacles in the current legislation using UAS in operative missions. Next table presents summary of publications.

Publication	Publication 1	Publication 2	Publication 3	Publication 4	Publication 5
Title of publication	How real time picture and situational awareness can be improved by using Unmanned Aircraft Systems (UAS)?	The strategic management challenges of developing Unmanned Aerial Vehicles in public safety organizations	How and why Unmanned Aircraft Vehicles can improve real-time awareness?	Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS)	Legislation Aspects of Service Design and Innovation Utilizing Remotely Piloted Aircrafts
Main index	Importance of expertise for improving situational awareness and real-time picture	Challenges of strategic management in public organizations	Improving real-time awareness, absence of aviation regulations, cooperation	UAS cooperation and networking between organizations	Service innovation designing, obstacles to produce services, UAS standardization
Method	Case Study	Design Science	Case Study	Design Science	Case Study
Authors	Tikanmäki I Tuohimaa T	Tuohimaa T Tikanmäki I	Tikanmäki I Tuohimaa T Rajamäki J	Tuohimaa T Tikanmäki I Rajamäki J	Tikanmäki I Rajamäki J
Main results	Network between authorities to achieve synergies, importance of author's professionalism	Service providers familiar with UAV, enhancement of cooperation, networking	Fragmented budgets of authorities, UAV's development and deployment costs, networking	Government collaboration development, efficient use of resources	Obstacles in current legislation, social general ignorance of RPA
Published	Mar 2011	Mar 2011	May 2011	May 2011	Oct 2011

Table 7: Publications' basic facts.

Finnish Defence and Aerospace Industries Association introduced Aviation Industry and Aviation Technology Program criteria to various operators and government representatives (Finnish Aviation Industry and Aviation Technology Program Criteria 2008). The surveys' key targets are co-development of the aviation cluster network, ensuring and development of aerial technical training and development of unmanned aerial systems and associated systems capacity-building (Finnish Aviation Industry and Aviation Technology Program Criteria 2010).

The vision and aim of the Finnish aerospace and aeronautical engineering professionals is to provide an ability to develop and maintain UAS systems, and process the ability to refine international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs (Finnish Aviation Industry and Aviation Technology Program 2010;Finnish Aviation Industry and Aviation Technology Program 2008.)

Unmanned aircrafts are currently used mainly for various military purposes. Civilian use of UAS's is restricted by the lack of legislation. Government operations and the civilian activities of the UAS could be used for many different purposes. UAS international aviation regulations concerning Visual Line-of-Sight (VLOS) in the use of Light Unmanned Aircraft Systems (LUAS) might be ready at 2012-2015. Total aviation regulations might be ready in 2020, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented.

3.1 Publication 1: How real time picture and situational awareness can be improved by using Unmanned Aircraft Systems (UAS)?

Publication [P1] was presented on 10th World Scientific and Engineering Academy and Society's (WSEAS) International Conference on communications, electrical & computer engineering in Spain on March 2011 and it was published by WSEAS Press.

Publication deals with the importance of expertise for improving situational awareness and real-time picture, as an example is Unmanned Aircraft Systems (UAS). Research process began by defining the topic and objectives as well as the theory of the experience. Research material was collected through interviews and by analyzing scientific publications, newspaper articles and video clips. Most of the scientific publications from the subject concentrate on the building, on the planning and on the technical properties of UAS. The unmanned model planes are used mainly for different military purposes at the moment. On the basis of this it was ensured that studying this issue in question, it should be among the first ones in Finland. In this publication the method is case study research in improving the situational awareness and real-time picture by using UASs in organizations.

The basis for this publication was to determine how situational awareness can be improved by using UAS. Study focused on UA Systems in general. Research showed how important the author's professionalism is for the research, especially when available scientific material is limited. The research showed the needs for UAS, but it also showed a social general ignorance of UAS use in civilian use. One fact to take account is that different actors develop their own systems and do not invest in the joint development of the system. UA systems' use should centralize to a single service provider, thus can achieve the best output-input ratio of the use of the system. As a result of above mentioned follows, that it is important to create a network between actors and thus to achieve synergies in the development and deployment of UA system.

3.2 Publication 2: The strategic management challenges of developing Unmanned Aerial Vehicles in public safety organizations

Publication [P2] was also presented on March 2011 at 10th World Scientific and Engineering Academy and Society's (WSEAS) International Conference on communications, electrical & computer engineering on Spain and it was published by WSEAS Press.

Publication addresses the challenges of strategic management in public organizations for improving situational awareness and a real-time picture. A significant strategic management tool for operational activities is situational awareness including creating a real-time picture. Unmanned aircraft system (UAS) is used as an example for improving situational awareness and creation of a real-time picture. Persons acting on the ground, their leaders and other decision-makers should be able to exploit a real time picture of the situation when making decisions. For example police, border control authorities, customs and fire departments need the situational real-time picture.

For decision-makers and their assistants, situational awareness means understanding about events, circumstances affecting these events, the objectives of various parties and possible options, which are needed to make decisions on a specific item or the complete operation. In society, the efficient use of resources is a sensible, economical and appropriate target. Strategy work requires a new perspective where actors must have the ability to see large complexes. Different entities interact with each other and strategic decisions require courage. Successful organizations create a successful strategy, implement it and are able to renew their strategies with the latest requirements.

Strategic management problems and, above all, obstacles to the realization of the strategy in public administration are; 1) the strategies do not appear in everyday life, and don't spread to the organization, 2) lack of vision and ideas, 3) strategy process is not linked to annual operational and financial planning and monitoring, 4) management systems and management culture is not supported by sufficient support implementation of the strategy, but rather the daily reactive management, 5) the absence of strategy elements, such as personnel, communications, information management, service quality that are linked to a common strategy, 6) staff involvement in the strategy process is the exception rather than the rule, and 7) implementation of the strategy is not monitored or revised systematically.

The main focus of the strategy will be in the future and that is the most important and the key issue to look for and find. Strategic thinking requires the ability to think through a variety of concepts, but the final strategy is very practical and applicable. A good strategy will ensure that the right things are done and making a variety of functions to make sure that things are done correctly. It can be said that the strategy is eternal and that it is under control. Finding the truth is the beginning of wisdom to the strategies. The importance of cooperation is emphasized when using UASs. A number of various actors, as several different sectors under the Ministry of Interior, such as police, rescue, customs and border control authorities, need services.

The service provider must be familiar with the needs of players and be able to respond to the demand in an appropriate way. Product choice, due to the different needs of actors, must therefore deserve special attention. Enhancement of cooperation to ensure a comprehensive real-time situation picture, and remove obstacles to cooperation, is essential. This is based on a broad cooperation with the traditional security authorities, other public authorities, businesses and civil society organizations to attain the same goals. Joint research, education and training activities related to authorities' communications, and partnership between the public authorities, ensures management, situational awareness, and compatibility of communications systems, and the potential integration, contribute to that target. Therefore, it is very important to create a network, and thus to obtain synergies large-scale deployment of UAS.

3.3 Publication 3: How and why Unmanned Aircraft Vehicles can improve real-time awareness?

Publication [P3] is an extended version of publication [P1] and it was published on International Journal of Circuits, Systems and Signal Processing Issue 5, Volume 5, 2011. Publication focuses on improving real-time awareness by using UAS. UASs have been used for a long time to improve situational awareness for many parties. During last 30 years UAV's role has received more attention and interest in global perspective. Many reasons explain how and why this has occurred. This publication highlights why this matter is important and considerable. When discussing about situational awareness and real time picture, we should remember that many parties need this knowledge when working. Especially decision makers and their assistants need knowledge about happenings in the field. For that reason, it is noteworthy to focus on one of the most important way how to accelerate making of situational awareness and real-time picture. UAS is one of the components how to do it and why it is needed.

Results of this publication base on interviewees' answers and collected articles among other data. It is clear, according to this publication, that civilian use of UAS is restricted by the lack of aerial legislation. Scheduled tasks with UAS both governmental as well as scientific research work and civilian use can be implemented after aviation regulations are ready. SWOT – analysis of this publication shows main points of strengths, weaknesses, opportunities and threats of the implementation of UAS. A publication also shows how important cooperation between authorities is; interoperable services for fire and rescue, police, customs and border control authorities in use of UAS is essential. On the other hand, service providers should be familiar with the different actors' needs in order to meet the demands in the right way.

Public safety authorities, with their own budgets, are fragmented into several operators, which limit implementing of UAVs. Authorities' point of view is, UAVs are too expensive for one organization's own use, and they suggest that UAVs should be concentrated to larger user groups to maximize the benefit of the devices. The challenges as economic point are development, and deployment costs. A variety of tools and equipment are renewing on the market constantly, and their management is challenging. Anyhow, in previous years, some purchase and development work have been tried. Today, the financial situation prevents to invest in this kind of large development projects. Consequently, it is pertinent by networking obtain synergies to development of UAS.

3.4 Publication 4: Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS)

Publication [P4] is extended version of publication [P2] and it was published in International Journal of Systems Applications, Engineering and Development, Issue 5, Volume 5, 2011.

This publication deals with the importance of networking and co-operating between authorities and their duties. As an example is unmanned aircraft system (UAS) utilization for improving and speeding up a situational awareness and a real-time picture. Networking is emphasized between cooperation with national authorities, because the players are under the supervision of different ministries. Inter-ministerial co-operation is already in a good shape in Finland, but given the relevant persons in the mutual interaction may be scarce. In this point of view, the challenge for UAS's use include ministries fragmented budgets, a lack of common practices of the new system of exploitation and the lack of cultural activities.

It has revealed a need for networking between the authorities in cooperation of implementation of UAS. Different levels of networking means to cooperation between organizations: 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. The importance of cooperation between authorities has discovered an important subject to develop. The Finnish Government's Security and Defence Policy states that close cooperation between the authorities achieves synergies by cutting overlap and support functions thus enabling an efficient use of resources.

Situational awareness and government collaboration will be developed both nationally and internationally. Efficient use of resources in society is a sensible, economical and appropriate. Therefore, in UAS development activities, must participate many counter parties (Police, Fire and Rescue Services, Border Guard, Customs, etc.). Strategy work requires a new perspective and you must be able to see large complexes. Different entities interact with each others and strategic decisions require courage. Successful organizations create a successful strategy, implement it and are able to renew strategies with the latest requirements.

3.5 Publication 5: Legislation Aspects of Service Design and Innovation Utilizing Remotely Piloted Aircrafts

Publication [P5] is submitted to Service Design and Innovation (ServDes 2012) Conference for evaluation on October 2011. ServDes 2012 conference theme on 2012 is 'Co-creating Services' and Publication [P5] converse on legislation aspects of Remotely Piloted Aircrafts (RPA) and objectives to make a service innovation with RPA Systems.

The purpose of this study was to find out what kind of new service innovations can be designed by utilizing Unmanned Aircraft Systems (UAS). This case study provides an improved understanding of the current obstacles to producing these services. Especially, the legal issues of using UAS in public and private organizations are examined. The biggest challenge for operationally use of Unmanned Aircraft Vehicles (UAVs) is that legislation does not know well enough UAVs as an aircraft. Training and other requirements are not specified for UAS-operation as well of the operator and the actual flyer. UAV's development is waiting for standardization.

The aim of this research was to analyze and assemble summary about this issue by using different kind of data. From the research perspective, there are needs for UAS but also social general ignorance how UAS 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 market has a huge economic promise for different UAS classes. By other means it can not be achieved the same benefits as using the UAS system, so the societal benefits are particularly high. UAS would be able to significantly increase the number of the biggest priorities of safety, security and environmental issues.

This study started with questions; how services can be produced by using Remotely Piloted Aircrafts / Unmanned Aerial Vehicles? What obstacles there might be in legislation point of view? There was a desire to explore if and how, by using UAS, it is possible. This research was limited to civilian use of UAS where are restrictions because of absence of current legislation. The focus of the analysis was obstacles in the current legislation using UAS. National Aviation Acts differ widely from each other; hence focus is on in the preparation for the international aviation laws. In this study, it was clear that UAS can be used for many different kinds of purposes, both for public and private use. The need for UAS services is obvious but most importantly, the study showed also social general ignorance how UASs can exploit in civilian use.

3.6 UAS Use Cases

Numerous of organizations can utilize the needs of UAS. Users can include border control authorities, customs, civil protection, and energy companies, who need to carry real-time situation picture. UAS's use may be locating small vessels for both the Border Control and Customs needs, for example, illegal immigrants locating in the marine area. In Search and rescue missions UAS can be used in fire situations, to locate fire target, where can not be sent fire personnel and researching the earthquake in the area of damage and locating the victims. Police and rescue missions such as hostage situations, shootings and bomb threat cases UAS's use may be in the monitoring of the situation assessment and thus enable decision-making easier. Energy companies' pipe-line condition monitoring for predictive maintenance and repair permit may be one of the UAS's application.

With UAVs it's possible for government agencies and business companies to increase efficiency, save money, improve security, and even save lives. Interest is growing a wide variety of uses, from aerial photographs, to surveying the land and the plants, the forest fire monitoring, and environmental conditions, to protecting borders and ports from intruders (RTCA 2010). Table 8 presents potential use cases for non-military UAS applications.

Custom Authorities	**Police Authorities**
Coastal Patrol	Information gathering (in buildings)
On-shore border patrol	Special operations, anti-terrorist
EU maritime surveillance	Urban law enforcement
EU on-shore border patrol	Pre-intervention info gathering
	Urban riot control
Civil Security & National Police	Perimeter defence
Contamination management	Hostile protest control
Systematic search operations	Criminal investigation (several days)
Natural disaster monitoring	Surveillance of public gathering
Emergency medical/food supply	Surveillance of public gathering
	Road traffic surveillance
Regional Fire Brigade	Delivery of non-lethal disabling means
Forest Fire Surveillance	Coastal border immigration control
	Ship lane surveillance
National Fire Brigade	Permanent police surveillance
Forest fire surveillance	Land border immigration control
Natural disaster monitoring	Maritime immigration control
	EU land border immigration control
Environmental	**Contractor Supplied Flight Services**
Local science missions	Training
Atmospheric measurements	Terrain mapping
Wild game surveillance	Aerial photography
Fishery control	Monument inspection
Ozone measurements	Network communication relay
Weather assessment	Emergency communication network
Crop monitoring Sandbank shift measurement	**EU Civil Security**
	Maritime surveillance
Civil Security	
Avalanche survivor search	
Coastal water surveillance	
Maritime search & rescue	

Table 8: Potential governmental use cases for non-military UAS applications (modified from van Blyenburgh 2008).

UAS could be used of improving and completing situational awareness, for instance by fire and rescue forces' and police leadership in supervision vehicles. The system can be integrated with existing management vehicles, when the system becomes an integral part of situation and field management systems (Tikanmäki & Tuohimaa 2011). UAS's more efficient use of creating and speeding up the real time picture fastens decision making and provides operating management tool to take appropriate measures such as real-time video and image based still camera. For example, in a large building fire situation, we can control the UAV over the fire and basis by a live-picture, to determine whether the roof is safe for fire personnel to moving through the fire location.

Non-military UAS applications are divided into following 5 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'. As Table 9 shows, numerous of applications can be operated by using UAS.

	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
VLOS = Visual Line-of-Sight BLOS = Beyond Line-of-Sight						

Table 9: Current UAS Applications and Quantity in EU (European Commission 2011).

Security related applications have neither uniform rules nor regulations and all those missions in European Union (EU) are experimental. However, some routine missions in Canada and United States are carried out. Safety related UAS applications are routine missions in EU, merely in UK and all such missions outside the EU are experimental. Scientific and Research related application missions are mostly done with UAS maximum take-off mass (MTOM) < 150 kgs and with Visual Line-of-Sight (VLOS). VLOS rules and regulations are varying country to country. After all there is a balance between missions inside and outside of EU. Scientific and Research related missions are currently most common in UAS applications. Almost all missions in this category are executed with < 150 kgs UASs and VLOS conditions and below 150 meters above ground level with electric powered UASs. These missions are not legally possible current in United States. Civil/military cooperation concentrates use of > 150 kgs UAS and no uniform rules and regulations for those flights exist.

Estimate of the forecasted market has done by comparing several sources' results and conclusions. Summary of the projected applications in EU is presented in following Table 10.

	MTOM < 150 kgs			MTOM > 150 kgs		
	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

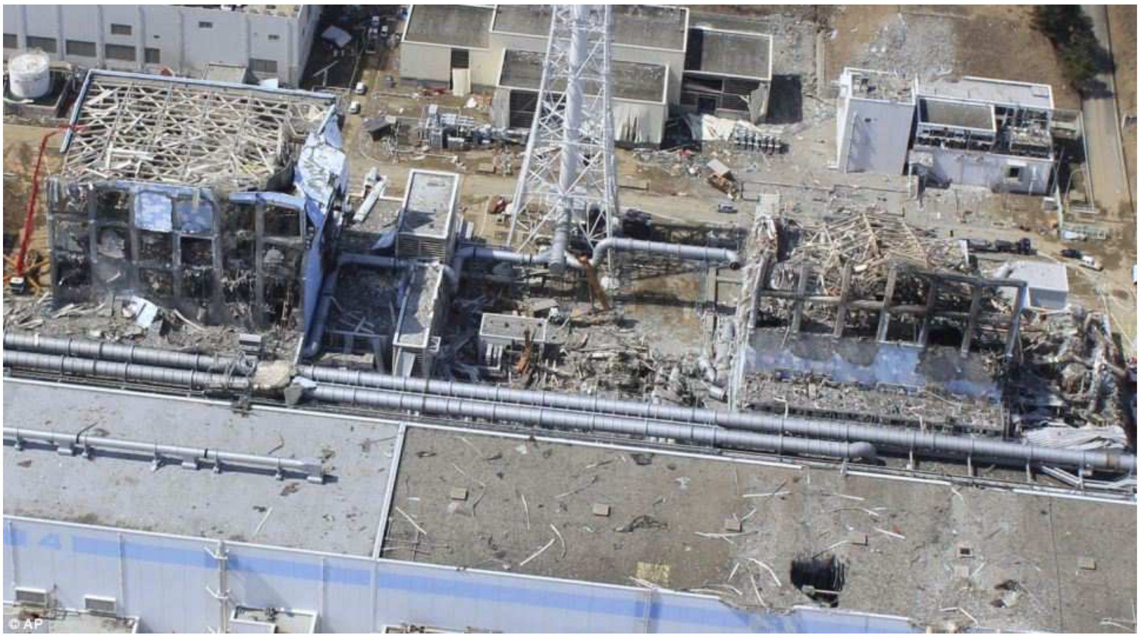
Table 10: Overview of projected UAS applications in EU (European Commission 2011).

Potential UAS applications base on the assumption that the regulatory problems are solved. Multiple applications in security related -category are for UAS < 150 kgs both for VLOS and Beyond Line-of-Sight (BLOS) conditions. Prominent number of applications is for BLOS conditions and UASs > 150 kgs. Likewise security related applications also safety related ones are many for < 150 kgs UASs, both VLOS and BLOS conditions. For > 150 kgs UASs significant applications are principally for BLOS conditions, however VLOS missions stay in high demand. Scientific & Research related applications stay with < 150 kgs and BLOS & VLOS conditions. UAS < 150 kgs in category of contractor supplied services stay in high demand and increases with BLOS missions. In mutualisation use of UAS in future < 150 kgs with BLOS capabilities is a growing number of applications. (European Commission 2011.)

Recently, in spring 2011 UAVs were used in Fukushima successfully to identify the damages. Pictures taken from Fukushima Nuclear Plants after the disaster from satellites or from airplanes have been, one way or another, grainy. UAV can fly near the target because there is no harm for people inside the vehicle. Next figures show how disasters such as the nuclear power plant accident, can be safely observed and monitored and target rescue authorities to the right place without endangering human lives. So far, Fukushima images were grainy, and they have been taken from a safe distance because of security reasons. Following images taken from UAV, offer the first high-quality pictures of the place (Associated Newspaper Ltd 2011).

Picture 1: Full Fukushima site, UAV shots offer high-resolution images of the site (Associated Newspaper Ltd, 2011).

Picture 2: Directly above the site taken photo on 20th of March, radioactive steam whirls from Unit 3 (Associated Newspaper Ltd, 2011).



Picture 3: An aerial view taken on March 24, Units 4 and 3 of the plant (Associated Newspaper Ltd, 2011).

On the basis of the above mentioned data, it is clear that the market has a huge economic promise for all UAS MTOM classes. By other means it can not be achieved the same benefits as using the UAS System, so the societal benefits are particularly high. UAS would be able to 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 could have significant spin-off potential. The significant use of new air services' increase can be expected to be available in the near future. UAS joint use, both civilian and military, is a key condition for non-military government applications.

3.7 SWOT Analysis

The main characteristics according to informants' answers concerning strengths, weaknesses, opportunities and threats, i.e. it illustrates SWOT-analysis of using UAS in improving real-time picture are summarized in publication [P1]. Following table 11 presents European Commissions workshop's SWOT analysis of UAS's present situation in Europe.

Strengths of Europe	Weaknesses of Europe
European civil aeronautics established as a world leader	Lack of coherent, well-funded, central procurement authority for governmental applications
Aviation industry prepared to reinvest returns in R&D	US budgets lead to domination of market share
Military UAS capability can act as early adopter	Availability of off-the-shelf products from US and Israel
Mutualisation being seriously considered	Commercial presence of Israeli players
Establishment of STANAG 4671 for military UAS	No common, harmonized legislation to enable UAS insertion into non-segregated airspace
Establishment of EASA responsibility for UAS <150 kg	UAS standards and Certification criteria are not established at the European level
JARUS been established and contributing European level harmonization of rules and regulations	Initiatives to promote non-military applications have been ad-hoc and uncoordinated
UAS operations taking place under special arrangements	Key technologies for traffic insertion still maturing i.e. sense and avoid LOS and BLOS equipment, health management and autonomy
Non-military BLOS (scientific) operations taking place in Norway under special conditions granted by CAA	Rules for segregated UAS operations vary between nations
Wide industry base including a large number of SME's involved with UAS systems and subsystems	Lack of agreed RF communications and sensor spectrum
	No European-level agreement on training and licensing of UAS crews
	No federation of European universities involved with aviation
	No coordinating of regional UAS-related initiatives on European level
	No European centre of excellence
Opportunities for Europe	**Threats to Europe**
Civil market offers opportunities in very short term and the future	American investment in UAS development and political drive to regulate and enable commercial application of UAS
Europe is very conscience of environmental issues, UAS have wide application possibilities	Israel industrial drive towards civil certification
Europe can position the industrial base to set standards for the rest of the world	Emergence of new entrants in the field of design, development and production (BRIC countries, Asia, Middle East)
Early access to non-segregated airspace enables Europe to exploit the global markets	US (FAA) will drive agenda for setting of standards and shape international regulatory framework
Emerging technologies hold promise for exploitation across aviation and other sectors	Fragmentation of European market for UAS through diverse and uncoordinated national rule-sets
UAS have potential to be more cost-effective than manned solutions	Loss of aeronautical engineering competence

UAS are capable to missions that would not be possible with manned aircraft	
UAS can be more effective than manned platforms in dull, dirty and dangerous tasks	
Dual-use technologies have emerged and are already exploited	
Exploitation of military UAS operational experience	
Mutualisation of UAS assets offers potential for non-military government and European organizations	
Non-military UAS applications can create a new flight services industry	

Table 11: SWOT analysis of UAS issues in Europe (modified from European Commission 2011).

European Commission organised workshop on July 2011 aiming to prepare a strategy for Unmanned Aircraft Systems in the European Union. Workshop was dedicated to UAS industry and market and discussion concentrated to economic, technological and social benefits. Workshop started to identify the main obstacles to the developing of civil applications of the various types of UAS.

3.8 Legal Issues: Privacy perspective

This chapter treats on issues that are related to citizens' legal rights also when using UAS for monitoring and surveillance. Following sections present legal issues from privacy perspective to consider operative use of UAS in Finland. An important issue of developing UAS and systems use is to clear out if a special legislation must be observed from privacy perspective, before UAS may become in operative use compendiously. Following aspects of law are unofficially translated from original Finnish Code and therefore are not legally binding.

Finnish Criminal Code Section 3 describes i*nvasion of public premises* (585/2005) as follows:

> “A person who unlawfully by force, stealth or deception, enters a public office, business premises, office, production installation, meeting place, other similar premises or another similar building, or the fenced yard of such a building, a barracks area or another area in the use of the armed forces or frontier guard, where movement is restricted by the decision of the competent authority, or hides or stays in premises referred to in paragraph shall be sentenced for invasion of public premises to a fine or to imprisonment for at most six months”. (Finnish Ministry of Justice 1889.) However, “an act that has caused only a minor disturbance does not constitute an invasion of public premises”.

Section 5 of Finnish Criminal Code (531/2000) treats *eavesdropping* in the following way:

> "A person who unlawfully listens to or records with a technical device a discussion, talk or other sounds of private life, where these are not intended for his or her knowledge, and which occur or arise in domestic premises or in secret in other than in domestic premises, talk that is not intended to his or her knowledge or to the knowledge of third parties in general, where the circumstances are such that the speaker has no reason to believe that a third party is listening shall be sentenced for *eavesdropping* to a fine or to imprisonment for at most one year. An attempt is punishable". (Finnish Ministry of Justice 1889.)

Illicit observation (531/2000) in the same code's section 6 is described this way:

> "A person who unlawfully watches or monitors with a technical device a person in domestic premises, a toilet, a dressing room or another comparable place, or a person in a building, apartment or fenced yard that is closed to the public as referred to in section 3, where this violates the person's privacy, shall be sentenced for illicit observation to a fine or to imprisonment for at most one year. An attempt is punishable". (Finnish Ministry of Justice 1889.)

Preparation of eavesdropping and illicit observation, (531/2000) section 7, has the same order of magnitude for sanction as earlier mentioned illegal observation and eavesdropping:

> "A person who sets up a technical device referred to in section 5 or 6 for use in eavesdropping or illicit observation shall be sentenced for preparation of eavesdropping or preparation of illicit observation to a fine or to imprisonment for at most six months". (Finnish Ministry of Justice 1889.)

Domestic premises according to Finnish Criminal Code Section 11 (531/2000) are defined as follows:

> "Domestic premises refer to homes, holiday homes and other premises intended for residential use, such as hotel rooms, tents, mobile homes and vessels with sleeping capacity, as well as the stairwells and corridors of residential buildings and the private yards of the residents and their immediate outbuildings". (Finnish Ministry of Justice 1889.)

Police action is defined in Chapter 3 Section 28: Provisions on gathering information (493/1995; amendments up to 560/2007 included). *Definitions* (525/2005) for police act are:

For the purposes of this Act:

1) "*technical monitoring* means the continuous or repeated viewing of or listening to members of the public, vehicle drivers, pedestrians or vehicles with the help of technical devices, or the automatic recording of voices or images";

2) "*surveillance* means the continuous or repeated gathering of information on certain persons or their activities";

3) "*technical surveillance* means the continuous or repeated listening to certain persons with the help of technical devices and the recording of voices (*interception*), viewing and photographing or videotaping (*technical observation*), and the tracking of the movements of vehicles and goods (*technical tracking*)".

Section 29 defines *Preconditions for technical monitoring* in the following way:

"After giving prior notification, the police have the right to carry out technical monitoring in a public place or on a public road in order to maintain public order and security prevent offences, identify a person suspected of an offence and guard special targets to be monitored".

In Section 30 are terms for *Preconditions for surveillance*:

(1) "Police officers have the right to keep persons under surveillance in places other than a residence in order to prevent or intervene in the commission of an offence if the person's behaviour or other circumstances give cause to suspect that he or she would commit an offence".

(2) "For a purpose referred to in subsection 1, surveillance can also apply to persons outside domestic premises who may reasonably be suspected of contributing to an offence for which the maximum punishment provided is more severe than six months' imprisonment".

Section 30a converse on *Surveillance by government officials of foreign States* (525/2005):

(1) "A competent government official of a State applying the Schengen acquits referred to in Article 41 of the Schengen Convention has the right, as provided in the Schengen acquit binding on Finland, to continue the surveillance or technical surveillance of a person in the territory of Finland for the purpose of investigating an offence if the surveillance or technical surveillance started in the territory of his or her own country". An additional requirement is that "a Finnish police officer, or within his or her competence, a Finnish border guardsman or a Finnish customs officer, is not able to immediately continue the surveillance or technical surveillance in the territory of Finland".

(2) "The surveillance may be carried out using the technical means that a Finnish police officer has the right to use under the provisions on technical surveillance. A report on the surveillance and technical surveillance shall be submitted to the District Police of the municipality in which most of the activities took place".

Section 31 in turns handles *Preconditions for technical surveillance* (21/2001):

(1) "Police officers have the right to keep a person, vehicle or goods under technical surveillance in places other than a room or space used for permanent living if there is good reason to assume that the information necessary to prevent an offence can be obtained with such a measure". Under the same preconditions, "persons serving a sentence in prison or confined to an institution for preventive detention or held in pre-trial detention can be kept under technical surveillance while they are in their cell or in other premises of an institution used by inmates".

(2) "If technical surveillance so requires, a device used in technical surveillance may be placed in premises where technical surveillance is allowed under subsection 1. On the order of a commanding police officer, a police officer may access the premises in question in order to install and remove the device. If the device consumes energy produced by a vehicle or the premises in which it is placed, compensation shall be given for consumption which is higher than a minimal level".

(3) Another precondition for interception is that "the person's behaviour or other circumstances give reasonable cause to suspect that he or she could commit an offence for which the maximum punishment is at least four years' imprisonment, or a narcotics offence, or become guilty of preparing an offence to be committed with terrorist intent", as referred to in Chapter 34a, section 2 of the Criminal Code. Similarly, "a precondition for technical observation and technical tracking is that the person's behaviour or other circumstances give reasonable cause to suspect that he or she could commit an offence for which the maximum punishment is more than six months' imprisonment, or contribute to such an offence". However, "a person in the custody of the Finnish Prison Service, referred to in subsection 1, may only be kept under technical observation if the person's behaviour or other circumstances give reasonable cause to suspect that he or she could commit an offence for which the maximum punishment is at least four years' imprisonment or a narcotics offence, or become guilty of preparing an offence to be committed with terrorist intent", as referred to in Chapter 34a, section 2 of the Criminal Code. (525/2005)

(4) Police officers also have the right "to keep persons staying in a place of residence under technical surveillance, if this is essential to carry out police measures safely and to

> prevent the lives or health of the persons carrying out the measures, the persons to be apprehended or the persons protected from being put in immediate danger". (525/2005)

The above presented sections of a Finnish law point out the fact that when conceiving the use of UAS in operations, operator have to know precisely justification for UAS actions.

3.9 Legal Issues: Aerial Legislation

The biggest challenge for operationally use of UAV's is that legislation does not know well enough UAV's as an aircraft. Training and other requirements are not specified for UAS-operation as well of the operator and the actual equipment. Especially large UAVs development is waiting for standardization. As one informant in publication [P3] aptly impressed:

> *"Legislation lives in the past, in a time when an airplane was always manned."*

As main obstacles for Light (small) UAS (25 - 150 kg) are the applicable of national certification standards and rules. In Norway and UK, basic standards and rules exist; Czech Republic, the Netherlands and France have nearly ready rules, which are, however, not harmonized in European level. Sense and Avoid relative, especially for Small UAS, funded research is not ongoing or upcoming at the moment. (European Commission 2011.)

International Civil Aviation Organization (ICAO 2006) has defined in Chicago Convention in Article 8 a pilotless aircraft flight at airspace as follows: "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".

Unmanned Aircraft Systems Study Group (UASSG) stated in their First 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" (ICAO 2009).

Currently, most military UAV operations in Europe are restricted to run only in the reserved airspace for the use of UAV that is separate from other air traffic, or UAV's are flying above the sea, using the special arrangements. If action takes place outside the segregated airspace there will be various constraints in order to protect the other aircrafts' safety using the same airspace. (EUROCONTROL 2007.) For UK industry was launched 'The Light Unmanned Aircraft System Scheme (LUASS) in 2008. LUASS consist of an inspection, assessment, design and operational approval of Light UAS (maximum take-off mass < 150 kg) in order to operate in UK. (EuroUSC 2010, 3.)

In order to take full advantage of current and future UAV platforms' unique features and implement, a training program have to perform the safe operation of UAVs. Military authorities in Europe insist that the UAVs can be used with all classes of airspace, and they must be allowed to operate across national borders. The above requires UAV's use outside of segregated airspace. Pan-European rules for military UAVs outside the segregated airspace do not exist. Furthermore, those regulations that exist at national level are not conducive to routine operations.

In addition, in the light of an enthusiastic and obvious interest in, and a lack of anything similar in the rest of the world, non-European countries could decide to accept the specifications. Specifications may also provide a basis for future ATM for civil UAVs. Other aspects outside the jurisdiction of Eurocontrol such as airworthiness, certification, system safety, training and licensing of personnel, etc. must be dealt with the appropriate bodies.

In the point of view of technology's economic estimate, even if some R & D funding occurs, most of the industrial R & D expenses will direct to UAV operators. Sense and avoid is likely to be highly significant cost factor. Progressing Technology extends to all the parts of the UAV 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. (EUROCONTROL 2007.)

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; he is required adequate training so that he can interact with ATC and other airspace users. For example, for an IFR flight, this requires an instrument flight rating. Training costs would be lower than manned aircraft pilot is required, but more than the basic requirements for UAV operators. As the specifications require that the air traffic services provided to UAVs should be equal to manned aircraft, only controllers would need additional training, primarily in emergency situations, which are unique to UAVs.

Air traffic ccontrollers 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 Air Traffic Management (ATM) integration of UAS operations, UAS need to respond to and communicate with Air Traffic Control (ATC), to navigate and to monitor air space and air to operate, to sense and avoid collisions, and 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 in operator's documentation has to include manuals and charts. Pilot in charge has to be a licensed pilot. (ICAO 2009.)

Definition for 'non-segregated' airspace according to Eurocontrol is: "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". Eurocontrol defines 'segregated' airspace as "Airspace that is segregated for exclusive use and into which other traffic is not permitted". (Eurocontrol 2007, 26.)

ICAO's ongoing UAS-related tasks are to analyze the issues of existing 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 Standard and Recommended Practice (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. (ICAO 2009.)

Study Group's development concepts in terminology are; RPA + Remote-controlled Pilot Station + Command and Control links (C2) form the RPAS. According to ICAO (2010b) RPAS evolved concepts are:

- RPAS is a part of UAS
- RPA requires a registration and Certification of Airworthless (CofA)
- CofA considers the whole system
- State of RPA design includes a remote pilot station type certificate data sheets
- Remote pilot station's state monitoring is essential

- Defining Quality of Service (QoS) and Required Communications Performance (RPC) for Command and Control links
- UAS operator's certificate details must be accurate.

Remote pilot's licensing is one of the pending issues according to ICAO; 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 remote piloted station. Remote pilot in any case requires new arrangements. (ICAO 2010b.) Chicago Convention Article 32 determines Licenses of personnel; Convention incorporates 'pilot' and 'other members of the operating crew' but not remote pilot (ICAO 2006).

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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 (CAA 2010).

4 Discussion

The starting point of this research was to find out how real time picture and situational awareness can be improved. The research started by a desire to explore is it possible and how it can be done by using UAS. This research was limited to civilian use of UAS's, which is restricted by the absence of legal framework. Government activities and the civilian side of the UAS could be used for many different purposes of actions. The aim of this research was to analyze and assemble a clear summary about this issue by using different kind of data. The study succeeded to clarify the implications for different organizations when UAS is used in the future.

Several sources in research revealed growing needs for UAS. The findings of this study showed how important it is to continue the research of UAS. Research objectives were successfully and the research questions were received answers. From the research can be seen the needs for UAS and also social general ignorance how UAS can be exploit in civilian use. The theoretical part focused on theory building of case study and design science research and how to exploit it in this thesis.

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UASs is restricted by the lack of legislation. Government activities and the civilian utilization of the UAS could be used for many different purposes. UAS international aviation regulations concerning Visual Line-of-Sight (VLOS) in the use of Light Unmanned Aerial Systems (LUAS) might be ready 2012-2015. Total aviation regulations might be ready in 2020, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented (Finnish Aviation Industry and Aviation Technology Program (ILO) Criteria 2010, 6-8). An exception is the United Kingdom, which has prepared the provisions of unmanned aircraft for the purpose. Military aviation authorities have national regulations for the use of UAV's, including Finland. (Finnish Aviation Industry and Aviation Technology Program (ILO) Criteria 2008, 11-12.)

As mentioned, the scientific publications from this subject concentrate on the building, planning and technical properties of UAS (Austin, 2010, Finn & Scheding, 2010, Mueller et al, 2006). The unmanned model planes are used mainly for different military purposes at the moment. Due to the character of the use, it is difficult to get public written source material. From this point, it was ensured that a specific research aim has been a relatively new one. Therefore, it is used a case study approach, which is generally recommended as a suitable research design for theory-building (Yin, 2009; Eisenhardt, 1989). Design knowledge is to be applied by people who have received formal education in that field (Van Aken 2004, 225). It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge (Orlikowski & Baroudi 1991, 24).

As noted in the literature review, research focused on aerial legislation and privacy perspective that can affect the use of UAS. It was noticed that there is not ready special legislation concerning the use of UAS in this issue.

With UAVs it's possible for government agencies and business companies to increase efficiency, save money, improve security, and even save lives. Interest is growing a wide variety of uses, from aerial photographs, to surveying the land and the plants, the forest fire monitoring, and environmental conditions, to protecting borders and ports from intruders. 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 (Porter & Stern 2001, 2).

Cooperation between authorities has become essential when considering the use of UAS because interoperable services are widely needed. Customs, border control, police and fire and rescue services may select a common product in order to implement their needs in using UAS services. Public safety UAS operations must comply with following minimum criteria: 1) economy, 2) ease of use, 3) credibility, 4) real-time documentation and the real-time picture creation, 5) speed, and 6) reliability. Equipment should be concentrated to a large user groups to maximize the benefit of the UAS's. Therefore, a special attention should give the selection of this kind of product with a wide variety of different operational needs.

According to Ståhle & Laento (2000), network-like organizational action creates the necessary flexibility and speed, as well as the opportunity for continuous data integration, a new creation, and foster innovation (Ståhle & Laento 2000, 21). The network consists of invisible relations and it is the stronger, the more it has bilateral linkages. Network relationships are vital because they act as channels of information; without the relationship information does not pass, accumulate and hence become rich. At the same time, improvement in progress doesn't happen. All change, development, growth and innovation are based solely and exclusively to the rapid outflow of information and enrichment. (Ståhle & Laento 2000, 121.)

One main characteristic of the network is that information spreads rapidly because of the impact of global relationships, and linkages are already in place. Information exchange and the quantity and spontaneity keep the network alive (Ståhle & Laento 2000, 121). As Ojasalo (2004) states Key Network Management (KNM) is a systematic way to manage key networks. Key network is according to Ojasalo: "a set of actors mobilized by the focal company to realize an opportunity". In case of UAS use for several authorities for their needs it is necessary to designate the focal company which takes control of managing the UAS.

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. For example, police, securing international meeting does not need to acquire tanks or airplanes. Police may ask for official assistance from Defence Forces when in need of special equipment or expertise. When something happens, it is decided the responsible party who is responsible for operations, but which receives support from other public authorities.

Networking is very important for the use of the development of UAS in a small country like Finland with limited resources. One player is unable to cope on their own for systems implementation and use of it. Funding for such a large system of the whole does not succeed in a one public organization measures. That is why it is vitally important to create network, and thereby obtain synergies from a wide-scale deployment of the UAS. The importance of networks and networking in the world today can not be overstated. A smooth and seamless cooperation between different spheres of government contributes UAS's implementation for public needs for improving and speeding up situational awareness and creation of real-time picture.

In order to take full advantage of current and future UAV platforms' unique features and implement the necessary training program to perform the safe operation of UAVs, the military authorities in Europe insist that the UAVs can be used with all classes of airspace, and they must be allowed to operate across national borders. The above requires UAV's use outside of segregated airspace. Pan-European rules for military UAVs outside the segregated airspace do not exist. Furthermore, those regulations that exist at the national level are not conducive to routine operations. (EUROCONTROL 2007.)

Integration of UAS is a challenge but also an opportunity for the growth of the aviation system. ICAO states that a need shows up for UAS operations to non-segregated airspace in order to optimize airspace. ICAO has already announced 'Unmanned Aircraft Systems' Circular in ICAONET on October 2010. Next step in integrating UAS to non-segregated airspace is to develop manuals and SARPs/PANS for UAS's. (ICAO 2010a.) In addition, in the light of an enthusiastic and obvious interest in, and a lack of anything similar in the rest of the world, non-European countries could decide to accept specifications. Specifications may also provide a basis for future ATM for civil UAVs. Other aspects outside the jurisdiction of Eurocontrol such as airworthiness, certification, system safety, training and licensing of personnel, etc. must be dealt with the appropriate bodies. (EUROCONTROL 2007.)

In the point of view of technology's economic estimate, even if some R & D funding exists, most of the industrial R & D expenses will direct to UAV operators. Sense and avoid being likely to be the highly significant cost factor. Progressing Technology extends to all the parts of the UAV 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.

> *"UAV's have potential but must prove to be cost effective compared to manned flights. UAVs need to proof usefulness (legal) and cost-effectiveness".*

UAVs have potential in maritime surveillance, long range and long endurance. (FRONTEX 2010.)

Development projects are scattered throughout the different authorities, and development work carried out, each on their own. All the authorities have similar problems. Common terminology and concepts are missing, both nationally and internationally, as well as practices that co-operation models vary greatly between countries. The challenges for the situational picture are according to TEKES (2009); identification of action and needs, different users, machine and human interaction, distribution of information, safety requirements, reliability requirements, complex systems, lots of information, support for decision making and integration requirements. Research is only part of the answer to the challenges outlined above. Development requires international cooperation (EU, UN, NATO, the Nordic countries, Baltic countries). Real-time requirements are growing. Development will require international cooperation, and situational awareness is a wide-ranging. Situational picture is formed by the sensor data through data fusion, and the research area is fragmented in Finland (TEKES 2009).

The annual production volumes are limited, so traditional business models, where the return is based on the sold products and systems are not attractive and barely companies invest much in product development. As the ICT concept for domestic needs alone is expensive, access to international markets is of paramount importance. Finland is an ideal place to develop solutions, because Finland has traditionally had good co-operation between different authorities. Safety authorities and the private sector, security sector actors, are also developed. This is a demanding entity, which must take into account operational and ergonomic aspects of reference and boundary conditions of different actors.

By grouping together the technologies and solutions enables the standardization of the compatibility and sharing of paternity between the various actors and creates a critical mass and long-term approach to arouse interest in the industry. Technologies must be multi-functional, for example, to use of the security sector, commercial sector and other appropriate authorities (TEKES 2009). UAS could be used of improving and completing situational awareness, e.g. by fire and rescue forces' and police leadership in supervision vehicles. The system can be integrated with existing management vehicles, when the system becomes an integral part of situation and field management systems.

UAS's more efficient use of creating and speeding up the real time picture fastens decision making and provides operating management tool to take appropriate measures such as real-time video and image based still camera. For example, in a large building fire situation, UAV can control over the fire and basis by a live-picture, to determine whether the roof is safe for fire personnel to moving through the fire location (Tikanmäki & Tuohimaa 2011). End users must work together with developers, and potential entrepreneurs to develop business plans for UAS services that are likely to be self-sufficient of self-sustaining use, in order to attract investors and customers (Ruoslahti et. al. 2009).

Important issue is the selection of right type of equipment, helicopter or fixed-wing type aircraft. Fixed wing type vehicle can locate the target and monitor a larger area, while the helicopter type of vehicle can stay above the target and transmit the exact real-time picture from the position. As a sensor can use different types of cameras depending of the appropriate use (still, video, thermal, and infrared). Forward looking infrared (FLIR) camera can be used to find the people from the terrain, and it can also be used for locating other sources of heat. Taking samples from a variety of sources, such as ash and radiation, sensors have been developed, and those sensors have also been used successfully.

Literature focuses mainly on the UAV's construction and engineering, but the operating issues and education literature does not exist. It is therefore important to invest in the creation of user training. A good example is in Kemijärvi Finnish Lapland, Eastern Lapland Vocational College, where the education establishment operators have started a pilot course. In April 2011 was held the first official Finnish UAS -course in Kemijärvi. In that course, UAS related activities were generally divided into three sections: business, training and end users. Participating on that pilot course get views for further development of that education and other UAS related issues, including aerial legislation.

Laurea University of Applied Sciences (LAUREA) R&D project is aiming to ICT integration to the emergency vehicles as a part of larger project (Rajamäki et al. 2010). There is a need for ease decision making and situational awareness and also ease to use different kind of sensors and the information that sensors produce. By adding UAS as a part of emergence vehicles helps decision makers to rapidly improve situational awareness (Tikanmäki & Tuohimaa 2011).

In case of security in various public events like football matches, demonstrations and other public-safety issues, operational management as well as maintaining of situational awareness enhances by using UAS. Violent threats have become more common, for instance, armed or dangerous person’s search. In this kind of case, the local police resources may be very limited in the beginning of the situation. In major disasters overview of the creation of the situational picture, monitoring and management support to the activities is important. In massive fire and building fires, UAV’s can observe the fire area size and allow the exact location of fire detection.

Terrain and forest fire emergency observation is by law organized, when fire danger is obvious or other legitimate reason. UAV can be used, for example, to search smoke or to locate oil and to support leadership. Intelligence task can be, for example, storm damage and flood damage detection or any other similar task. Rescue service has responsibility for leading the rescue authority on land and inland waters, fire and related measures of fire, explosion accidents, oil spills, etc. In this kind of situations UAV can help rescue management.

UAS could be used of improving and completing situational awareness, e.g. by fire and rescue forces and police leadership in supervision vehicles. The system can be integrated with existing management vehicles, when the system becomes an integral part of situation and field management systems. UAS's more efficient use of creating and speeding up the real time picture fastens decision-making and provides operating management tool to take appropriate measures such as real-time video and image based still camera. For example, in a large building fire situation, UAV can control area over the fire and basis by a live-picture, to determine whether the roof is safe for fire personnel to moving through the fire location.

According to Subramaniam and Youndt (2005, 460); "Our study provides an empirically grounded framework simultaneously linking various aspects of intellectual capital and their interrelationships to different types of innovative capabilities. This framework shows how organizations need to distinctively utilize their varied knowledge resources to achieve different types of capabilities for innovation. It also provides a structure for future research probing of more specific questions regarding the knowledge-innovation link."

As a conclusion for this chapter are main informant's applicable words in publication [P1]:

> *"By far the biggest challenge to the UAS world is that international and national aviation legislation does not recognize unmanned aviation… although the UAS can accomplish some things more easily, more efficiently, safer, and more preferably in a way that has not previously been possible, UAS is only one tool among many. … the entire aviation world is not changing unmanned."*

5 Conclusions

The purpose of this thesis was to increase understanding of the RPA/UAS and to examine the possible applications of RPA/UAS. The research function of this thesis was also to investigate obstacles for use of these systems. The evidence of this thesis showed how important the existing legislation is in terms of starting operation with UAS and the services UAS can provide. The absence of UAS aviation law in this particularly case, in a large extend, slow down and complicate the completion of UAS's useful features at both commercial applications and for public use.

5.1 Answering the research questions

The aim of this research was to analyze and assemble a clear summary about this issue by using the different kind of data. The study succeeded to clarify the implications for different organizations when UAS is used in the future. Research objectives were successfully, and the research questions were received answers. This study showed the needs for UAS but also 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.

Research Question: How UAS is understood in the terms of legislation

Constraint of UAS's civilian use is the lack of legislation in whole or inadequacy in legislation. To the legislation, it is expected to become major changes in European level in 2015. In abroad and in Finland, there are UAS operators despite shortcomings in the legislation. Standards, regulations and training requirements increase in unmanned aviation will continue to grow over the next ten years, so the UAV's flying will also include a pilot's license regulations. Unmanned aviation becomes part of the overall aviation, but a manned aviation is not going to disappear completely. With lighter UAS systems can be cost-effectively to manage the future roles and functions, which are needed now heavier, manned, equipment.

There was a sub-question in facilitating the complexity of the topic: How services can be produced by using Unmanned Aircraft Systems and what obstacles are there in the legality point of view?

Finnish aviation authority, Finnish Transport Safety Agency (Trafi Aviation) plays a crucial role in the development of Finnish aviation legislation and the creation of the regulations. Finnish aviation legislation recognizes the unmanned aviation but less than 150 kgs UAVs are divided into categories, which are still to be done. When designing commercial activities of service it should remain in LUAS because of their lighter body.

Mini-and micro-sized UAV's flying do not need a separate license if the equipment is up to a maximum weight of 10-20 kg, and will be flown below 150 m altitude. Notable is, however, that below 150 m altitudes are flying, for example, military planes and seaplanes. It is also noted that flying should take place within VLOS, and perception must take place in the eyes. A point in the sky does not meet this condition! Transition to heavier equipment flying changes also regulations and flying requires in practice to go through the permit process as shown in following figures.

Figure 6 illustrates UAV MTOM under 20 kg situation and Figure 7 over 20 kg weight of UAV's permission procedure for Finnish Aviation Authority.

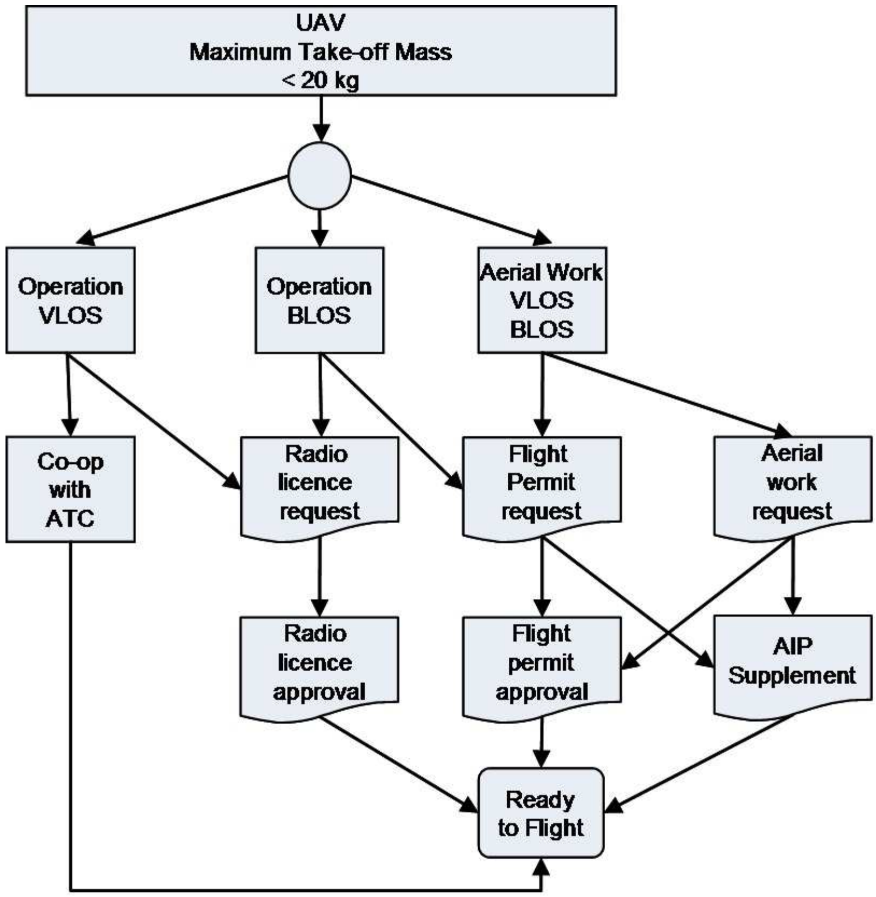

Figure 6: Licensing procedures in Finland to enable < 20 kg UAV flight.

Flight permit insists, among other information; technical specifications of the type of UAS, information of the flyer, guidelines for the activity, risk analysis, co-operation and corresponding agreements, and airspace reservation. Notable is that airspace reservation must be done 10 weeks before carried out the planned operation.

When UAV's MTOM grows over 20 kgs also the permit process will change heavier: there is no difference between VLOS and BLOS permit application procedure.

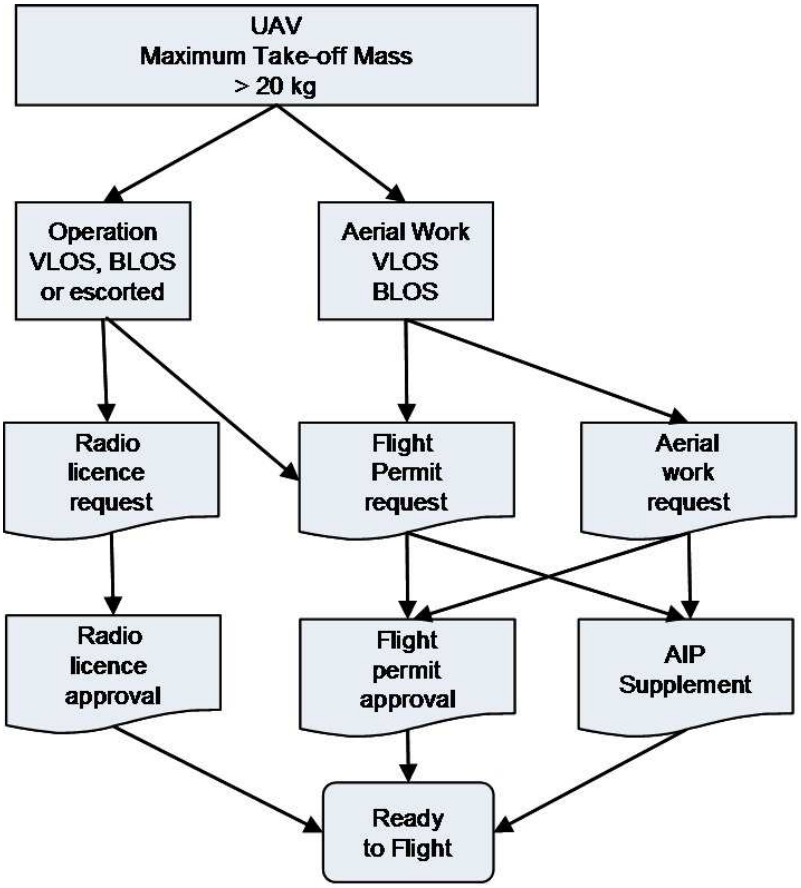

Figure 7: Licensing procedures in Finland to enable > 20 kg UAV flight.

Closure of the airspace allows flying when operating BLOS conditions. In Public Sector case is easy; the notification to ATC and a request for closure of airspace. Authority may also ask for closure the airspace over the target area of one day, for example, in a case of a major accident. When a matter is a civil action, it becomes more difficult; it is needed to apply permission from Trafi Aviation for airspace closure of 10 weeks prior to the intended BLOS flies. The authorization process includes conducting risk analysis, assessment of the level of training of involved staff, describing the usable UAS, UAV and the flight interruption method, technical data and taken into account of the other parties with necessary co-operation agreements.

Research Question: What are the main obstacles in development of UAS activity?

The analysis of the main obstacles concerning the development of UAS had sub-questions to division main issues into smaller parts: What and why will be the biggest challenges, weaknesses and restrictions on the operation at this point in functionally, economically and legally both nationally and internationally?

There was a desire to explore if and how, by using UAS, it is possible to produce services. This research was limited to civilian use of UAS and the restrictions because of absence of current legislation. The focus of the analysis was obstacles in the current legislation using UAS. National Aviation Acts differ widely from each other; hence, the focus is on the preparation for the international aviation laws. In this study, it was clear that there is much of a different kind of purposes, both for public and private use, where UAS can be used. The need for UAS services is obvious but most importantly, the study showed also social general ignorance how UASs can exploit in civilian use.

One fact to take account is that different actors develop their own systems and do not invest in the joint development of the system. UA systems' use should centralize to a single service provider, thus can achieve the best output-input ratio of the use of the system. As a result of above mentioned follows, that it is important to create a network between actors and thus to achieve synergies in the development and deployment of UA system. From the research perspectives are needs for UAS but also social general ignorance how UAS can be exploiting 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 market has a huge economic promise for different UAS classes. By other means, it cannot be achieved the same benefits as using the UAS system, so the societal benefits are particularly high. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

Sub Research Questions: How real time picture and situational awareness can be improved by using unmanned aircraft systems? How and in what way UAV's can accelerate and improve maintaining of the real-time picture?

The basis for this research was to determine how situational awareness can be improved by using UAS. Research showed how important the author's professionalism is for the research, especially when available scientific material is limited. The research showed the needs for UAS, and focused on UA systems in general. The initial position of the research in publications was to determine how real time picture and situational awareness can be improved. The other baseline for research was to investigate if it is possible and how, on the other hand, it can be done by using Unmanned Aircraft System.

The approach angle is different in publications in a way that some publications converse deeper backgrounds of UAS and other publications concentrate on legal aspects of service design and making innovation by utilizing RPAs. Unit of Analysis in publications [P1] and [P3] case study researches is expert's best perceptions of the situation awareness and UAS's role in it. On the other hand, experts gave their own opinion, not the organization's official position or vision. In publication [P5] the unit of analysis is organizations that are preparing and/or proposing legal aspects of using UAS's in European airspace.

In order to achieve triangulation, data were gathered from multiple sources. In publications data was collected with interviews, from documents, collected articles and printed books. First interviews were organised by e-mail. Before sending questions, interviewees were called and assured they are willing to answer to survey. In extended version of publications data deepens the knowledge acquired from additional literature and collected articles. Focus interviews provided a lot of information on this subject. Thus, focus interviews were beneficial collecting method for data.

5.2 The body of knowledge

Research interview in publications revealed, how important interviewee's expertise is, when much of scientific material is not available. The empirical section showed that the author of this thesis has a long experience in organizations where the needs of UAS can be utilized. Without expertise could be difficult to do research of this issue. The empirical part of research concentrates to legislation concerning the use of UAS and privacy aspects when using UAS for operations in different cases. I have looked this matter from the point of view of both case study and design science research. I believe that the development of UAS for operational activities and to maintain situational awareness will benefit both the case study research and the topic of expertise.

This thesis attempted to generate new theory based on the 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 mainly a case study approach, which is generally recommended as a suitable research design for theory-building (Yin, 2009; Eisenhardt, 1989). Design knowledge applies people who have received formal education in that field (Van Aken 2004, 225). Require is that researchers understand the implications of their research perspective, and act in ways that reflect the knowledge (Orlikowski & Baroudi 1991, 24). Figure 8 points out the body of knowledge.

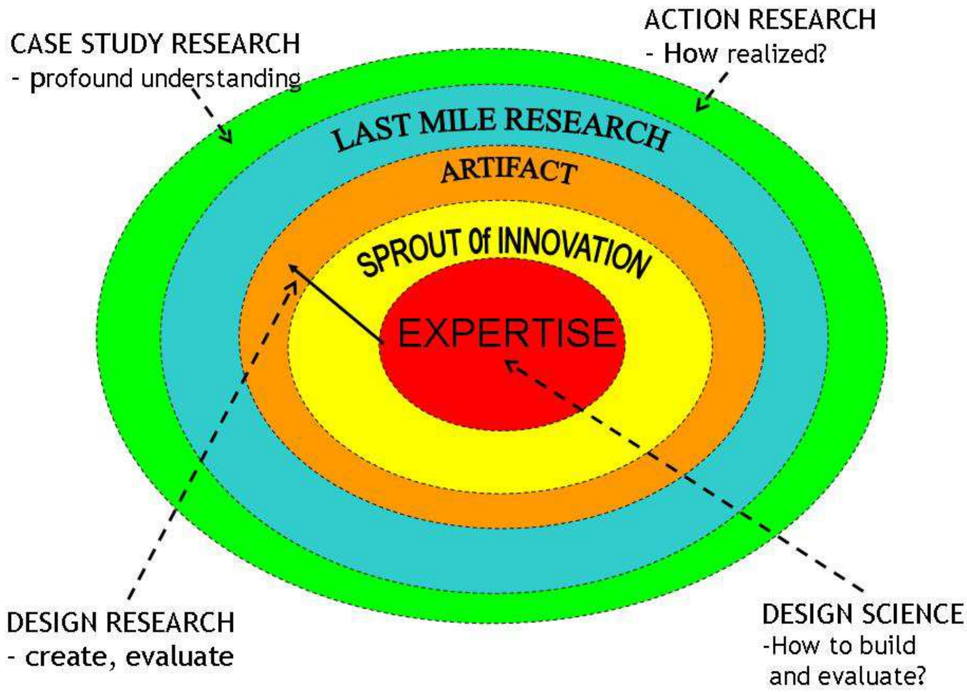

Figure 8: Body of Knowledge (Tikanmäki & Tuohimaa 2010).

Among other factors, the research method depends on the researcher's current knowledge, and the nature of the topic. It is essential that professionals communicate and share their experiences together and thus generate innovation. The prerequisite is that the researchers know their field. The importance of expertise is highlighted when the object is placed in its own environment.

The analysis of documents and other sources of evidence created a deeper understanding of the subject. Document analysis reinforced information that was collected in different ways. Focus interviews during UAS Familiarization Course gave detailed information on the subject. The focus of the analysis in publications [P1] and [P3] was doing SWOT-analysis on a basis of the interviews. Publications' [P2] and [P4] concentrated in cooperating challenges on the use of UASs and analysis was based on identifying various authorities' opportunities and means. Data analysis of latest publication [P5] primarily conversed on current legislation obstacles when using UAS.

Research findings in publications [P1] and [P2] have been presented in international conference to academic audience and published. Publications [P3] and [P4] have published in international journals. During the studies findings are also presented to research colleagues.

Submitted publication [P5] has presented to lectures and co-students of Laurea University of Applied Sciences.

5.3 Validity and reliability of the thesis

Yin's (2009) four tests can be regard as a relevant in assessing the quality of research design. Different methods are used to deal with these tests, when planning and making case studies. However, all the tactics do not occur in case study's formal planning stage. Next table presents four design tests for case study tactics. (Yin 2009, 40.)

Tests	Case Study Tactic	Phase of research in which tactic occurs
Construct validity	- use multiple sources of evidence - establish chain of evidence - have key informants review draft case study report	data collection data collection composition
Internal validity	- do pattern matching - do explanation building - address rival explanations - use logic model	data analysis data analysis data analysis data analysis
External validity	- use theory in single-case studies - use replication logic in multiple-case studies	research design research design
Reliability	- use case study protocol - develop case study database	data collection data collection

Table 12: Case Study Tactics for Four Design Tests (Yin 2009, 41).

Construct validity is the first test according to Yin (2009, 41). This thesis used multiple sources of evidence in order to achieve triangulation. In Publication [P1] case study data was collected with interviews, from documents, collected articles and printed books. Publication's [P1] extended version [P3] data deepens the knowledge acquired from additional literature and collected articles. One prominent collecting method for data was focus interviews. Focus interviews were accomplished concerning certain specific issues with student colleagues and teachers in UAS course in April 2011. The results of these focus interviews were used for publication [P5].

Yin (2009) teaches explanatory case study investigators that internal validity is mainly for studies where a researcher tries to explain how and why the event x lead to the event y (Yin 2009, 42). Case study relates to interference every time an event cannot be directly observed (Yin 2009, 43). This study had experts as interviewees as well as teachers in UAS course, who discussed the research findings, opportunities, strengths and other study related issues.

The third test, external validity, according to Yin (2009) “deals with the problem of knowing whether a study’s findings are generalizable beyond the immediate case study”. It is difficult to compare one case to other and thus generalize outcomes. Yin guides, instead of generalize other studies to generalize results to a theory. Lack or problem of external validity is the main obstacle to a case study according to Yin. (2009, 43.) In this study, the characteristics of the external validities in different publications, are the research questions and themes which are, on the other hand, close to each other, but they are very specific at the same time.

The forth and the final Yin’s test is reliability. Reliability measures the quality of the research; if a later investigator follows the same procedure as an earlier investigator, the later investigator should arrive at the same findings and conclusions when doing same study again (Yin 2009, 45). In this study, reliability is assured by accurate documentation of the research. Documentation includes both interview questionnaires and answers, likewise a proper compilation of the research data. It is important for the result of the research to find the right interviewees; it was managed to get interviewed in Finland's top experts in their respective fields. However, repeating the research does not give the same results if the interviewees are different as in the original study.

Overall, the case study could have been more interviewees. On the other hand, all the interviewees who were all aware of, one way or another, how UAS can be used and what the system could do. However, because they are all professionals in the current region, gave a lot of useful information in this case. Snowball sampling method was used; discussions were held with a wider group, but it wasn't necessary to expand the sample interviewed, because it would not have brought more added value to the survey. That is to say; the information gathered reached saturation, and additional interviews would not gather important information on the subject.

5.4 The future of Remotely Piloted Aircrafts

UAS always means a system. UAV means the flying part of UAS, and that is to say, UAV is a chassis. Basic elements of the system are the data link and data transmission. The above-mentioned three components must be in all UAS systems. Crew member is always required even if the system is automatically constructed, as the autonomic aviation does not exist, and the term should not be used in order to avoid misunderstandings.

UAS categorization is only indicative, because they are not official. Typically, UAVs are classified as body weight, operation height, operation distance, and operation time. Mini-Systems typically weigh a few tens of kilos, weighing less than 150 kgs of equipment are known as Light-UAS system (LUAS). LUAS operating time is typically an hour to two hours, operating at a distance of kilometers to tens of kilometers and altitudes and flight levels are hundreds of meters. LUAS are abundant and they are constantly being developed further. Transition to a larger equipment decreases operational use, because the operating costs will increase when the size of a flying machine grows. For example, maintaining situational awareness with Predator; 2-3 aircraft is needed to operation continuing for one week, and it requires up to 300 people to maintain a situational picture.

The media gives a misleading impression of UAS in use by claiming UASs are only in military use. In reality, a small percentage, however, the most reportage part, of UAS activity takes place at a military side. One reason for the above is probably the fact that the devices and systems are developed for military technology, and was originally introduced to military use in the world. The advantages of UA systems like crisis-management forces' increased security, can easily forget by the media. Mini UAS's improve, for example, Finnish soldiers' security in Afghanistan by reconnaissance of the target in advance before the troops moves in there. It thus may be the best way to avoid an ambush, roadside bombs and snipers effect.

When designing business activity it is desirable to identify as a potential and large customer market police departments, fire and rescue and border control agencies. It is worth noting that an obtaining, completion, sharing and integration of the situational picture for those in need in the future play a significant part of the UAS operation. UAS has a large role in producing, improving and complementing the situational picture of the authorities. The sensor and electronic technologies have progressed to make smaller and lighter components, which mean that UAVs can also be smaller in size and lighter in weight. In this manner is achieved a longer operating time and range.

UAS needs radio relay systems from ground to plane and vice versa, so the importance of secure data transmission is high. The radio spectrum is not specifically reserved for UAS use, and free use of spectrum frequencies is desirable to the concurrent use. Ficora operates the authority issues in Finland, and provides more information of the radio spectrum and the use of the spectrum as well as the planning of radio frequencies. When using a UAS to the gainful employment, it is typical professional aerial work, so the criteria and conditions for carrying out an aerial work will find with Trafi Aviation. Aviation employment is defined UAS's use of some purpose, not pay to obtain a performance. Aviation work related permits are applied from Trafi Aviation. Privacy has to take into account in UAS activity, and it is regulated by Criminal Code Chapter 24 in Finlex 2000.

In the traditional flying, the pilot has been involved in the machine, but the UAS equipment will flow by remotely controlled station. The main matter is for example, how to avoid other air traffic? Aviation regulations are made around the world in several different aviation organizations, so that the comprehensive regulations completion and synchronization take a lot of time.

The use of airspace are taken into account many issues; the air space can not be just about to go to any device whether it is even a balloon, or UAV, because the aviation and air travel have been built to be safe. Airspace philosophy is based on the safety culture, where the aircraft commander has a major responsibility, whether it's manned or unmanned aviation, that are governed by the same regulations. UAS activities, like other flight operations, are aviation professionals' job. Aviation is a transparent operation; it is not to search for loopholes. If an error has occurred, it is reported to the aviation authority, as well as to other parties, so that similar events can be avoided in the future. Aviation Law and aviation regulations require a lot of familiarizations.

UAV flying is not just having fun, but series of different serious actions, what requires professional skills and discipline. Air traffic regulations and provisions must rigorously be followed. UAS operation is part of the aerial work, and that must be kept constantly in mind when these activities are exercised. Safety regulations are very important part of all kinds of aerial work. Risk factors must be considered very carefully, also in unmanned aerial work, causing a risk to a third party, property, etc. Therefore, also in unmanned aerial, a hobby activity is not desirable in any case.

5.5 Suggestions for further research

Research results of this thesis open up a number of interesting perspectives on the development and activities of UAS. Situational Awareness & Real Time Monitoring needs further researching in order to search information of management of emergencies and legal issues when operating with UAS. Both public and private sector actors in the area of UAS need a training program. Multi-authority security tactics and training by common recourses and expertise with various authorities in identifying opportunities and means is also needed. Further research may address, for example, for authorities common UAS-system.

The importance of cooperation between authorities has discovered an important subject to be developed. The Finnish Government's Security and Defence Policy states that the close cooperation between the authorities achieves synergies between overlap functions by cutting and support functions to enable efficient use of. According to Government's Security and

Defence Policy Report, "situational awareness and government collaboration will be developed both nationally and internationally" (Prime Minister's Office, 2009.)

In this point of view the challenge for UAS's use include ministries fragmented budgets, a lack of common practices of the new system of exploitation and the lack of cultural activities. In earlier studies (Tikanmäki & Tuohimaa, 2010) has revealed a need for networking between the authorities in cooperation of implementation of UAS. National strategy for using UAS could be to define and to clarify the responsibilities of authorities and their roles in UAS operations. General commercialization and business models for UAS service providers need more in-depth examination. On the other hand, different kinds of users of the services, with different operation modes need to take advantage of UAS services.

I believe that the future implementation of UAS's activities will benefit both the situational awareness and real-time picture enhancement, not to mention the importance of appropriate expertise. I also believe it has not been paid enough attention to networking between different authorities and experts concerning UAS's use in public safety duties. Through my studies, I have learned to understand the importance and the meaning of networking. I strongly believe it can help me now and in the future. Finally, I can say, that the promising results are expected in the development of UAS implementing - both national and international level over the next few years.

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Appendices

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I. Tikanmäki, T. Tuohimaa, How real time picture and situational awareness can be improved by using Unmanned Aircraft Systems (UAS)?, 10th WSEAS international conference on communications, electrical & computer engineering, Playa Meloneras, Spain, Mar 2011, ISBN: 978-960-474-286-8, pp. 28-33.

How real time picture and situational awareness can be improved by using Unmanned Aircraft Systems (UAS)?

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Abstract: This paper deals with the importance of expertise for improving situational awareness and real-time picture. As an example we use Unmanned Aircraft Systems (UAS). Our research process began by defining the topic and objectives as well as the theory of experience. Research material was collected through interviews and by analyzing scientific publications, newspaper articles and video clips. Most of the scientific publications from the subject concentrate only on the building, on the planning and on the technical properties of UAS. The unmanned model planes are used mainly for different military purposes at the moment. On the basis of this we ensured that we are studying this issue in question among the first ones in Finland. In this paper we use the method of case study research to improve the situational awareness and real-time picture by using UASs in organizations.

Key-Words: Real time picture, Situational awareness, Unmanned Aircraft Systems

1 Introduction

Unmanned aerial vehicles (UAVs) have been designated in many ways: remotely piloted vehicle (RPV), drone, robot plane, and pilotless aircraft are a few of those names. In most cases, they are called unmanned air vehicles. United States Department of Defense (DoD) defines unmanned aircraft as follows[1]: *"An aircraft or balloon that does not carry a human operator and is capable of flight under remote control or autonomous programming. Also called UA." "That system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft. Also called UAS." "A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semi ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles. Also called UAV."*

UAVs have a century-old history in aviation. UAVs were tested During World War I in 1920. At that time UAVs were not used in combat. Germany used a simple but deadly V-1 "flying bomb" during World War II what made base for post-war UAV programs in U.S. In Vietnam War UAV's were first time used in surveillance tasks. However, same type of UAV was modified to carry payload and had its first test flight on December 2002 [2].

The Israeli Air Force (IAF) had several UAVs in late 1970's and 1980's. It was noticed that Israel used UAVs successfully in Lebanon 1982. That encouraged U.S. Navy to acquire a UAV capability for the U.S. Navy [2].

There are several reasons why the UAV's role has only recently received more attention and interest in wider. Technique, which was not available a few years ago, is now available. UAVs might have received more attention in the past, if the crisis should be addressed by enforcement and intelligence during the conflict. The absence of such crises, together with the paradigm change needed to happen before unmanned vehicles were adopted, meant that the UAV is an advanced technology and has become available [2].

2 Problem Formulation

2.1 Theoretical framework

Theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test. It is impossible to achieve this ideal of a clean theoretical slate. Attempting to approach this ideal is important because preordained theoretical perspectives or propositions may bias and limit the findings. Investigators should formulate a research problem and possibly specify some potentially important variables, with some reference to extant

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literature. They should avoid thinking about specific relationships between variables and theories as much as possible, especially at the outset of the process [3].

A relevant property of theory building is to compare emergent concepts, theory, or hypotheses with the extant literature. This includes questions what is this similar to, what does it contradict, and why? An answer to this process is to consider a wide range of literature [3]. Case study research will answer questions of “how?” and “why?” [4].

More importantly, conflicting literature represents an opportunity. The juxtaposition of conflicting results forces researchers into a more creative thinking than they otherwise could be able to achieve. The result can be deeper insight into the emergent theory and the conflicting literature, as well as sharpening of the limits to generalizability of the focal research [3].

The development is learning by doing. Researchers who construct case study often participate in the development or implementation of the system they are researching [5]. The constructive research is one of the options currently available for a case researcher [6].

The constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world and to make a contribution to the theory of the discipline in which it is applied. The central notion of this approach, the (novel) construction, is an abstract notion with great number of potential realizations. All human artifacts are constructions. Artifacts are invented and developed, not discovered [6]. Use of design evaluation methods in case of case study is recommended [7]. By using observational method one has to study artifact in depth in business environment. Success is based on the researcher's skills; developing or constructing a theory or an object and the selection of appropriate means to justify the theory or to evaluate the item [7].

It is important to emphasize the significance of five components of a research design in case study; question, propositions, unit(s) of analysis, the logic linking the data to propositions and the criteria for interpreting of the study [4].

First strength of theory building from cases is its likelihood of generating novel theory. A second strength is that the emergent theory can be tested with constructs. A third strength is that the resultant theory can be empirically valid. The likelihood of valid theory is high because the theory-building process is tied with evidence that it is very likely that the resultant theory will be consistent with empirical observation. In well executed theory-building research, investigators answer to the data from the beginning of the research [3].

Some factors that lead to strengths in theory building from case studies also lead to weaknesses. The intensive use of empirical evidence can lead to theory which is overly complex. The result can be theory which is very rich in detail, but poor in the overall perspective. Second weakness is that building theory from cases may result in narrow and simple theory. Case study theory building is a bottom up approach such that the specifics of data produce the generalizations of theory. The risks are that the theory describes a very simple phenomenon or that the theorist is unable to raise the level of generality of the theory [3]. Theory developed from case study research is likely to have important strengths like novelty, testability, and empirical validity, which arise from the close linkage with empirical evidence [3]. Theory building approach is well-suited to new research areas or research areas where existing theory seems inadequate.

It is recommended to researchers to use multiple sources of evidence (triangulation) in case study. There may be explanatory, descriptive and exploratory case studies [4].

2.2 Problem formation

Laurea University of Applied Sciences has studied micro aerial vehicles (MAV) and their use by public safety professionals [8],[9]. Visions and objectives of the Finnish aerospace and aviation fields of technology professionals as UAS/UAV-systems will create the ability to develop and maintain these systems, and marketing abilities profitable international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs [10].

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UASs is restricted by the lack of legislation. Government activities and the civilian side of the UAS could be used for many different purposes of use. UAS international aviation regulations might be ready 2012-2015, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented [11].

We will give examples of using unmanned aircraft in the Public Sector. Both of the participants in the preparation of this report have a long experience in organizations where the needs of UAS can be utilized.

Mass events and various events described below could be improved by using UAS's. In case of security in various public events like football matches, demonstrations and other public safety issues, operational management as well as maintaining of situational awareness enhances by using UAS.

In the case of lost or drowned person's search for land and inland waters and islands from air, or the lost of ship or boat, or search for locate in inland waters it is a police-led task [12].

The police have responsibility for leading various operational situations. Operational management situations can locate on land or inland waters. Police can appropriately provide rescue service related assistance to public order and security maintenance, hazard and disaster area isolation, transport, guiding, organizing the search for the lost, and other such measures [13].

Disaster or different kind of accidents investigation explains the cause of the accident and also the consequences of it. Accident Investigation Board maintains readiness to rapidly launch an investigation [14]. In major disasters overview of the creation of the situational picture, monitoring and management support to the activities is important.

In massive fire and building fires, UAS's can observe the fire area size and allow the exact location of fire detection. Terrain and forest fire emergency observation is by law organized, when fire danger is obvious or other legitimate reason. UAS can be used for example, to search smoke or to locate oil and to support leadership. Intelligence task can be, for example storm damage and flood damage detection or any other similar task.

Violent threats have become more common, for instance armed or dangerous person's search. In this kind of case, the local police resources may be very limited in the beginning of the situation. Rescue service has responsibility for leading the rescue authority on land and inland waters, fire and related measures of fire, explosion accidents, oil spills etc. In this kind of situations UAS can help rescue management.

3 Problem Solution

The research reported here has attempted to generate new theory on the basis of existing theoretical constructs to meet organizational needs. As we noted in the literature review, our specific research aim has been a relatively new one. Therefore, we use a case study approach, which is generally recommended as a suitable research design for theory-building [3],[4]. Design knowledge is to be applied by people who have received formal education in that field [15]. It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge [16]. Selection of research method to examine the research questions [17].

Interesting research topic in the IS field is how to effectively develop new systems. This is interesting because IT is developing and technical knowledge is growing. IT is applied to new areas, for example UAS, which were not previously believed to need IT support. In this process, new kinds of systems and development methods are created [18]. Case study research is a research to study one or at most a few carefully selected cases. The essential thing is to examine the case. The case study is the most common qualitative research method in business economics. Subject to research in case of the company is usually a process, function or department. In the case study is recommended to use a variety of sources, including interviews and written materials. All qualitative research is not a case study, but a case study may be greatly influenced by other trends in qualitative research [19],[20].

The process of building theory from case study research is a strikingly iterative one. When an investigator may focus on one part of the process at a time, the process itself involves constant iteration backward and forward [3]. Analyzing data is the heart of building theory from case studies and in the same time it is the most difficult and the least codified part of the process [3].

Researchers see the advantages of doing research in team. In our case team-work adds value and brings different point of views to research [21]. Examiner's prejudices should be anyhow avoided [2]. The investigator must be ready to receive and identify the opposite and contradictory information. In this sense, it is constructive to work with the researcher colleague.

Unit of Analysis in our case study is expert's best perceptions of the situation awareness and UAS's role in it. In the other hand, experts give their own opinion not the organization's official position or vision.

Interviewees were designated based on their expertise. Interview questions represented to eight interviewees, 7 of which were answered. Four interviewees represent the public administration, two private or commercial sector and one represent the academic sector.

Questions we selected base on the title of our report. Pilot interview was the basis of cross-questions to the following questions [4]. The main questions were chosen after the pilot interview. Interviewee's background concerning UAS was asked in basic questions: What is the organization you represent? In what role do you work? What is your earlier experience and knowledge in the UAV - area? In what task, how many years and what years? Interview questions of our survey concerned following topics of UAV's; How and in what way UAV's can accelerate and improve maintaining of the real-time picture?, what and why will be the biggest challenges, weaknesses and restriction on the operation at this point in functionally, economically and legally both nationally and internationally? We also asked interviewees if they have else UAV-related matters, they want to highlight.

In our case study we use triangulation of data sources to analyze our research findings. Results are based on the answers we got from interviewees, collected articles from newspapers and video clips we analyzed. In theoretical framework we read scientific publications. The focus of the analysis in this study is improving the situational awareness by using UAV's.

On the civilian use of UAS's is restricted by the lack of legislation. Government activities and the civilian side of the UAS could be used for many different purposes of use. Unmanned Aircraft System (UAS) international aviation regulations might be ready 2012-2015, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented. An exception is the United Kingdom, which has prepared the provisions of unmanned aircraft for the purpose. Military aviation authorities have national regulations for the use of UAV's, including Finland [11].

All the informants emphasize how important UAV's features with a quick decision-making in a proactive way and overall situational awareness are. Immediate creation and sending of data to the managerial position is particularly important. As well as an accurate real-time picture is necessary to transfer in real-time. Application for UAV's use to speed up the situational picture may be applications where the airplane's use is too expensive to endoscopy or to photograph the object. Informants emphasized the following: *"The situational picture can be accelerated by operating UAS, which is located in suitable sensors and by flying often enough above the target area and move the sensor data to the positions where it is needed." "The management can be provided by real-time picture of what is actually happening, and thereby speed up decision-making in a proactive way. Real-time picture can also be transmitted where it is needed." "Management needs real-time image and even the continuous live image."*

Informants also highlight the importance of a real-time videos and images recording and analysis possibility afterwards. One informant put that into following words: *"Files can be shared or to explore to the experts who can analyze it and give instructions to the management. Similarly, investigations, etc. can begin immediately."*

As weakness interviewees mention several operators scattered budgets, which are limiting issue of UAV's implement. They are also concerned that UAV's are too expensive for one organization for their own use and informants suggest that UAV's should be concentrated to one user group to maximize the benefit of the devices. According to informants there is limited operating experience in Finland and access to international cooperation. The economic challenges are the development and dissemination costs. Different kind of tools and equipment are constantly renewing and their management is challenging. Procurement and development have been tried to do in previous years, but the government financial situation prevents to invest in development projects. One informant verbalized like this: *"There is no equipment or personnel, which dominates the job. Devices are too expensive for only one organization for their own use. Everywhere should be linked to both authorities as municipalities, cities, industry, or with other research."*

One concern according to informants is resistance to change of new concepts and systems for dismounting the traditional way of operating hampers implementation of UAS. Authorities are developing their own systems; instead they invest in the common and workable system. Equipment should be concentrated to one user group to maximize the benefit of the devices: *"The market is ready for low cost and reasonable UAV equipment, initially, the matter is considered to be sufficiently simple and generally applicable." "In the future, the UAS is important, as the technology becomes more affordable to buy."*

Functionally the challenge is the lack of ignorance like some informants prompt: *"The general ignorance of the UAS is a major challenge, but as this interview shows for its part, we are getting rid of it." "The image media give of the UAV does not contribute to the expansion of activities. Media want to tear the large headlines like "Big Brother Watching" and "Robot Airplanes*

Throwing Missiles". Aforementioned is a very one-sided view on this matter."

The biggest challenge for operationally use of UAV's is that legislation does not know well enough UAV's as an aircraft. Training and other requirements are not specified for UAS-operation as well of the operator and the actual apparatus. Especially for large UAV's development is waiting for standardization. As one informant aptly impressed: *"Legislation lives in the past, in a time when an airplane was always manned."*

Following Table 1 summarizes the main characteristics according to informants' answers concerning strengths, weaknesses, opportunities and threats, ie. It illustrates SWOT-analysis of using UAS in improving real-time picture.

Table 1 SWOT-analysis.

Strengths	**Weaknesses**
Rapid situational awareness	Several operators scattered budgets
Equipment quickly in place where needed	Equipment too expensive for one organization for their own use
Data can be sent immediately to management center	Ignorance of the benefits of new activities
Real-time image and video can be stored for later analyzing	Lack of legislation
UAS per flight hour is cheap compared to helicopters	General ignorance of the UAS
Opportunities	**Threats**
Equipment concentrated to one user group to maximize the benefit	Authorities are developing their own systems
MAV's flight restrictions compared to UAV's flight restrictions are more liberal	Lack of legislation
UAS technology becomes more affordable to buy	Resistance to change of new concepts and systems
Market is ready for low cost and reasonable UAV equipment	

In threat prevention - by supplementing and maintaining real-time picture – UASs can be used for public order and safety, rescue, border security and immigration monitoring and observation [22].

As a conclusion for this chapter are our main informant's suitable words: *"By far the biggest challenge to the UAS world is that international and national aviation legislation does not recognize unmanned aviation... although the UAS can accomplish some things more easily, more efficiently, safer, and more preferably in a way that has not previously been possible, UAS is only one tool among many. ... the entire aviation world is not changing unmanned."*

4 Conclusion

The starting point of research was to find out how real time picture and situational awareness can be improved (How and why?). The research was started by a desire to explore is it possible and how it can be done by using UAS. Our research was focused to UAS generally and we delimited other systems like micro and mini aerial vehicles out.

The theoretical part focused on theory building of case study research and how we can exploit it in our report.. The scientific publications concentrate on the building of UAS, on the planning and on the technical properties. Unmanned aircrafts are currently used mainly for various military purposes. Research was limited to civilian use of UAS's, which is restricted by the various instruments lack. Government activities and the civilian side of the UAS could be used for many different purposes of use.

In the empirical section we highlight, that both of the participants in the preparation of this report has a long experience in organizations where the needs of UAS can be utilized. The empirical part of research was limited to few examples how UAS can be used in different cases.

Research interview revealed, how important is interviewee's expertise, when the method is case study research and not much scientific material is available. Without expertise it could be difficult to do research about this whole issue.

Case Study research improves profound understanding. The aim of this research was to analyze and assemble a clear summary about this issue by using different kind of data. We 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. From the research can be seen the needs for UAS and also social general ignorance how UAS can be exploit in civilian use.

Several sources in research revealed growing needs for UAS. The findings of our study showed that is important to continue the research of UAS's.

Further research may address, for example, the legality aspects, for authorities common UAS-system and the overall commercialization of UAS. In the future, this topic is covered much more to explore, and it will be interesting to watch, will developing and the use of UAS's raise or what will happen. In the future, it is also important to find out what have not yet been taken into account.

Overall, our case study could have had more interviewees because now questioned persons were all aware, one way or another, how UAS can be used and what the system might do. However, it is precisely because they are all professionals in the present area. That's why we gave a lot of useful and fresh information concerning complications there exists in this particular case.

We discussed with a broader group, but we did not find it necessary to expand the sample of interviewees, because it would not have brought more innovation to the research (snowball sampling method).

Authorities mention as weakness several operators scattered budgets, which are limiting issue of UAVs implement. They are also concerned that UAV's are too expensive for one organization for their own use and they suggest that UAV's should be concentrated to one user group to maximize the benefit of the devices. The economic challenges are the development and dissemination costs. Different kind of tools and equipment are constantly renewing and their management is challenging. Procurement and development have been tried to do in previous years, but the government financial situation prevents to invest in development projects.

Authorities are developing their own systems; instead they invest in the common and workable system. Equipment should be concentrated to one user group to maximize the benefit of the devices.

One player is unable to cope on their own for systems implementation and use of it. Funding for such a large system of the whole does not succeed in a one public organization measures. That is why it is vitally important to create network, and thereby obtain synergies from a wide-scale deployment of the UAS.

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The Strategic Management Challenges of Developing Unmanned Aerial Vehicles in Public Safety Organizations

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Abstract: This paper deals with the challenges of strategic management in public organizations for improving situational awareness and real-time picture. A significant strategic management tool for operational activities is situational awareness including real-time picture creation. In this paper we use, unmanned aircraft systems (UAS) as an example for improving situational awareness and real-time picture creation. Persons acting on the ground, their leaders and other decision-makers should be able to exploit a real time picture of the situation when making decision. E.g. police, border control authorities, customs and fire departments need real-time picture of the situation. For decision-makers and their assistants, situational awareness means understanding about events, circumstances affecting these events, the objectives of various parties and possible options, which are needed to make decisions on a specific item or the whole thing. In society, the efficient use of resources is a sensible, economical and appropriate target. Strategy work requires a new perspective where actors must have the ability to see large complexes. Different entities interact with each other and strategic decisions require courage. Successful organizations create a successful strategy, implement it and are able to renew their strategies with the latest requirements.

Key-Words: Strategic management, Unmanned Aircraft Systems (UAS), Unmanned Aerial Vehicle, (UAV) Public organizations

1 Introduction

This paper deals with the challenges of strategic management in public organizations for improving situational awareness and real-time picture. As an example, we use Unmanned Aircraft Systems (UAS). Most of the scientific publications from the subject concentrate on building, planning and technical properties of UAS [1], [2], [3].

The unmanned model planes are used mainly for different military purposes at the moment. There are several reasons why UAV's role has recently received more attention and interest in wider. Technique, which was not available a few years ago, is now developed.

UAV’s might have received more attention in the past, if the crisis should be addressed by enforcement and intelligence during the conflict. The absence of such crises, together with the paradigm change needed to happen before unmanned vehicles were adopted, meant that the UAV is an advanced technology and has become available [4].

UAV’s classification with regard to altitude and weight is presented in Fig. 1.

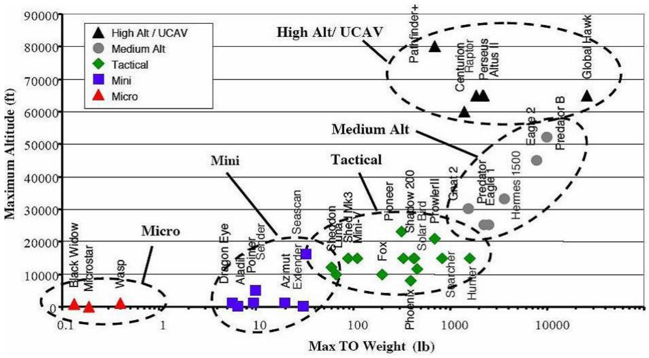

Fig 1. Altitude and Weight Classification of Current UAV’s [5]

Depending on the maximum total weight and maximum altitude, UAV’s can be divided into five categories; micro, mini, tactical, medium altitude and high altitude.

2 Problem Formulation

2.1 Theoretical framework

A new artifact is always based on one concept [6]. This means the concept of technical, human, or informational resource or a combination thereof, recovery [7]. Idea can also be based on a new theoretical invention.

When an artifact is placed in some environment, the significance of the expertise is emphasized. Expert knowledge of design science helps to implement appropriately designed artifacts and eliminate unwanted side effects [8]. Meetings of the professionals of the different field are considered as situations which are valuable and produce many innovations [9].

An instantiation is to understand an artifact in its environment. Instantiations implement constructs, models and methods. The Information Technology (IT) systems need to be instantiated using the experience and intuition. Design Science consists of two features: building and evaluation [10].

Design science will play an increasingly important role in the Information System (IS) profession. Challenge for the design-science researchers in IS is to inform leaders of the capacity and the impact of new IT objects (artifacts) [11].

Design science takes often a simplistic where designed artifacts must function. The design of an artifact, and an assessment of its utility, compared with competing artifacts, is an essential design-science research [11]. Technological logic of the rule is, if you want to achieve Y in situation Z, then do X action. X is a general solution concept for a type of field problem. Solution concept can be an act, a series of acts, but also a process or system [12]. In construction problems this can also mean building a new artifact out of previously unrelated materials [12].

Strategic management represents a prioritization of key success factors in the selection of strategic objectives, indicators, and the use of objective awareness, flexibility in structure and adaptability to environmental changes, which will be closely monitored, and in which react in advance [13].

2.2 Problem formation

The SWOT analysis is a typical strategic planning process. Strategic planning is a part of strategic management [13]. Strategic planning constitutes the framework for the design aspects, tactics, to identify the criteria or the constraints that must be taken into account in operational planning.

Public organizations can be generally divided into three categories, how they see their future: (1) drifted into the future. (2) adapted to the future and (3) the future makers [14].

Future management is based on the conclusion that the future can be created. All, what you do affect in the future. The future can be created and it can be influenced by own efforts, the future can be made, and action requires the organization to a proactive approach. Public organizations have traditionally alienated this approach, especially independent strategic flexibility and individual responsibility in its creation and its exploitation. Strategy is an essential part of the future. Public organizations should continuously evaluate their strategic position and it should be a natural part of normal activity [14].

According to Whittington being a good strategist might not be enough [15]. Leadership is more than a strategy to match action with the environment. It is self-adjustment to social environment.

There is a need for a new kind of strategic thinking, and - working tools, which emphasize the following starting points [14]:

1. Instead of making and analysing strategy attention should move to it, how to create strategies for action in practice
2. Strategy must based on the organization's right to exist and to express the common will of the desired future
3. The strategy process must geared towards strengthening the organization's skills and continuous learning
4. Strategy process should be based on participation and interaction
5. The success of the strategy requires constant communication

According to Kaplan & Norton [16] learning and growth strategy deal with the intellectual property which is needed in organization's activities and customer relationships for continuous improvement. This aspect relates to three areas:

1. *Strategic knowledge: strategic knowledge and skills that workers need to support the strategy.*
2. *Strategic technology: information systems, databases, tools and network required to support the strategy.*
3. *Operating Atmosphere: corporate cultural changes that are required to carry out a strategy to motivate staff, to empower and to adapt.*

3 Problem Solution

It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge [17].

Everlasting interesting research topic in the IS field is how to effectively develop new systems. This is interesting because IT is developing and technical knowledge is growing. IT is applied to new areas which were not previously believed to need IT support. In this process, new kinds of systems and development methods are created [18].

Hevner et al [11] created information systems research framework which is presented in Figure 1.

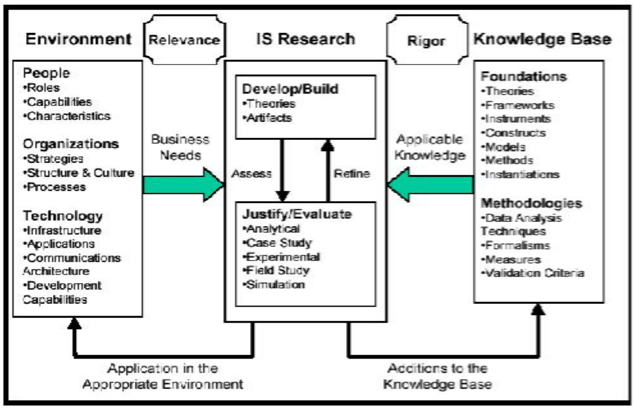

Fig. 2 IT Systems Research Framework [11].

Hevner et al consider as a basis for research the business environment which consists of people, business organization and technology [11]. The targets of research in their view are human form of roles and competencies as well as the organization's strategies and processes, and technologies which support these.

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UAV's is restricted by the various instruments lack. Government activities and the civilian side of the UAS could be used for many different purposes of use.

Unmanned Aircraft System (UAS) international aviation regulations might be ready 2012-2015, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented. An exception is the United Kingdom, which has prepared the provisions of unmanned aircraft for the purpose. Military aviation authorities have national regulations for the use of UAV's, including Finland [19].

Visions and objectives of the Finnish aerospace and aviation fields of technology professionals as UAS / UAV-systems will create the ability to develop and maintain these systems, and marketing abilities profitable international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs [20].

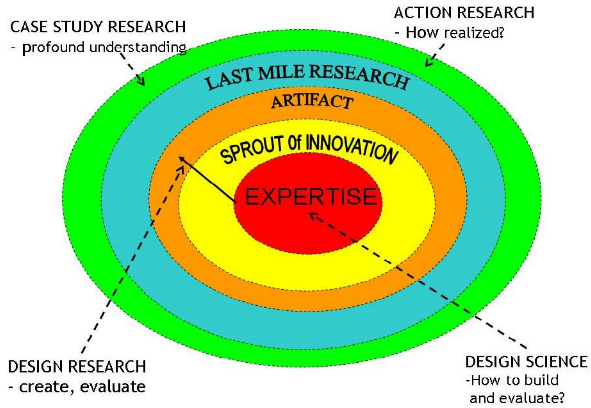

Fig. 3 Body of Knowledge.

In figure 3 we show, how the knowledge helps doing things also in strategic management [21].

Strategic management problems and, above all obstacles to the realization of strategies in public administration are [14]:

- strategies are in the air and do not interfere with everyday life, because it is not known, propagates the organization in the direction of strategy
- lack of vision and action ideas
- management of the budget process is over exaggerated, a strategy process is not connected to the annual operational and financial planning and monitoring
- management systems and attitudes do not sufficiently support the implementation of the strategy required for the interaction, but rather daily reactive management
- loose strategy elements (personnel, communications, information management, service, quality strategies, etc.) that are linked to common strategic disadvantage
- the majority of staff and middle management internalizes badly strategy and its importance
- staff participation in the strategy process is the exception rather than the rule
- implementation of the strategy are not monitored or revised systematically

There is a need for a new kind of strategic thinking, and - working tools, which emphasize the following starting points [14]:

1. Instead of drawing analysis of strategy attention should move to it, how to create strategies for action in practice
2. Strategy must be based on the organization's right to exist and to express the common will of the desired future
3. The strategy process must be geared towards strengthening the organization's skills and continuous learning
4. Strategy process must be based on participation and interaction
5. Successful process of strategy requires constant communication

Learning and growth strategy of intellectual property are needed in organization's activities and customer relationships for continuous improvement [16]. This aspect relates to three areas

1. Strategic knowledge: strategic knowledge and skills that workers need to support the strategy.
2. Strategic technology: information systems, databases, tools and network required to support the strategy.
3. Operating Atmosphere: corporate cultural changes that are required to carry out a strategy to motivate staff, to empower and to adapt.

Exporting strategy into practice mean that the management and staff are committed into following issues [14]:

- Vision and strategy are communicated to staff and it is connected to learning, action planning, rewarding and performance evaluation as part of management and values in implementation.
- Set a strategy for the operational objectives, the coordination of development projects, ensuring resources and define milestones unit-level strategies.
- Clarify connection of strategy and our own work to your personal level of performance and development discussions.
- Strategy objectives will be monitored regularly and respond quickly for good and poor accomplishment

Learning and growth strategies are a prerequisite for long-term and lasting change [16]. Management teams are a prerequisite for long-term and lasting change. Management teams are ready to recognize the importance of this aspect, but they are not usually very well aware of how these objectives will be defined or achieved. Careful planning of more opportunities increases learning and growth strategies successfully.

4 Developing cooperation

Developing a multi-authority security circumstances tactics and training by adding to the exploitation of common resources and expertise in the use of various authorities in identifying opportunities and means to support the goal should be taken in the account. The actions are based on extensive, real-time picture. Real-time picture is a basis for designing, dimensioning and coordinating the various authorities in the same complex tasks. It's carried out by activating the authorities to participate by using the shared resources.

By identifying various authorities' opportunities and means to support operations, the best results are achieved. When establishing a national strategy for UAS, this defines and clarifies the responsibilities of authorities and their roles of UAS operations. Developing and expanding operational cooperation aims practical co-operation and mutual interaction between the authorities, which will improve the situational picture. By exploring official actions and academic efforts factors that influence a real-time picture and current situation in Finland, government may organize authorities' training and a wide-ranging co-operation between authorities.

5 Conclusion

The major focus of strategy will be in the future and it is the most important and most essential thing to seek and find. Strategic thinking requires the ability to think by using of different concepts, but the final strategy must be very practical and applicable. A good strategy will ensure that the right things will be done and by doing different kind of operations, will ensure that things are done correctly. You could say that the strategy is eternal and it must be controlled. Finding the truth is the beginning of wisdom also to the strategies.

The importance of cooperation between UAS's in use is highlighted because the services are needed when a number of different industries such as the Ministry of the Interior under the auspices of actors, including police, rescue, customs and border control authorities. 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 should therefore be given special attention.

None of the authority is solely responsible for certain activities, because there is an exemplary cooperation between public authorities. For example, police, securing international meeting does not need to acquire tanks or airplanes. Police may ask for official assistance from Defence Forces when in need of special equipment or expertise. When something happens, it is decided the responsible party who is responsible for operations, but which receives support from other public authorities.

The government should plan to take into account the existing research dealing with UAS and if necessary initiating new research projects. The aim is that the requirements and opportunities to pursue UAS activity to improve a real-time picture and support the UAS-based activities will strengthen.

For example, the Ministry of Interior could set up a cross-administrative co-operation center that concentrates for maintaining the real-time picture. Center should be responsible for coordination and monitoring of progress and support for other authorities. Securing an adequate amount of resources, who have skills required for the task to manage UAS. Verification on Aviation Legislation and authorities' adequate and up-to-date means for the use of UAS in operations must ensure. Ministries will prepare the plan for implementation for their own responsibilities in respect. Ministry of Interior collects the plans, reconcile and coordinate the implementation-related issues. Plans will be updated at regular intervals.

Strengthening cooperation for ensuring comprehensive real-time situational picture, and to removal of barriers to cooperation, which are based on broad cooperation with the traditional security authorities, other public authorities, industry and NGOs confidential co-operate under the same goals is essential. Joint research, education and training activities related to authorities' communication, as well as the authorities' partnerships between the public authorities by ensuring management, situational picture and messaging systems for compatibility and possible integration contribute to the goal.

On this basis networking and common management is very important for the development of UAS to the use in a small country like Finland with limited resources. One player is unable to cope on their own for systems implementation and use of it. Funding for such a large system of the whole does not succeed in a one public organization measures. That is why it is vitally important to create network, and thereby obtain synergies from a wide-scale deployment of the UAS.

We believe that the development of UAS for operational activities and to maintain situational awareness constitutes strategic network management in many respects. The importance of networks and networking in the world today can not be overstated. A smooth and seamless cooperation between different spheres of government contributes UAS's implementation for public needs for improving and speeding up situational awareness and creation of real-time picture. Our environment and the whole world are constantly changing and that's why there is a growing need for authorities common UAS-system and command center.

We believe that the UAS's future implementation activities will benefit both the situational awareness and real-time picture improvement, not to mention the importance of appropriate expertise. We can wait promising results in the future in creation of strategic network between authorities.

We also believe it has not been paid enough attention to common management between different authorities and experts concerning UAS's use in public safety duties. We understand the importance and the meaning of strategic networking and cooperation between authorities. Challenge is to reconcile the needs of different authorities under common management. In the future, this topic is covered much more to explore, and it will be interesting to watch, will developing and the use of UAS's raise or what will happen.

Balanced success strategy, a key value and goal, is according to Määttä & Ojala the participation of different parts of the organization's various departments and personnel [14]. Critical success factors of strategy must be to communicate, to be discussed and questioned. Participatory and inclusive strategy work is a challenge for the entire organization. Balanced success strategy is a journey - not a destination.

Future success is not based on the same kind of operation than today's success. In strategic knowledge and leadership must be able to combine the strategic success factors for each other. The future must be established – not expected.

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How and why Unmanned Aircraft Vehicles can improve Real-time awareness?

Ilkka Tikanmäki, Tuomo Tuohimaa and Jyri Rajamäki

***Abstract*—**Unmanned Aerial Vehicles (UAV) have been used for a long time to improve situational awareness for many parties. During last 30 years UAVs role has received more attention and interest in global perspective. There are many reasons how and why this has occurred. This paper highlights those issues; why this matter is important and considerable. When discussing about situational awareness and real time picture, we should remember that many parties need these issues when they are working. Especially decision makers and their assistants need to know what is happening in the field. For that reason, it is noteworthy to focus on one of the most important way how to accelerate making of situational awareness and real-time picture. This is one of the components how to do it and why we need it.

***Keywords*—**Public Safety, Real-time awareness, Real-time picture, Situational awareness, Unmanned Aerial System, Unmanned Aerial Vehicle.

I. Introduction

UNMANNED aerial vehicles (UAVs) have been designated in many ways: remotely piloted vehicle (RPV), drone, robot plane, and pilotless aircraft are a few of those names. In most cases, they are called unmanned aerial vehicles. United States Department of Defense (DOD) defines unmanned aircraft as follows [1]: *"An aircraft or balloon that does not carry a human operator and is capable of flight under remote control or autonomous programming. Also called UA." "That system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft. Also called UAS." "A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semi ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles. Also called UAV."*

UAS comprises the aircraft and the following elements [2]: 1) control station, 2) software, 3) health monitoring, 4) communication link(s) (for command & control + data), 5) data terminal(s) (payload exploitation), 6) payload, 7) launch & recovery systems, 8) flight termination system(s), 9) support & maintenance equipment, 10) power generation, distribution & supply, 11) air traffic control communications equipment (voice & data), 12) handling, storage & transport equipment, and 13) all required documentation related to aforementioned.

UAVs have a century-old history in aviation. UAVs were tested During World War I in 1920. At that time UAVs were not used in combat. Germany used a simple but deadly V-1 "flying bomb" during World War II what made base for post-war UAV programs in U.S. In Vietnam War UAVs were first time used in surveillance tasks. However, same type of UAV was modified to carry payload and had its first test flight on December 2002 [3].

The Israeli Air Force (IAF) had several UAVs in late 1970's and 1980's. It was noticed that Israel used UAVs successfully in Lebanon 1982. That encouraged U.S. Navy to acquire a UAV capability for the U.S. Navy [3].

There are several reasons why the UAVs role has only recently received more attention and interest in wider. Technique, which was not available a few years ago, is now available. UAVs might have received more attention in the past, if the crisis should be addressed by enforcement and intelligence during the conflict. The absence of such crises, together with the paradigm change needed to happen before unmanned vehicles were adopted, meant that the UAV is an advanced technology and has become available [3].

A. UAS categories

UASs have categorized many ways. According [2] UASs are categorized by size and altitude: a) Micro (μ), b) Mini, c) Mini; Lighter-Than-Air, d) Close Range (CR), e) Short Range (SR), f) Medium Range (MR), g) Medium Range Endurance (MRE), h) Low Altitude Deep Penetration (LADP), i) Low Altitude Long Endurance (LALE), j) Medium Altitude Long Endurance (MALE), k) High Altitude Long Endurance (HALE), l) Unmanned Combat Aerial Vehicle (UCAV), and m) Optionally Piloted Aircraft (OPA) & Converted Manned Aircraft.

UAVs are sometimes classified in following categories [4]: a) Tactical, b) Endurance, c) Vertical Takeoff & Landing (VTOL), d) Man Portable (larger than micro air vehicles), e)

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Optionally Piloted Vehicle (OPV) (capable of manned or unmanned flight operations), f) Micro Air Vehicle (MAV), and g) Research (developed for specific investigations).

B. UAS related organizations

EUROCONTROL, Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) are coordinating their UAS activities. International Civil Aviation Organization (ICAO) has also started an official UAS study Group which have 14 countries and 7 international organizations participating. [2]

The European Organisation for the Safety of Air Navigation, EUROCONTROL, is an intergovernmental organisation with 39 member States and the European Community. EUROCONTROL was founded in 1960 as a civil-military organisation that is European repository of air traffic management (ATM). EUROCONTROL leads and supports ATM improvements across Europe and it is committed to build a single European Sky which delivers the ATM performance. EUROCONTROLs role in UAS aspects is to verify that ATM runs into requirements of justified airspace operators. EUROCONTROLs legality aspects include international (ICAO), regional (EASA) and national cooperation. [5]

Legal aspects which EUROCONTROL is dealing include: a) Regulatory Framework, b) Certification, c) Airspace, d) Licensing, e) Liability/Insurance, f) Interoperability of systems, g) High Seas Airspace, h) Control: responsibility and authority, i) Communication: e.g. spectrum (Air-Ground, Ground-Ground), j) Cross-border operations, k) Civil/military, and l) Airborne Collision avoidance (ACAS).

The European Organisation for Civil Aviation Equipment, EUROCAE, is an organisation which formed at Lucerne (Switzerland) in 1963. EUROCAE's aim is to provide a European forum for resolving technical problems with electronic equipment for air transport. EUROCAE applies only to aviation standards and related documents as required for use in the regulation of aviation equipment and systems.

EUROCAE is an association composed of members who are specialized technical fields of Aeronautics and many of them are considered to be among world's leaders in their fields. Members of EUROCAE include Equipment and Airframe Manufacturers, Regulators, European and International Civil Aviation Authorities, Air Navigation Service Provider (ANSP), Airlines, Airports and other users.

EUROCAE organises Working Groups (WG) in order to develop EUROCAE Documents (ED). WG members are experts working on a voluntary basis and they come from the association membership. EUROCAE has developed aviation standards over 43 years. [6]

In United States RTCA, Inc. (known as Radio Technical Commission for Aeronautics until their re-incorporation in 1991 as a not-for-profit corporation) develops consensus-based recommendations among other issues for air traffic management systems. RTCA is a federal advisory committee. RTCA Inc. was organized in 1935 and it includes more or less 400 government, industry and academic organizations around the world. Those member organizations stand for all sectors of the aviation, including government organizations, airlines, airspace users, airfield society and labour unions as well as aviation service providers and equipment suppliers. Its recommendations are used by the Federal Aviation Administration (FAA) based on policies, programs and legislative decisions and the basis for private sector development, investment and other business decisions. RTCA Inc. is a non-profit corporation founded to promote art and science of aviation and aviation electronic systems for the benefit of citizens. The organization operates a federal as a Federal Advisory Committee and develops consensus-based recommendations for the modern aviation problems. With UAVs it's possible for government agencies and business companies to increase efficiency, save money, improve security, and even save lives. Interest is growing a wide variety of uses, from aerial photographs, to surveying the land and the plants, the forest fire monitoring, and environmental conditions, to protecting borders and ports from intruders. [7]

The Federal Aviation Administrator (FAA) regulates and oversees all civil aviation aspects in the U.S. and is that fore National Airworthiness Authority. FAA established the Unmanned Aircraft Program Office (UAPO) to combine the UAS safely and effectively into the National Airspace System (NAS). To achieve this goal, UAPO works closely with the UAS community trough RTCA SC-203 to determine Minimum Aviation System Performance Standards (MASPS). SC-203 recommendations are based on the assumption that UAS and their activity do not have a negative impact on existing NAS users. [8]

The European Aviation Safety Agency (EASA), agency of the European Union, has specific regulatory and executive functions in civil aviation safety and environmental protection. EASA is an important factor in European aviation safety by promoting and developing common standards of safety and environmental protection in civil aviation as well as common rules at the European level. It monitors Members States' standards implementation and provide technical expertise, training and research for them. [9]

UVS International is an association which operates in France. UVS International presents manufacturers of UAS, subsystems and critical components and associated equipment for UAS, research organizations and academia. UVS International has members in 34 countries on 5 continents. Focus area of UVS International is UAS related airworthiness, certification and air traffic management (ATM) issues. The UAS associated problems are global, hence UVS International puts effort to harmonise various national and international approaches at the easiest possible stage aim to inserting UAS into non-segregated airspace. [2]

The Association for Unmanned Vehicle Systems International's (AUVSI) mission is to promote and support the unmanned systems community through communication, education and leadership. AUVSI is a global organization that holds robotics / unmanned systems community. AUVSI as a key player in unmanned systems and robotics community it is committed to facilitating the extension of knowledge and to promote educational opportunities of UAS. AUVSI is recognized as a source of knowledge in robotics and unmanned systems, and has been recognized both by governments, industry and universities. [10]

The European Unmanned Systems Centre (EuroUSC™) is independent Light UAS Approvals specialist. It's authorised to asses the airworthiness of Light UASs of maximum weight 150 kg. Safety is the main objective and the mission of EuroUSC™ is to make the light UAS revolution a reality. EuroUSC™ has background in military and civil aircraft operations; therefore it has understanding the commercial realities of UAS as well as operations and training. EuroUSC™ works with organisations and companies which develops practical ways to operate UASs. [11]

World's oldest non-profit-making association The Unmanned Aerial Vehicle Systems Association (UAVS) focuses on the development of networks, increased cooperation and a safe, integrated and comprehensive utilization of unmanned aerial systems. UAVS is an information channel between the government and industry in the UK and represents the UAS industry, and provides information about what is happening in the field of legislation, in particular in the UK. UAVS regularly consults its members and even wider the industry for future UAS topics that focus on UASs civilian use and commercialization. UAVS collect the information proposals to improve the CAP 722, 4^{th} edition, the Unmanned Aircraft System Operations in the UK airspace -guidance. [12]

The Civil Aviation Authorities of Austria, Belgium, Czech Republic, France, Germany, Italy, the Netherlands, Spain and the United Kingdom have formed an organization named Joint Authorities for Rulemaking Unmanned Systems (JARUS). JARUS' active members are also EASA and Eurocontrol. Organization's final purpose is a single set of draft airworthiness, both airspace and operational requirements for civilian UAS below 150 kg or which are for research purposes and are accepted by participating countries.

The above-mentioned organizations and associations are just examples of dozens of different entities, which operate in the field of unmanned aerial vehicles.

C. Structuring of the rest paper

Chapter II of this paper discusses the theoretical background of this study and has two viewpoints; what is case study as a research method, case study and the development or implementation of the system and innovation; problem formation section discusses the historical use of UASs and gives examples potential governmental use cases for non-military UAS applications. Chapter 3 presents the problem solution of this case study. Chapter 4 sets out the conclusion of the case study and answers to research questions.

II. Theoretical Framework

A. Case study research

Theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test. It is impossible to achieve this ideal of a clean theoretical slate. Attempting to approach this ideal is important because preordained theoretical perspectives or propositions may bias and limit the findings. Investigators should formulate a research problem and possibly specify some potentially important variables, with some reference to extant literature. They should avoid thinking about specific relationships between variables and theories as much as possible, especially at the outset of the process [13].

Case studies have been used in teaching and research since the early 1900`s and have become increasingly popular [14]. It has been used for exploratory, descriptive and explanatory purposes, depending on basic questions such as "what, who, where, how many, how and why?" [14]. Case studies are often assumed to be more holistic than other types of business analysis, for instance by mixing quantifiable and qualitative data [14].

A relevant property of theory building is to compare emergent concepts, theory, or hypotheses with the extant literature. This includes questions what is this similar to, what does it contradict, and why? An answer to this process is to consider a wide range of literature [13]. Case study research will answer questions of "how?" and "why?" [15].

Case study can be descriptive in its nature but it can also test theories. Information can be obtained by survey, interview, observation and the use of archival material. Collected information may be either quantitative or qualitative. A case study will examine one case or multiple cases [16].

More importantly, conflicting literature represents an opportunity. The juxtaposition of conflicting results forces researchers into a more creative thinking than they otherwise could be able to achieve. The result can be deeper insight into the emergent theory and the conflicting literature, as well as sharpening of the limits to generalization of the focal research [13].

Case study, as a method, has been criticized; inter alia, the lack of scientific rigor [16]. Every researcher has to follow systematic procedures, reliable evidence and neutral perspective in case study research [15]. The second point of criticism of case study method is that case study provides a little basis for scientific research [16].

The development is learning by doing. Researchers who construct case study often participate in the development or implementation of the system they are researching [15]. The constructive research is one of the options currently available for a case researcher [14].

The constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world and to make a contribution to the theory of the discipline in which it is applied. The central notion of this approach, the (novel) construction, is an abstract notion with great number of potential realizations. All human artifacts are constructions. Artifacts are invented and developed, not discovered [14]. Use of design evaluation methods in case of case study is recommended [17]. By using observational method one has to study artifact in depth in business environment. Success is based on the researcher's skills; developing or constructing a theory or an object and the selection of appropriate means to justify the theory or to evaluate the item [17].

It is important to emphasize the significance of five components of a research design in case study; question, propositions, unit(s) of analysis, the logic linking the data to propositions and the criteria for interpreting of the study [15].

First strength of theory building from cases is its likelihood of generating novel theory. A second strength is that the emergent theory can be tested with constructs. A third strength is that the resultant theory can be empirically valid. The likelihood of valid theory is high because the theory-building process is tied with evidence that it is very likely that the resultant theory will be consistent with empirical observation. In well executed theory-building research, investigators answer to the data from the beginning of the research [13].

Some factors that lead to strengths in theory building from case studies also lead to weaknesses. The intensive use of empirical evidence can lead to theory which is overly complex. The result can be theory which is very rich in detail, but poor in the overall perspective. Second weakness is that building theory from cases may result in narrow and simple theory. Case study theory building is a bottom up approach such that the specifics of data produce the generalizations of theory. The risks are that the theory describes a very simple phenomenon or that the theorist is unable to raise the level of generality of the theory [13]. Theory developed from case study research is likely to have important strengths like novelty, testability, and empirical validity, which arise from the close linkage with empirical evidence [13]. Theory building approach is well-suited to new research areas or research areas where existing theory seems inadequate.

It is recommended to researchers to use multiple sources of evidence (triangulation) in case study. There may be explanatory, descriptive and exploratory case studies [15].

The process of building theory from case study research is a strikingly iterative one. When an investigator may focus on one part of the process at a time, the process itself involves constant iteration backward and forward [13]. Analyzing data is the heart of building theory from case studies and in the same time it is the most difficult and the least codified part of the process [13].

B. Problem formation

Laurea University of Applied Sciences has studied micro aerial vehicles (MAV) and their use of public safety professionals [18], [19]. The vision and aim of the Finnish aerospace and aeronautical engineering professionals is to provide an ability to develop and maintain UAS systems, and process the ability to refine international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs [20].

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UASs is restricted by the lack of legislation. Government activities and the civilian side of the UAS could be used for many different purposes of use. UAS international aviation regulations concerning Visual Line of Sight (VLOS) in the use of Light Unmanned Aerial Systems (LUAS) might be ready 2012-2015. Total aviation regulations might be ready in 2020, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented [21].

Next, we present a few examples of how to use unmanned aircraft in the Public Sector. There are numerous of organizations where the needs of UAS can be utilized.

Mass events and various events described below could be improved by using UASs. In case of security in various public events like football matches, demonstrations and other public safety issues, operational management as well as maintaining of situational awareness enhances by using UAS.

In the case of lost or drowned person's search for land and inland waters and islands from air, or the lost of ship or boat, or search for locate in inland waters it is a police-led task [22].

The police have responsibility for leading various operational situations. Operational management situations can locate on land or inland waters. Police can appropriately provide rescue service related assistance to public order and security maintenance, hazard and disaster area isolation, transport, guiding, organizing the search for the lost, and other such measures [23]. Violent threats have become more common, for instance armed or dangerous person's search. In this kind of case, the local police resources may be very limited in the beginning of the situation.

Disaster or different kind of accidents investigation explains the cause of the accident and also the consequences of it. Accident Investigation Board maintains readiness to rapidly launch an investigation [24]. In major disasters overview of the creation of the situational picture, monitoring and management support to the activities is important.

In massive fire and building fires, UASs can observe the fire area size and allow the exact location of fire detection. Terrain and forest fire emergency observation is by law organized, when fire danger is obvious or other legitimate reason. UAS can be used for example, to search smoke or to locate oil and to support leadership. Intelligence task can be, for example storm damage and flood damage detection or any other similar task.

Rescue service has responsibility for leading the rescue authority on land and inland waters, fire and related measures of fire, explosion accidents, oil spills etc. In this kind of situations UAS can help rescue management.

International tracking issues have become important after European integration. UASs use can improve criminals tracking by creating a situational picture in multinational and interagency operations [25]. UASs may reduce risk to human life and they are cost effective when comparing to manned aircraft in some types of missions [26].

With UAVs it's possible for government agencies and business companies to increase efficiency, save money, improve security, and even save lives. Interest is growing a wide variety of uses, from aerial photographs, to surveying the land and the plants, the forest fire monitoring, and environmental conditions, to protecting borders and ports from intruders. [8]

Table I present potential use cases for non-military UAS applications. Following figures show how disasters such as the nuclear power plant accident, can be safely observed and monitored and target rescue authorities to the right place without endangering human lives. So far, Fukushima images were grainy, and they have been taken from a safe distance because of security reasons. Following images, taken from UAV, offer the first high-quality pictures of the place.

TABLE I
POTENTIAL GOVERNMENTAL USE CASES FOR NON-MILITARY UAS APPLICATIONS [2]

Custom Authorities	**Police Authorities**
Coastal patrol	Information gathering (in buildings)
On-shore border patrol	Special ops, anti-terrorist
EU maritime surveillance	Urban law enforcement
EU on-shore border patrol	Pre-intervention info gathering
Civil Security & National Police	Urban riot control
Contamination measurement	Perimeter defense
Systematic search ops	Hostile protest control
Natural disaster monitoring	Criminal investigation (several days)
Emergency medical/food supply	Surveillance of public gatherings
	Road traffic surveillance
Regional Fire Brigade	Delivery of non-lethal disabling means
Forest fire surveillance	Coastal border immigration control
National Fire Brigade	Ship lane surveillance
Forest fire surveillance	Permanent police surveillance
Natural disaster monitoring	Land border immigration control
Environmental	Maritime immigration control
Local science missions	EU land border immigration control
Atmospheric measurements	**Contractor Supplied Flight Services**
Wild game surveillance	Training
Fishery control	Terrain mapping
Ozone measurements	Aerial photography
Weather assessment	Monument inspection
Crop monitoring	Network comms relay
Sandbank shift measurement	Emergency comms network
Civil Security	**EU Civil Security**
Avalanche survivor search	Maritime surveillance
Coastal water surveillance	
Maritime search & rescue	

Fig. 1 Full Fukushima site, UAV shots offer high-resolution images of the site [27].

Fig. 2 Directly above the site taken photo on 20th of March, radioactive steam whirls from Unit 3 [27].

Fig. 3 An aerial view taken on March 24, Units 4 and 3 of the plant [27].

Fig. 4 Detailed close-up picture from Fukushima Unit 3 [27]

Fig. 5 Detailed close-up picture from Fukushima Unit 4 [27]

Pictures taken from Fukushima from satellites or from airplanes have been one way or another grainy. UAV can fly near the target because there is no harm for people inside the vehicle. Pictures above were taken following Fig. 6 type of UAV.

Fig. 6 Air Photo Service's Unmanned Aerial Vehicle [27]

III. PROBLEM SOLUTION

The research reported here has attempted to generate new theory on the basis of existing theoretical constructs to meet organizational needs. As we noted in the literature review, our specific research aim has been a relatively new one. Therefore, we use a case study approach, which is generally recommended as a suitable research design for theory-building [13], [15]. Design knowledge is to be applied by people who have received formal education in that field [28]. It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge [29]. Selection of research method to examine the research questions [30].

Interesting research topic in the IS field is how to effectively develop new systems. This is interesting because IT is developing and technical knowledge is growing. IT is applied to new areas, for example UAS, which were not previously believed to need IT support. In this process, new kinds of systems and development methods are created [31]. Case study research is a research to study one or at most a few carefully selected cases. The essential thing is to examine the case. The case study is the most common qualitative research method in business economics. Subject to research in case of the company is usually a process, function or department. In the case study is recommended to use a variety of sources, including interviews and written materials. All qualitative research is not a case study, but a case study may be greatly influenced by other trends in qualitative research [32], [33].

The process of building theory from case study research is a strikingly iterative one. When an investigator may focus on one part of the process at a time, the process itself involves constant iteration backward and forward [13]. Analyzing data is the heart of building theory from case studies and in the same time it is the most difficult and the least codified part of the process [13].

Researchers see the advantages of doing research in team. In our case team-work adds value and brings different point of views to research [34]. Examiner's prejudices should be anyhow avoided [13]. The investigator must be ready to receive and identify the opposite and contradictory information. In this sense, it is constructive to work with the researcher colleague.

Unit of Analysis in our case study is expert's best perceptions of the situation awareness and UASs role in it. In the other hand, experts give their own opinion not the organization's official position or vision [35].

Interviewees were designated based on their expertise. Interview questions represented to eight interviewees, 7 of which were answered. Four interviewees represent the public administration, two private or commercial sector and one represent the academic sector.

A. Research questions

Questions we selected base on the title of our report. Pilot interview was the basis of cross-questions to the following questions [15]. The main questions were chosen after the pilot interview. Interviewee's background concerning UAS was asked in basic questions: What is the organization you represent? In what role do you work? What is your earlier experience and knowledge in the UAV – area? In what task, how many years and what years?

Interview questions of our survey concerned following topics of UAVs; How and in what way UAVs can accelerate and improve maintaining of the real-time picture?, what and why will be the biggest challenges, weaknesses and restriction on the operation at this point in functionally, economically and legally both nationally and internationally? We also asked interviewees if they have else UAV-related matters, they want to highlight.

In our case study we use triangulation of data sources to analyze our research findings. Results are based on the answers we got from interviewees, collected articles from newspapers and video clips we analyzed. In theoretical framework we read scientific publications. The focus of the analysis in this study is improving the situational awareness by using UAVs.

On the civilian use of UASs is restricted by the lack of legislation. Government activities and the civilian side of the UAS could be used for many different purposes of use. UAS international aviation regulations concerning VLOS in the use of LUAS might occur 2012-2015. Total aviation regulations might be ready in 2020 after which the scheduled tasks as a government, as well as scientific research work can probably be implemented. An exception is the United Kingdom, which has prepared the provisions of unmanned aircraft for the purpose. Military aviation authorities have national regulations for the use of UAVs, including Finland [21].

B. SWOT -analysis

All the informants emphasize how important UAVs features with a quick decision-making in a proactive way and overall situational awareness are. Immediate creation and sending of data to the managerial position is particularly important. As well as an accurate real-time picture is necessary to transfer in real-time. Application for UAVs use to speed up the situational picture may be applications where the airplane's use is too expensive to endoscopy or to photograph the object. Informants emphasized the following: *"The situational picture can be accelerated by operating UAS, which is located in suitable sensors and by flying often enough above the target area and move the sensor data to the positions where it is needed." "The management can be provided by real-time picture of what is actually happening, and thereby speed up decision-making in a proactive way. Real-time picture can also be transmitted where it is needed."*
"Management needs real-time image and even the continuous live image."

Informants also highlight the importance of a real-time videos and images recording and analysis possibility afterwards. One informant put that into following words: *"Files can be shared or to explore to the experts who can analyze it and give instructions to the management. Similarly, investigations, etc. can begin immediately."*

As weakness interviewees mention several operators scattered budgets, which are limiting issue of UAVs implement. They are also concerned that UAVs are too expensive for one organization for their own use and informants suggest that UAVs should be concentrated to one user group to maximize the benefit of the devices. According to informants there is limited operating experience in Finland and access to international cooperation. The economic challenges are the development and dissemination costs. Different kind of tools and equipment are constantly renewing and their management is challenging. Procurement and development have been tried to do in previous years, but the government financial situation prevents to invest in development projects. One informant verbalized like this: *"There is no equipment or personnel, which dominates the job. Devices are too expensive for only one organization for their own use. Everywhere should be linked to both authorities as municipalities, cities, industry, or with other research."*

One concern according to informants is resistance to change of new concepts and systems for dismounting the traditional way of operating hampers implementation of UAS. Authorities are developing their own systems; instead they invest in the common and workable system. Equipment should be concentrated to one user group to maximize the benefit of the devices: *"The market is ready for low cost and reasonable UAV equipment, initially, the matter is considered to be sufficiently simple and generally applicable." "In the future, the UAS is important, as the technology becomes more affordable to buy."*

Functionally the challenge is the lack of ignorance like some informants prompt: *"The general ignorance of the UAS is a major challenge, but as this interview shows for its part, we are getting rid of it." "The image media give of the UAV does not contribute to the expansion of activities. Media want to tear the large headlines like "Big Brother Watching" and "Robot Airplanes Throwing Missiles". Aforementioned is a very one-sided view on this matter."*

The biggest challenge for operationally use of UAVs is that legislation does not know well enough UAVs as an aircraft. Training and other requirements are not specified for UAS-operation as well of the operator and the actual apparatus. Especially for large UAVs development is waiting for standardization. As one informant aptly impressed: *"Legislation lives in the past, in a time when an airplane was always manned."*

Table II summarizes the main characteristics according to informants' answers concerning strengths, weaknesses, opportunities and threats, i.e. it illustrates SWOT-analysis of using UAS in improving real-time picture.

TABLE II
SWOT-ANALYSIS OF USING UAS

Strengths	**Weaknesses**
Rapid situational awareness	Several operators scattered budgets
Equipment quickly in place where needed	Equipment too expensive for one organization for their own use
Data can be sent immediately to management center	Ignorance of the benefits of new activities
Real-time image and video can be stored for later analyzing	Lack of legislation
UAS per flight hour is cheap compared to helicopters	General ignorance of the UAS
Opportunities	**Threats**
Equipment concentrated to one user group to maximize the benefit	Authorities are developing their own systems
MAV's flight restrictions compared to UAVs flight restrictions are more liberal	Lack of legislation
UAS technology becomes more affordable to buy	Resistance to change of new concepts and systems
Market is ready for low cost and reasonable UAV equipment	

In threat prevention - by supplementing and maintaining real-time picture – UASs can be used for public order and safety, rescue, border security and immigration monitoring and observation.

UAS based knowledge of the authorities must increase to influence the development of confidential relations between different authorities and actors. In this way may be found new ways of working. Cross-administrative strategic definition of policy approach must be taken into account in all UAS activity. Developing, raising awareness and drawing attention to the authorities and other actors to cooperate extensively the operation of the UAS and activate the function is essential. Clarifying the definition of UAS in such a way that public authorities and other actors have UAS similar interpretations in purpose that there is a common language on the same terms. Enhance the capability of UAS implementation in order to accelerate and improve of a real-time picture through the systematic training and guidance. Implementing UAS -system and developing recommendations for action for UAS use in purpose to improve legislation and UAS performance.

Strengthening cooperation for ensuring comprehensive real-time situational picture, and to removal of barriers to cooperation, which are based on broad cooperation with the traditional security authorities, other public authorities, industry and NGOs confidential co-operate under the same goals. The actions are based on extensive, real-time picture. Real-time picture is a basis for designing, dimensioning and coordinating the various authorities in the same complex tasks. It's carried out by activating the authorities to participate by using the shared resources.

As a conclusion for this chapter are our main informant's suitable words: *"By far the biggest challenge to the UAS world is that international and national aviation legislation does not recognize unmanned aviation… although the UAS can accomplish some things more easily, more efficiently, safer, and more preferably in a way that has not previously been possible, UAS is only one tool among many. ... the entire aviation world is not changing unmanned."*

IV. CONCLUSION

The starting point of this study was to find out how real time picture and situational awareness can be improved (How and why?). The research was started by a desire to explore is it possible and how it can be done by using UAS. Our study was focused to UAS generally and we delimited other systems like micro and mini aerial vehicles out [36].

The theoretical part focused on theory building of case study research and how we can exploit it in our report. Most scientific publications concentrate on building, planning and technical properties of UAS. Unmanned aircrafts are currently used mainly for various military purposes. Our study was limited to civilian use of UASs, which is restricted by the various instruments lack. Government activities and the civilian side of the UAS could be used for many different purposes of use.

The empirical part of the study was limited to few examples how UAS can be applied in different cases. Research interviews revealed, how important is interviewee's expertise, when applying case study research method and little or no scientific material is available. Without expertise, research work about the whole issue could be worthless.

Case study research improves profound understanding. The aim of the study was to analyze and assemble a clear summary about the issue by utilizing different kind of data. We succeeded to clarify the implications for different organisations when UAS is applied in the future. Research objectives were successfully and the research questions were received answers. From the research, the needs for UASs can be seen, as well as social general ignorance how UASs could be exploited in civilian use.

Several sources in our study revealed growing needs for UASs. Our findings showed the importance of continuing the research in the field of UASs. Further research may address, e.g. the legality aspects, possibilities for authorities common UASs, and the overall commercialization and business models of UASs. In the future, this topic will be much more explored. Following of technical and operational developments of UASs is interesting. The future shows, how quickly the use of UASs raises or what will happen. In the future, it is also important to find out what have not yet been taken into account.

Cooperation between different users of UASs is essential and interoperable services for e.g. fire and rescue, police, customs and border control authorities are needed. Service providers must be familiar with the various actors' needs to be able to meet the demand by the right way. Therefore, selecting a product with a wide variety of different operational needs should be given special attention.

Public safety UAV operations must meet at least the following six criteria: 1) economy, 2) ease of use, 3 credibility, 4) real-time documentation and the creation of a snapshot, 5) speed, and 6) reliability. In threat prevention – by supplementing and maintaining real-time picture – UASs can be used for public order and safety, rescue, border security and immigration monitoring and observation [36].

Public safety authorities are fragmented into several operators with scattered budgets, which are limiting issue of UAVs implement. In their view, UAVs are too expensive for one organization's own use, and they suggest that UAVs should be concentrated to larger user groups to maximize the benefit of the devices. The economic challenges are the development and dissemination costs. Different kind of tools and equipment are constantly renewing and their management is challenging. In previous years, some procurement and development work have been tried. Today in Finland, the government financial situation prevents to invest in development projects.

Today, all authorities are developing their own systems; instead they should invest in the common and workable system. Equipment should be concentrated to larger user groups to maximize the benefit of the devices. One player is unable to cope on their own for systems implementation and operation. Funding for such a large system than a UAS does not succeed within a one public organization measures. For that reason, it is essential to create a network, and thereby obtain synergies from a wide-scale deployment of UAS.

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Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS)

Tuomo Tuohimaa, Ilkka Tikanmäki and Jyri Rajamäki

Abstract—This study deals with the importance of networking for co-operating authorities and their duties. As an example, we will dissect unmanned aircraft system (UAS) utilization for improving and speeding up a situational awareness and a real-time picture. Networking is emphasized between cooperation with national authorities, because the players are under the supervision of different ministries. Inter-ministerial co-operation is already in a good shape, but given the relevant persons in the mutual interaction may be scarce. In this point of view, the challenge for UASs use include ministries fragmented budgets, a lack of common practices of the new system of exploitation and the lack of cultural activities. It has revealed a need for networking between the authorities in cooperation of implementation of UAS. Different levels of networking means to cooperation between organizations: 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 (sectored, regional, level) mention areas.

The importance of cooperation between authorities has discovered an important subject to be developed. The Finnish Government's Security and Defense Policy states that the close cooperation between the authorities achieves synergies between overlap functions by cutting and support functions to enable efficient use of. Situational awareness and government collaboration will be developed both nationally and internationally. Efficient use of resources in society is a sensible, economical and appropriate. Therefore, in UAS development activities, must participate many part-sides (Police, Fire and Rescue Services, Border Guard, Customs, etc.). Strategy work requires a new perspective and you must be able to see large complexes. Different entities interact with each other and strategic decisions require courage. Successful organizations create a successful strategy, implement it and they are able to renew their strategies with the latest requirements.

***Keywords*—**Public safety, UAS, UAV, Unmanned aircraft system, Unmanned air vehicles

I. Introduction

THIS paper deals with the cooperation challenges in public safety organizations for improving situational awareness and real-time pictures. As an example, we dissect unmanned aircraft systems (UASs). At the moment, the unmanned types of planes are mainly used for military purposes. There are several reasons why unmanned air vehicles (UAVs) role has recently received more attention and interest; uppermost being the development of new technology, which was not available a few years ago [1], [2], [3].

In the past years, UAVs have extensively been applied in such areas as reconnaissance, intelligence and border security. In those specified missions, UAVs are required to operate at a high accuracy. The dynamic modeling and especially the automatic control system design are playing very important roles [4].

Scientific and technological developments in mobile communications, sensors, drive systems and other areas are rapidly making it possible to develop UAVs with advanced technology [5]. In the past, UAVs might have received more attention, if crisis should be addressed by enforcement and intelligence during the conflict. The absence of such crises, together with the paradigm change needed to happen before UAVs were adopted, meant that the advanced technology for UAVs has become available [6].

UAVs classification with regard to altitude and weight is presented in Fig. 1. Depending on the maximum weight and altitude, UAVs can be divided into five categories; micro, mini, tactical, medium altitude and high altitude [7].

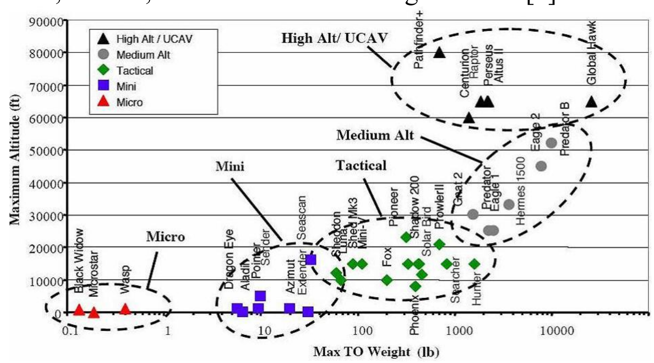

Fig. 1. Altitude and Weight Classification of Current UAVs [7].

The outline of the paper is as follows. First, the issue is presented and the theoretical framework is formulated in Chapter II. Then, in Chapter III the method applied in this paper is presented. Chapter IV presents problem formulation and Chapter V shows the problem solution. Chapter VI illustrates developing cooperation between public safety authorities and Chapter VII presents the results. Finally, on Chapter VIII the most important conclusions are drawn.

II. Theoretical Framework

Strategic management represents a prioritization of key success factors in the selection of strategic objectives, indicators, and the use of objective awareness, flexibility in structure and adaptability to environmental changes, which will be closely monitored, and in which react in advance [10].

As shown in Fig. 2, end-users of UASs can generally be divided into two sections; private and public. This study

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concentrates in using UASs on public sector. Naturally, private and public sector already cooperate in many ways and development of that cooperation continues growing.

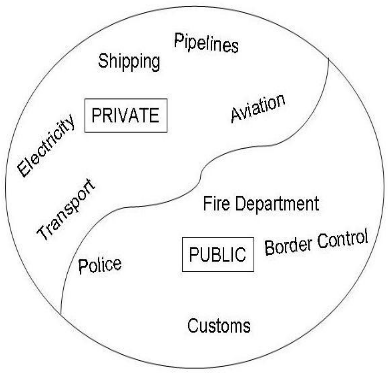

Fig. 2. Examples of UAS End-users.

The importance of cooperation between authorities has discovered an important subject to be developed. The Finnish Government's Security and Defense Policy states that the close cooperation between the authorities achieves synergies between overlap functions by cutting costs and support functions. According to [11], situational awareness and government collaboration will be developed both nationally and internationally.

In network of multilateral cooperation, companies are looking for cooperation in providing solutions to challenges and problems when their own resources are insufficient [12]. Networking is the 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 [13]. Good experiences create confidence. Confidence is paving the way for information exchange, joint projects, especially joint learning [12]. Trust, however, requires a lot of open discussion. The key to building trust is a gradual increase in transparency. Transparency applies to all activities. Subjects must learn to consider both by your company's as well as network's point of view.

Networking means multilateral cooperation, with joint work to seek solutions to the challenges and problems which can solve their own resources are insufficient. The initial operation of the network is based on precise rules while later will be needed flexibility enabled by trust [12]. Networks of two or more independent companies for the long-term cooperation relationship with the companies will jointly implement the business to achieve stronger competitive positions. Networking is the 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 [13].

A network construction is simpler when there is a focal company available. Such action, however, requires a common understanding of the advantages of the network; develop mutual trust and a common way to understand the issues and a shared vision [12]. Processes like networking cooperation are planned together with networked companies. Key elements of activities are trust, commonly recognized values and flexibility [13]. Key Network Management (KNM) is a systematic way to manage key networks. According to [14], key network is a set of actors mobilized by the focal company to realize an opportunity. In the case of UAS use within several authorities for their needs, it is necessary to designate the focal organization which takes control of managing the UAS.

Already long time, networking has been one of the key elements of Finland's defense construction. Networked defense know-how and performance abilities will be utilized in cooperation with partners. Interagency cooperation is essential that various actors have sufficient knowledge of others concepts, measures, resources and plans [15]. Collaboration is central to the local and regional settlement. Interagency co-operation aims at the cost savings that increase the efficiency [16].

For example, large public events in support of the police leadership have been set up command centers for general and field management. Command centers have liaison officers of different actors that allow coordination of actions. Command centers have usually represented by the police, event organizer, rescue services, border guards, customs and military representatives. Depending of the nature of the event design and operation also other public authorities may be presented. Authorities in the future will join the increasingly interconnected. For example, law on the Defense Forces, Rescue act and the Police act define the cooperation between the authorities and other authorities to support very important tasks [16].

External and internal securities are linked closely together. Preparedness and response for security threats require Finland to a strong national and international co-operation, a pre-agreed arrangements for cooperation between the authorities, business and NGOs [17]. One of the statutory duties of the Defense Forces is to support other agencies.

Assistance is requested from another authority in situations where the responsible authority in the resources for the performance to be reached or is missing from a particular sub-region. In addition to Defense Forces' normal development of capabilities related tasks, Defense Forces develops the ability to support other agencies. Defense Forces provide assistance of about 500 times a year to other authorities, so the ability to cooperate and manage leadership develop as well [18].

Vital functions of society and the responsibility of division between ministries and sectors is defined in the functions vital to society security strategy. The Homeland Security program sets a cross-administrative targets, strategic guidelines and measures in different sectors of government to achieve the objective [19]. A Cross-administrative entity in principle is shown in Fig. 3.

Condition is influencing the future development of cooperation, because individual operators have limited ability to influence global and diverse in society [19]. Each administrative domain is responsible for the administration in the exercise of its functions. Resource sharing, fraud coordination and authorities' joint planning are prerequisites for the wide comprehensive security concept under the new threat images [19]. Important issue is the flow of information between the authorities and availability of the mobile real-time picture.

Functioning management system is based on a reliable real-time picture. In addition to real-time situation picture it is needed to a proactive and comprehensive environment for analysis. Securing the Functions Vital to Society as part of the implementation of the strategy will be a real-time picture of the Government in parallel with the sectored development of a real-time situational picture [19]. The Ministry of Finance, Ministry of Interior, Ministry of Defense, Ministry of Transport and Communications and the Ministry of Foreign Affairs are co-developing safety net, which will be used for military, police, border guard and rescue needs. Developing network environment allows for a later stage the development of the common real-time picture for the authorities [18].

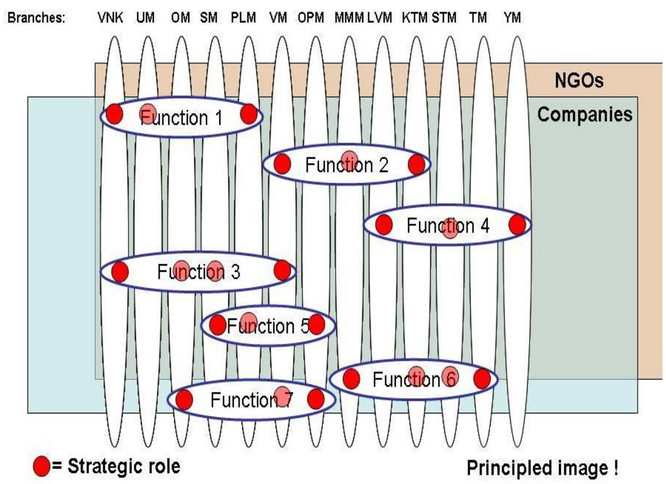

Fig. 3. A cross-administrative entity [19].

III. Method

Design science often takes a simplistic view according which designed artifacts must function. Designing of an artifact, assessing of its utility and comparing it with competing artifacts are essential tasks of design-science research [8]. The applied technological logic of the rule is that if you want to achieve Y in situation Z, then do X action. X is a general solution concept for a type of field problem. Solution concept can be an act, a series of acts, but also a process or system. In construction problems this can also mean building a new artifact out of previously unrelated materials [9].

In this study, we apply case study research method. The research report has an attempt to generate new theory on the basis of existing theoretical constructs to meet organizational needs. As we noted in the literature review, our specific research aim has been a relatively new one. Therefore, we apply a case study approach, which is generally recommended as a suitable research design for theory-building [20], [21]. Design knowledge is to be applied by people who have received formal education in that field [22].

Case study can be descriptive in its nature but it can also test theories. Information can be obtained by survey, interview, observation and the use of archival material. Collected information may be either quantitative or qualitative. A case study will examine one case or multiple cases [23].

The development is learning by doing. The information obtained by development process, can be integrated into case study. Researchers who construct case study often participate in the development or implementation of the system they are researching [24]. The constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world and to make a contribution to the theory of the discipline in which it is applied [25].

The result can be theory which is very rich in detail, but poor in the overall perspective. Second weakness is that building theory from cases may result in narrow and simple theory. Case study theory building is a bottom up approach such that the specifics of data produce the generalizations of theory. The risks are that the theory describes a very simple phenomenon or that the theorist is unable to raise the level of generality of the theory [21].

There are six sources of evidence for case studies; documentation, archival records, interviews, direct observation, participation-observation and physical artifacts. All mentioned case study sources have their weaknesses and strengths. It is recommended to researchers to use multiple sources of evidence in case study [20].

Interesting research topic in the information system (IS) field is how to effectively develop new systems. This is interesting because information technology (IT) is developing and technical knowledge is growing. IT is applied to new areas, for example UASs, which were not previously believed to need IT support. In this process, new kinds of systems and development methods are created [26].

Case study research is a research to study one or at most a few carefully selected cases. The essential thing is to examine the case. The case study is the most common qualitative research method in business economics. In the case study is recommended to use a variety of sources, including interviews and written materials. All qualitative research is not a case study, but a case study may be greatly influenced by other trends in qualitative research [27], [28].

Case study has mentioned to be one of the least systematic research methods methodologically. There are three areas where case study researchers should pay attention to. These areas are; design issues, data collection and data analysis. They also highlight the apparent lack of rigor that is one area where qualitative, including case study, research should improve [29].

The process of building theory from case study research is a strikingly iterative one. When an investigator may focus on one part of the process at a time, the process itself involves constant iteration backward and forward. Analyzing data is the heart of building theory from case studies and in the same time it is the most difficult and the least codified part of the process [21].

Researchers see the advantages of doing research in team. In our case team-work adds value and brings different point of views to research [29]. Examiners' prejudices should be avoided. The investigator must be ready to receive and identify the opposite and contradictory information. In this sense, it is constructive to work with the researcher colleague [23]. Unit of Analysis in our case study was expert's best perceptions of the situation awareness and UASs role in it. In the other hand, experts give their own opinion not the organization's official position or vision.

IV. PROBLEM FORMULATION

The SWOT analysis is a typical strategic planning process. Strategic planning is a part of strategic management [10]. Strategic planning constitutes the framework for the design aspects, tactics, to identify the criteria or the constraints that must be taken into account in operational planning.

Public organizations can be generally divided into three categories, how they see their future: (1) drifted into the future. (2) adapted to the future and (3) the future makers [30]. Future management is based on the conclusion that the future can be created. All, what you do affect in the future. The future can be created and it can be influenced by own efforts, the future can be made, and action requires the organization to a proactive approach. Public organizations have traditionally alienated this approach, especially independent strategic flexibility and individual responsibility in its creation and its exploitation. Strategy is an essential part of the future. Public organizations should continuously evaluate their strategic position and it should be a natural part of normal activity [30].

Being a good strategist might not be enough. Leadership is more than a strategy to match action with the environment. It is self-adjustment to social environment [31]. Strategic management problems and, above all obstacles to the realization of strategies in public administration are [30]:

1. strategies are in the air and do not interfere with everyday life, because it is not known, propagates the organization in the direction of strategy
2. lack of vision and action ideas
3. management of the budget process is over exaggerated, a strategy process is not connected to the annual operational and financial planning and monitoring
4. management systems and attitudes do not sufficiently support the implementation of the strategy required for the interaction, but rather daily reactive management
5. loose strategy elements (personnel, communications, information management, service, quality strategies, etc.) that are linked to common strategic disadvantage
6. the majority of staff and middle management internalizes badly strategy and its importance
7. staff participation in the strategy process is the exception rather than the rule
8. implementation of the strategy are not monitored or revised systematically.

Learning and growth strategy deal with the intellectual property which is needed in organization's activities and customer relationships for continuous improvement. This aspect relates to three areas [32]:

1. Strategic knowledge: strategic knowledge and skills that workers need to support the strategy.
2. Strategic technology: information systems, databases, tools and network required to support the strategy.
3. Operating Atmosphere: corporate cultural changes that are required to carry out a strategy to motivate staff, to empower and to adapt.

The vision and aim of the Finnish aerospace and aeronautical engineering professionals is to provide an ability to develop and maintain UAS systems, and process the ability to refine international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs [33].

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UASs is restricted by the lack of legislation. Government activities and the civilian side of the UAS could be used for many different purposes of use. UAS international aviation regulations might be ready 2012-2015, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented.

There are numerous of organizations where the needs of UAS can be utilized. Mass events and various events described below could be improved by using UASs. In case of security in various public events like football matches, demonstrations and other public safety issues, operational management as well as maintaining of situational awareness enhances by using UAS.

In major disasters overview of the creation of the situational picture, monitoring and management support to the activities is important. In massive fire and building fires, UASs can observe the fire area size and allow the exact location of fire detection. Terrain and forest fire emergency observation is by law organized, when fire danger is obvious or other legitimate reason. UAS can be used for example, to search smoke or to locate oil and to support leadership. Intelligence task can be, for example storm damage and flood damage detection or any other similar task.

V. PROBLEM SOLUTION

It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge [35]. Everlasting interesting research topic in the IS field is how to effectively develop new systems [26].

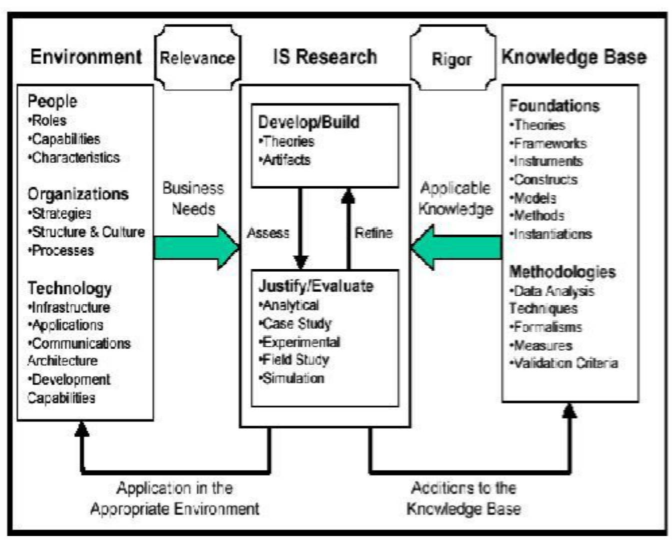

Fig. 4. IT Systems Research Framework [8].

Information systems research framework is shown in Fig. 4. Reference [8] considers as a basis for research the business environment which consists of people, business organization and technology. The targets of research in their view are human form of roles and competencies as well as the organization's strategies and processes, and technologies which support these.

Unmanned aircrafts are currently used mainly for various military purposes. On the civilian use of UAVs is restricted by the various instruments lack. Government activities and the civilian side of the UAS could be used for many different purposes of use.

Unmanned Aircraft System (UAS) international aviation regulations might be ready 2012-2015, after which the scheduled tasks as a government, as well as scientific research work can probably be implemented. An exception is the United Kingdom, which has prepared the provisions of unmanned aircraft for the purpose. Military aviation authorities have national regulations for the use of UAVs, including Finland [36].

Visions and objectives of the Finnish aerospace and aviation fields of technology professionals as UAS / UAV-systems will create the ability to develop and maintain these systems, and marketing abilities profitable international business. Prerequisite for this kind of activity include, inter alia, its own mini-systems development, subsystem development (sensors, data flow) and research involvement in international development programs [33].

There is a need for a new kind of strategic thinking, and -working tools, which emphasize the following starting points [30]:

1. Instead of drawing analysis of strategy attention should move to it, how to create strategies for action in practice.
2. Strategy must be based on the organization's right to exist and to express the common will of the desired future.
3. The strategy process must be geared towards strengthening the organization's skills and continuous learning.
4. Strategy process must be based on participation and interaction.
5. Successful process of strategy requires constant communication.

Learning and growth strategy of intellectual property are needed in organization's activities and customer relationships for continuous improvement [32]. This aspect relates to three areas

1. Strategic knowledge: strategic knowledge and skills that workers need to support the strategy.
2. Strategic technology: information systems, databases, tools and network required to support the strategy.
3. Operating Atmosphere: corporate cultural changes that are required to carry out a strategy to motivate staff, to empower and to adapt.

Fig. 5 shows how the knowledge helps doing things also in strategic management. Exporting strategy into practice mean that the management and staff are committed into following issues [30]:

4. Vision and strategy are communicated to staff and it is connected to learning, action planning, rewarding and performance evaluation as part of management and values in implementation.
5. Set a strategy for the operational objectives, the coordination of development projects, ensuring resources and define milestones unit-level strategies.
6. Clarify connection of strategy and our own work to your personal level of performance and development discussions.
7. Strategy objectives will be monitored regularly and respond quickly for good and poor accomplishment.

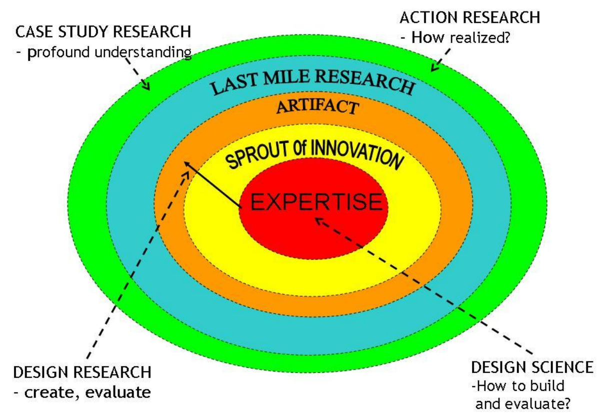

Fig. 5. Body of Knowledge [34].

Learning and growth strategies are a prerequisite for long-term and lasting change. Management teams are a prerequisite for long-term and lasting change. Management teams are ready to recognize the importance of this aspect, but they are not usually very well aware of how these objectives will be defined or achieved. Careful planning of more opportunities increases learning and growth strategies successfully [32].

VI. Developing Cooperation

Developing a multi-authority security circumstances tactics and training by adding to the exploitation of common resources and expertise in the use of various authorities in identifying opportunities and means to support the goal should be taken in the account. The actions are based on extensive, real-time picture. Real-time picture is a basis for designing, dimensioning and coordinating the various authorities in the same complex tasks. It is carried out by activating the authorities to participate by using the shared resources.

By identifying various authorities' opportunities and means to support operations, the best results are achieved. When establishing a national strategy for UAS, this defines and clarifies the responsibilities of authorities and their roles of UAS operations. Developing and expanding operational cooperation aims practical co-operation and mutual interaction between the authorities, which will improve the situational picture. By exploring official actions and academic efforts factors that influence a real-time picture and current situation in Finland, government may organize authorities' training and a wide-ranging co-operation between authorities.

Inspection of various terrains, in case to find the target of interest, is a task that can be combined for example with various civil and military activities. Possible applications are the search and rescue mission, which aim to find the missing, injured or persons who have been in any kind of danger. These operations can last several days and they require a large and diverse group of technical support. Therefore, also the need for substantial funding exists [37].

It can be said that an image processing subsystem is a necessary and important part of an efficient and complete search and rescue system. It is surprising, that there are not many articles or literature about this area of interest [37].

Management should be an effective expression of will, cooperation, collaboration, interaction, operability and interoperability in depressed or disaster areas of trans-national extent. Modern crisis are difficult to predict and plan. All surprises are possible. This intuition provides improvement of situation awareness, because technological capacity may be not sufficient for all situations. International, crisis- and emergency response management preparedness is possible, in information exchange. Successfully solved interoperability brings more positive effects in cooperation and collaboration of operational entities. Operational processes must act integrally in different tasks and in different sectors [38].

E.g. Cofin project was carried out in Italy in 2004. The project aimed to design and develop a platform for environmental monitoring, involving fire detection and prevention, industrial areas reconnaissance, and natural disaster monitoring. An aerial platform of as small size and weight as compatible to mission requirements was chosen to carry on-board sensors and cameras to provide the user real time picture and information about the area. The mission requirements included capability of remotely piloted flight and autonomous flight [39].

There are many scenarios, where wireless access to heterogeneous information sources would be very valuable. For example law enforcement, access to medical information from an ambulance and major disaster management such as Tsunami. The disaster management personnel need a fast and reliable access to many information sources already before crisis occur. Not to mention what kind of need for different kind of information exists during the crisis and afterwards [40].

VII. RESULTS

We will use UAS as an example of the use of networking in order to bring out the importance of interagency cooperation and a need for common real-time situational picture. The need for collaboration and networking among many actors exists.

A real-time situational picture is used to form a picture of the threat or disaster situation. A picture of the system is geared to produce pre-analyzed information on accident persons acting on decision-making. Grammatically situation awareness refers to the awareness of the situation and situational awareness refers to awareness that only happens sometimes in certain situations [41].

Nowadays different authorities have their own situational pictures for their own purposes. For example, rescue authorities use the picture of the situation to guide the rescue operations; police may by the situational picture help determine evacuation areas and efforts to limit the right places. Authorities are developing their own systems; instead they invest in the common and workable system. Equipment should be concentrated to one user group to maximize the benefit of the devices. Networking benefits of government activities are emphasized, because the authorities do not need a duplication of resources.

Authorities mention as weakness several operators scattered budgets, which are limiting issue of UAVs implement. They are also concerned that UAVs are too expensive for one organization for their own use and they suggest that UAVs should be concentrated to one user group to maximize the benefit of the devices. The economic challenges are the development and dissemination costs. Procurement and development have been tried to do in previous years, but the government financial situation prevents to invest in development projects [30].

A network management develops knowledge for the professionals in its field. Networking can be understood in different sectors, areas and levels to take place. Sectoral networking means in the same field of networking. Regional networking refers to particular geographic area cooperation. Different levels of networking means to cooperation between organizations: 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 (sectoral, regional, level) mention areas [42].

The work culture related to networking is called the confidence and expertise working culture. Networked professional skills are emphasized collaborative skills, independent decision making and continuous development. Previously, expertise was enough a versatile and robust sense of reality, now is also needed to sense of prospect. The expert must be able to overcome both organizational and discipline boundaries [42].

Specific pressures, direct to management: the former issues and the management of people have raised alongside different knowledge management and knowledge management ideologies [42].

We need a new approach, the networking, which ensures rapid flow of information and expertise in the unification. Organizational boundaries are blurred, services and products in a multi-enterprise collaboration. These generated virtual networks, capable of individual companies (authorities) are more competitive because of its speed and its real-time [43].

Network-like organizational action creates the necessary flexibility and speed, as well as the opportunity for continuous data integration, a new creation, and foster innovation [43]. The networks activity is based on partnership, which means the actors, organizations and individuals' co-operation and new forms of co-design. Networked co-operation relates to the strong principle of reciprocity. All these partners will prosper and develop. Common context and objectives provide a framework to stimulate experience-sharing [42].

Network management will play an increasingly important role in interagency cooperation. The manager has a key role of a development and change management. Network Management and modification are not only a leader role; it is a common task and then it has the potential to succeed [42].

VIII. Conclusion

The major focus of strategy will be in the future and it is the most important and most essential thing to seek and find. Strategic thinking requires the ability to think by using of different concepts, but the final strategy must be very practical and applicable. A good strategy will ensure that the right things will be done and by doing different kind of operations, will ensure that things are done correctly. You could say that the strategy is eternal and it must be controlled. Finding the truth is the beginning of wisdom also to the strategies.

The importance of cooperation between UASs in use is highlighted because the services are needed when a number of different industries such as the Ministry of the Interior under the auspices of actors, including police, rescue, customs and border control authorities. 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 should therefore be given special attention.

None of the authority is solely responsible for certain activities, because there is an exemplary cooperation between public authorities. For example, police, securing international meeting does not need to acquire tanks or airplanes. Police may ask for official assistance from Defence Forces when in need of special equipment or expertise. When something happens, it is decided the responsible party who is responsible for operations, but which receives support from other public authorities.

The government should plan to take into account the existing research dealing with UAS and if necessary initiating new research projects. The aim is that the requirements and opportunities to pursue UAS activity to improve a real-time picture and support the UAS-based activities will strengthen.

For example, the Ministry of Interior could set up a cross-administrative co-operation center that concentrates for maintaining the real-time picture. Center should be responsible for coordination and monitoring of progress and support for other authorities. Securing an adequate amount of resources, who have skills required for the task to manage UAS? Verification on Aviation Legislation and authorities' adequate and up-to-date means for the use of UAS in operations must ensure. Ministries will prepare the plan for implementation for their own responsibilities in respect. Ministry of Interior collects the plans, reconcile and coordinate the implementation-related issues. Plans will be updated at regular intervals.

Strengthening cooperation for ensuring comprehensive real-time situational picture, and to removal of barriers to cooperation, which are based on broad cooperation with the traditional security authorities, other public authorities, industry and NGOs confidential co-operate under the same goals is essential. Joint research, education and training activities related to authorities' communication, as well as the authorities' partnerships between the public authorities by ensuring management, situational picture and messaging systems for compatibility and possible integration contribute to the goal.

Developing a multi-authority security circumstances tactics and training by adding to the exploitation of common resources and expertise in the use of various authorities in identifying opportunities and means to support the goal should be taken in the account. The actions are based on extensive, real-time picture. Real-time picture is a basis for designing, dimensioning and coordinating the various authorities in the same complex tasks. It's carried out by activating the authorities to participate by using the shared resources.

By identifying various authorities' opportunities and means to support operations, the best results are achieved. When establishing a national strategy for UAS, this defines and clarifies the responsibilities of authorities and their roles of UAS operations. Developing and expanding operational cooperation aims practical co-operation and mutual interaction between the authorities, which will improve the situational picture. By exploring official actions and academic efforts factors that influence a real-time picture and current situation in Finland, government may organize authorities' training and a wide-ranging co-operation between authorities.

On this basis networking and common management is very important for the development of UAS to the use in a small country like Finland with limited resources. One player is unable to cope on their own for systems implementation and use of it. Funding for such a large system of the whole does not succeed in a one public organization measures. That is why it is vitally important to create network, and thereby obtain synergies from a wide-scale deployment of the UAS.

We believe that the development of UAS for operational activities and to maintain situational awareness constitutes strategic network management in many respects. The importance of networks and networking in the world today can not be overstated. A smooth and seamless cooperation between different spheres of government contributes UASs implementation for public needs for improving and speeding up situational awareness and creation of real-time picture. Our environment and the whole world are constantly changing and that's why there is a growing need for authorities common UAS-system and command center.

We believe that the UASs future implementation activities will benefit both the situational awareness and real-time picture improvement, not to mention the importance of appropriate expertise. We can wait promising results in the future in creation of strategic network between authorities.

We also believe that it has not been paid enough attention to common management between different authorities and experts concerning UASs use in public safety duties. We understand the importance and the meaning of strategic networking and cooperation between authorities. Challenge is to reconcile the needs of different authorities under common management. In the future, this topic is covered much more to explore, and it will be interesting to watch, will developing and the use of UASs raise or what will happen.

Balanced success strategy, a key value and goal, is the participation of different parts of the organization's various departments and personnel [30]. Critical success factors of strategy must be to communicate, to be discussed and questioned. Participatory and inclusive strategy work is a challenge for the entire organization. Balanced success strategy is a journey - not a destination.

Future success is not based on the same kind of operation than today's success. In strategic knowledge and leadership must be able to combine the strategic success factors for each other. The future must be established – not expected.

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Legislation aspects of service design and innovation utilizing Remotely Piloted Aircrafts

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Abstract

The purpose of this study is to find out what kind of new service innovations can be designed by utilizing Unmanned Aircraft Systems (UAS). This study provides an understanding of the current obstacles to 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 doesn't recognise enough UAV as an aircraft. Training and other requirements for the operator and the actual flyer aren't specified 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 it can't be achieved the same benefits as using the UAS system, therefore societal benefits are particularly high. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

KEYWORDS: Legislation, public, private, unmanned aircraft system, unmanned aerial vehicle, service provider

1 Introduction

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

There are several obstacles in utilizing UAS for routine missions; 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 that its generated potential does not yet been understood, 3) governmental cooperation is not sufficiently innovative and forward looking, cooperation should in all cases always be possible and 4) the limited resources restrict the introduction of new concepts. (Aviation Industry and Aviation Technology Program Criteria 2010, 6-8.)

As Table 1 shows, there are numerous of current applications which can be operated by using UAS.

	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

Table 1 Current UAS Applications and Quantity in EU (European Commission 2011).

Non-military UAS applications are divided into 5 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 UASs into two categories according to their weight: maximum take-off mass (MTOM) under 150 kg and MTOM above 150 kg. UAS's use of different kind of security, safety and scientific & research related missions as well as contractor supplied flight services and civil/military cooperation is growing in Europe. Summary of the projected applications in EU is presented in following Table 2.

Visions and objectives of the Finnish aerospace and aviation fields of technology professionals as UAS-systems utilization is to create the ability to develop and maintain these systems, and marketing abilities profitable for international business. 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 (Porter & Stern 2001, 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

Table 2 Overview of projected UAS applications in EU (European Commission 2011).

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

2 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. (Prime Minister's Office, 2009.)

In earlier studies revealed a need for networking between the authorities in cooperation of implementation of UAS (Taitto et al. 2007). 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 use 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 (Taitto et al 2007, 24). Toivola (2006, 17) states that 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. Different levels of networking means to cooperation between organizations: 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 in support of the police leadership have been set up command centres for general and field management. In command centres, the 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 (Taitto et al 2007, 41).

With regard to the development of UAS services, networking is very important 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.

3 Research method and process

This case study research finds out how services can be produced by applying Unmanned Aircraft Systems and what obstacles are there in the legality point of view by using UAS in 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, the study approach, generally recommended as a suitable research design for theory-building (Yin, 2009; Eisenhardt, 1989) is selected. It is required that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge (Orlikowski & Baroudi 1991, 24). The first author of this paper has along experience in an organization where the needs of UAS can utilize.

In the case study, it is recommended to use a variety of sources, including interviews and written materials (Eriksson & Koistinen, 2005; Koskinen et al. 2005, 154 - 157.) There are many ways to collect evidence, and none of methods is unique to the case study and techniques differ greatly (Gerring 2007, 69). The material collected for this study is based on interviews, international and national aviation regulations, scientific publications, collected articles and literary material. One prominent collecting method for data was focus interviews. Focus interviewees designated based on their expertise on aviation laws and aviation industry. Interviewees operate in the preparation of aerial legislation, as training providers or as service providers.

Analyzing data is the heart of building theory from case studies and in the same time it is the most difficult and the least codified part of the process (Eisenhardt 1989, 539). This case study use triangulation of data sources to analyze the research findings. The focus of the analysis is obstacles in the current legislation using UAS. National Aviation Acts differ widely from each other; hence we focus on in the preparation for the international aviation laws. Dubé & Paré (2003, 627) point out three areas where case study researchers should pay attention to; design issues, data collection and data analysis. During the research process we paid special attention to above-mentioned points.

4 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 as well of the operator and the actual flyer. Especially, the development of large UAVs is waiting for standardization.

As main obstacles for Light (small) UAS (25 - 150 kg) are the applicable of 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, especially Small UAS, funded research is not ongoing or upcoming at the moment. ‘Sense and avoid’ binding funded research is not ongoing or upcoming at the moment. (European Commission 2011.)

International Civil Aviation Organization (ICAO 2006) has defined in Chicago Convention Article 8 a pilotless aircraft flight at airspace as follows:

> *“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”.*

Definitions for ‘segregated’ and ‘non-segregated’ airspace are: Non-segregated airspace; “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 “Airspace that is segregated for exclusive use and into which other traffic is not permitted”. (Eurocontrol 2007, 26.)

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” (ICAO 2009).

Currently, most military UAV operations in Europe are restricted to run only in the reserved airspace for the use of UAV that is separate from other air traffic, or UAVs are flying above the sea, using the special arrangements. If action takes place outside the segregated airspace there will be various constraints in order to protect the other aircrafts’ safety using the same airspace. (Eurocontrol 2007.)

In order to take full advantage of current and future UAV platforms’ unique features and implement, a training program have to perform the safe operation of UAV’s. Military authorities in Europe insist that the UAVs can be used with all classes of airspace, and they must be allowed to operate across national borders. The above requires UAV's use outside of segregated airspace. Furthermore, those regulations that exist at a national level are not conducive to routine operations.

In addition, in the light of an enthusiastic and obvious interest in, and a lack of anything similar in the rest of the world, non-European countries could decide to accept the specifications. Specifications may also provide a basis for future Air Traffic Management (ATM) for civil UAVs. Other aspects outside the jurisdiction of Eurocontrol such as airworthiness, certification, system safety, training and licensing of personnel, etc. must deal with the appropriate bodies.

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; he is required adequate training so that he can interact with Air Traffic Control (ATC) and other airspace users. For example, for an IFR flight, this requires an instrument flight rating. Training costs would be lower than manned aircraft pilot is required, but more than the basic requirements for UAV operators.

As the specifications require that the air traffic services provided to UAVs should be equal to manned aircraft, only 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 to respond to and communicate with ATC, to navigate, and to monitor air space and air to operate, to sense and avoid collisions, and 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. (ICAO 2009.)

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. (ICAO 2009.)

The Study Group's development concepts in terminology are; RPA + Remote-controlled Pilot Station + Command and Control links (C2) form the RPAS. According to ICAO (2010) 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 ICAO; 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. (ICAO 2010.) Chicago Convention Article 32 determines Licenses of personnel; Convention incorporates 'pilot' and 'other members of the operating crew' but not remote pilot (ICAO 2006). 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 (CAA 2010).

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. (Eurocontrol 2007.)

5 Discussion

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 legality 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 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 (Yin, 2009; Eisenhardt, 1989). Design knowledge applies people who have received formal education in that field (Van Aken 2004, 225). Require is that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge (Orlikowski & Baroudi 1991, 24).

6 Conclusions

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.

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