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Development of situation picture - real-time video in the use of rescue service authorities

Case:

Dangerous chemicals accident

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Laurea University of Applied Sciences
Leppävaara

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Degree Programme in Security Management
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Abstract

Riku Leppänen

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The purpose of this thesis is to evaluate the suitability of situation information produced by real-time video to the officer in charge of rescue services. The thesis ultimately attempted to understand real-time video in rescue services as a phenomenon, which possibilities are not yet utilized. The study focused on different levels of rescue service leading and addresses three real-time video production sources.

The scientific approach of the thesis is defined as a qualitative case study which uses three different research methods to understand the researched phenomenon. The empiric data for the study was collected through a literature review, professional interviews and observation of an operational dangerous chemicals accident exercise. The operational exercise was conducted in cooperation between Laurea University of Applied Sciences, Emergency Services College, Eye Solutions Ltd. and VideoDrone Ltd. during spring 2015.

The results of this study indicate that real-time video offers numerous possibilities for rescue services. Situation information acquired through real-time video makes the production of rescue service officers' situation picture more efficient and accurate. Real-time video also serves distance leading exceptionally well and makes decision making a lot easier because of more accurate situation information. The results also indicate that the use of real-time video includes challenges which need to be addressed comprehensively before implementation to rescue services.

In the future it is essential to identify the different types of rescue service situations where information produced by real-time video can be utilized. The identified rescue service situations need to be tested with and without the use of real-time video. Further researching of specific situation types and testing of technical equipment provides the rescue service authorities more detailed information along with much needed use experiences.

Keywords: Real-time video, situation information, situation picture, rescue services

Laurea-ammattikorkeakoulu **Tiivistelmä**
Leppävaara
Degree Programme in Security Management

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Tilannekuvan kehittyminen - reaaliaikainen videokuva pelastustoiminnan viranomaisten käytössä

Vuosi 2015 Sivumäärä 68

Tämän opinnäytetyön tarkoituksena oli arvioida reaaliaikaisella videolla tuotetun tilannetiedon käytettävyyttä pelastustoiminnan johtajalle. Työ ennen kaikkea yritti ymmärtää reaaliaikaisen videon käyttöä pelastustoiminnassa ilmiönä, jonka mahdollisuuksia ei ole vielä täysin hyödynnetty. Tutkimus keskittyy pelastustoiminnan eri johtamistasoihin ja käsittelee kolmea eri reaaliaikaisen videon tuottamislähdettä.

Työn tutkimukselliseksi lähestymistavaksi määriteltiin kvalitatiivinen tapaustutkimus. Tutkimuksessa hyödynnettiin kolmea eri tiedonkeruumenetelmää, joilla pyrittiin ymmärtämään tutkittu ilmiö. Työn empiirinen aineisto kerättiin kirjallisuuskatsauksesta, haastatteluista ja vaarallisten aineiden onnettomuus harjoituksen havainnoinnista. Operatiivinen vaarallisten aineiden harjoitus toteutettiin yhteistyössä Laurea-ammattikorkeakoulun, Pelastusopiston, Eye Solutions Oy:n ja VideoDrone Oy:n kanssa keväällä 2015.

Opinnäytetyön tutkimukset osoittavat, että reaaliaikainen video tarjoaa lukuisia mahdollisuuksia pelastustoiminnalle. Reaaliaikaisen videon avulla tuotettu tilannetieto tekee pelastustoiminnan johtajan tilannekuvan kehittymisestä tehokkaampaa ja tarkempaa. Reaaliaikainen video palvelee myös etäjohtamista poikkeuksellisen hyvin ja helpottaa päätöksentekoa tarkemman tilannetiedon ansiosta. Tulokset osoittavat, että reaaliaikaisen videon käytön mukana tulee myös haasteita. Haasteet on tarpeen käsitellä kattavasti ennen reaaliaikaisen videokuvan tuomista pelastustoiminnan viranomaisten käytettäväksi.

Jatkossa on olennaista tunnistaa eri pelastustoiminnan onnettomuustilanteet joissa reaaliaikaisella videokuvalla tuotettua tilannetietoa pystytään käyttämään. Tunnistamisen jälkeen onnettomuustilanteet on tarpeen testata reaaliaikaisen videon avulla ja ilman. Onnettomuustilanteiden yksityiskohtaisempi tutkimus tuottaa pelastustoiminnan viranomaisille kohdistuneempaa tietoa ja paljon alalla kaivattuja käyttökokemuksia.

Asiasanat: Reaaliaikainen video, tilannetieto, tilannekuva, pelastustoiminta

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List of abbreviations and symbols

AAR	After Action Review
AIRBEAM	AIRBorne information for Emergency situation Awareness and Monitoring
ES	Eye Solutions Ltd.
ESC	Emergency Services College
HD	High-definition
KriSu	Kriisisuunnittelu - Crisis action planning
KriSu 2015	Crisis action planning exercise 2015
LAUREA UAS	Laurea University of Applied Sciences
MACICO	Multi-Agency Cooperation in Cross-border Operations
PUC	Police University College
RDI	Research, Development and Innovations
SSS	Security Strategy for Society
TETRA	Terrestrial Trunked Radio
TFARS	The Finnish Air Rescue Society
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
VD	VideoDrone Finland Ltd.
VIKSU 2014	Young Firefighters' Camp 2014
VIRVE	Viranomaisverkko - Public Authority Network

1 Introduction

The development of technological image capturing and data transmission systems has made it possible for authorities to use more developed ways to attain more detailed situation information. This thesis focuses on the aspects of real-time video and its usage in rescue services as a supportive function focusing on the different levels of operational rescue service situation leading. The results are based on professional interviews, literature review and observation of operational dangerous chemicals accident exercise carried out in cooperation with Laurea University of Applied Sciences (Laurea UAS), The Emergency Services College (ESC) and two Finnish companies.

The Finnish Rescue Act from (379/2011) states in Section 32 that rescue departments are responsible for performing rescue operations tasks in situations where the tasks can't be carried out by the party which is affected by the accident or threat. The authorities are professionals in the field of rescue services and are trained through the Emergency Services College located in Petonen, which provides vocational and other rescue service training (Finland, Act on the Emergency Services College 607/2006).

As defined by the Finnish Security Strategy for Society (2010, 58) operative situation picture is developed an maintained in real-time as much as its possible. The objective for operative situation picture is that it must give as comprehensive and updated situation information as possible in order that required situation leading can be conducted (SSS 2010, 58). The analytical results of the interviews and exercise observation clearly show that real-time video in the use of rescue service authorities must be seen as a supportive function that supports more efficient development of situation picture.

Real-time video in the production of situation information is currently a very active topic with only a handful of previous studies. The subject for this Thesis was chosen in cooperation with Laurea UAS and ESC in order to provide combined and new information for the rescue service authorities in Finland. The expected effect of the study to society is to inspire and reinforce the discussion regarding the implementation of real-time video possibilities to the use of rescue service authorities. Based on the results of this study most of the technology is on a sufficient level to be used in rescue service situations, it is more of an implementation matter.

The next chapters of the thesis concentrate on clarifying the concepts of real-time video and situation awareness while also providing the research a focused theoretical framework, research questions, objectives and background information. The thesis has been composed in co-operation with Laurea University of Applied Sciences, The Emergency Services College, Eye Solutions Ltd. and VideoDrone Finland Ltd.

1.1 Operational environment - research partners

This thesis has a strong connection to the research, development and innovations projects of Laurea University of Applied Sciences. The research partners Emergency Services College, Eye Solutions Ltd. and VideoDrone Finland Ltd. have been involved in the study through existing connections of the author and other representatives of Laurea. Research is based on the mutual interest of Laurea UAS and ESC to study real-time video as a supportive function to rescue service leading more extensively through the observation of an operational exercise.

1.1.1 Laurea University of Applied Sciences

Laurea University of Applied Sciences offers professional education in the form of bachelors and masters degree programmes. Major part of the Laurea brand is also research, development and innovations (RDI) projects which target to develop national and international expertise in the areas of nursing work and coping at home, service business activities, security and social responsibility, as well as entrepreneurship and innovations. Laurea involves students from different degree programmes to experience RDI projects by offering for example internship positions and thesis subjects. (Laurea UAS 2015)

One of the main interests for Laureas' representatives regarding this thesis was to develop cooperation with The Emergency Services College, Eye Solutions Ltd. and VideoDrone Ltd.

1.1.2 The Emergency Services College

The Emergency Services College (ESC) is developed to provide employees for rescue departments in Finland. The learning institution is located in Petonen which is 10 kilometers south from Kuopio. An approximately 38 hectare wide training ground is located within 10 kilometers of Petonen at Korvaharju. The ESC participates in the research and development functions in the rescue services field of expertise and is also involved in some of the same international projects as Laurea UAS. (ESC 2015)

The main interests for the ESC regarding this thesis were to develop their knowledge in the field of real-time video when building a comprehensive situation picture and awareness. In key role was to also receive feedback from participation businesses regarding the operational exercise and to develop the cooperation between Laurea UAS. The main contact regarding this thesis to ESC was researcher Marko Hassinen.

1.1.3 Eye Solutions Ltd.

Eye Solutions Ltd. is a Finnish company which provides real-time awareness services nationally in Finland and internationally around the world. From business aspect one of the focus points for the company has been to provide real-time awareness services for military and authority use (Eye Solutions 2015). Their services are in use at the Pirkanmaa rescue department. Laurea UAS and Eye Solutions have cooperated in national RDI project before.

The main interest for Eye Solutions Ltd. to be part of this study was to do more testing of their products in an operative environment, create new contacts to the emergency services industry and to continue their co-operation with Laurea UAS. The main contacts to Eye Solutions Ltd. regarding this thesis were employees Pekka Ikonen and Vesa Lunden.

1.1.4 VideoDrone Finland Ltd.

VideoDrone Finland Ltd. is a Finnish company from Jyväskylä which is specialized in providing unmanned aerial vehicles (UAV's) and training for authority use in Finland. The company conducts development work to modify their products to be technically suitable for various ways in authority use (VideoDrone Finland 2015). Laurea UAS and VideoDrone Finland Ltd. have cooperated in national RDI project level before.

For VideoDrone the main interest to participate in this study was to test their product in a different rescue service situation type and to create new contacts towards the emergency services industry while maintaining the existing ones. The main contact to VideoDrone Finland Ltd. regarding this thesis was Juhani Mikkola.

1.2 Research questions and focusing definitions

The definitions focusing the study are described in two different categories. The first category of definitions focuses on the rescue service authorities, defining the amount of operational situation leading levels to correspond within the scope of the study and the operational exercise where observation material was gathered. The second category of definitions concentrates on the technical aspects of real-time video production, defining the video production platforms to correlate with the technical abilities of the research partners, while also taking into consideration the needs of the rescue services authorities.

Kananen (2013, 60) states that every research begins with defining the research problem. The research problem in this study is to evaluate the suitability of situation information produced by real-time video to the officer in charge of rescue services.

1.2.1 Definitions - rescue services

The legislation in Finland states that in the event of a threat or accident the consequences must be limited effectively (Finland, The Rescue Act 379/2011). Providing more accurate and detailed data through real-time video will allow the rescue service officers in different operational levels to act more efficiently. The interest to study real-time videos' usage in the different levels of leading was heavily emphasized by the Emergency Services College when the research advanced.

The thesis is defined to study three different levels of rescue situations' operational leading which are described in the following figure (figure 1). The research focuses on the functionalities that different types of real-time video will bring for the unit, team and rescue service officers. The limitations will leave out the Emergency Service Leading Center which is established in cases where the scale of the emergency situation is extensive (Kaukonen 2005, 36). The limitations will also leave out other rescue service supportive functions such as police or health care. The study always focuses on the rescue service officer in charge. Commonly this officer in charge is named as emergency service leader. Emergency service leader is the officer who is in charge of a specific rescue situation regardless of the leading level.

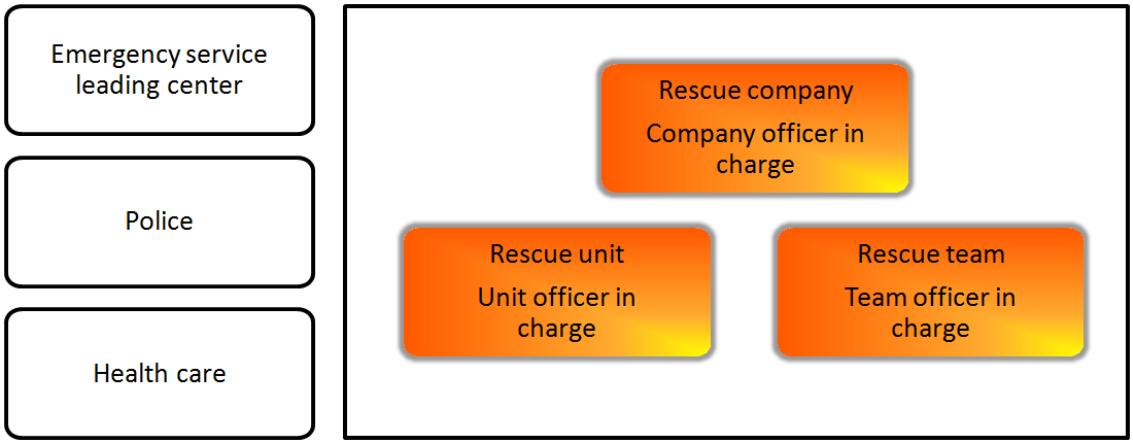


Figure 1: The definitions to rescue service leading levels in the use of real-time video

Two of the research questions derived from the research problem, within the emergency service defining framework, where the study pursues to find answers could be efficiently described as:

- How situation information produced by real-time video affects the situation picture development of rescue service officers?
- How situation information produced by real-time video affects rescue situation related decision making of rescue service officers?

1.2.2 Definitions - technological setup

In this thesis the production platforms of real-time video are separated to dynamically or statically produced video which are both transmitted to a real-time situation awareness platform. Situation awareness platform refers to a software provided by Eye Solutions Ltd. which allows the display of multiple video production sources through different devices. Term dynamic is used to refer to video which is produced from a source which is attached to a moving object or personnel. Term static is referred to video where the source stays still for the time real-time video is used. The concept of real-time video is defined more thoroughly in chapter 2.3.7.

Purely from a technology point of view the research is defined to evaluate three different real-time video platforms; single camera carried by an individual rescue service unit, single camera placed statically on a rescue service vehicle and single camera carried by an unmanned aerial vehicle (UAV). The definitions are illustrated in figure (2). The study focuses on only the mentioned sources of real-time video. However, other opportunities mentioned by the rescue service professionals in interviews are discussed. The selection of used sources for real-time video production is based on discussions with the research partners during the planning phase of the operational exercise.

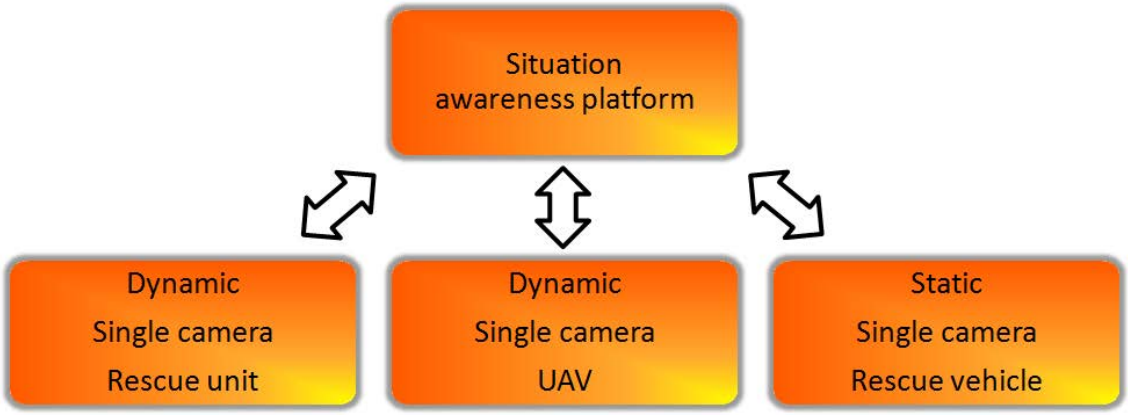


Figure 2: The definitions of technological sources for real-time video production

Third of the research questions derived from the research problem, within the technological definition framework, where the study pursues to find an answer could be efficiently described as:

- What types of video production sources can be utilized to make the development of rescue service officers' situation picture more efficient?

2 Research background

The Multiagency Cooperation in Cross-border Operations international (MACICO) project planned and carried out a major disaster exercise in the Viksu 2014 Young Voluntary Firefighters' Camp during summer 2014. The exercise was carried out with the cooperation of Laurea UAS, Eye Solutions Ltd. and two of the MACICO projects' consortium members, Ajeco Ltd. and Airbus Defence and Space (Leppänen 2014). One of the main findings from the exercise was that real-time video as a part of situation awareness needs to be integrated in to the operation models of the responsible organization. In Viksu 2014 camp the imagined emergency situation was carried out by the temporary camp organization, which didn't actively use real-time video provided from the field (Harvio 2014, 27).

The results regarding the communication demonstrations conducted in Viksu 2014 camp can be read from research made by Laurea UAS' students. Laurea UAS also published a project publication under the name "Multi-Agency Cooperation In Cross-border Operations Sample of Evidence Series: Volume 4". Chapter "Authentic evaluations: Case: Viksu 2014", from the MACICO publication focuses on the demonstrations carried out the in the Viksu 2014 camp. (Kämppi, Rajamäki, Tiainen & Leppänen 2014, 66)

The author of the thesis participated in the Viksu 2014 camp as Laureas' representative. Emergency Services College researcher Marko Hassinen also participated in the Viksu 2014 camp as a quest invited by Laurea UAS. Afterwards the thesis author and a Laurea project specialist Pasi Kämppi saw the need that the subject needs to be researched more and that real-time video would be a beneficial addition for rescue services when developing situation picture. Author of the thesis started to do background research work for the subject in October 2014. Situation quickly developed to the point where Pasi Kämppi contacted Marko Hassinen and a common interest in the topic between these institutions was confirmed.

During fall 2014 conversations first took place two times only with Laurea UAS and ESC. The emphasis between the conversations of Laurea UAS and ESC in fall 2014 was that real-time video and its implementation to rescue services must be addressed and developed further. Marko Hassinen from ESC confirmed that there is a need for more research within the subject. The interest for both parties was to evaluate the use of real-time video in an operational situation.

Eye Solutions Ltd. joined the conversations officially at the end of October 2014. The author had discussed with the Eye Solutions representatives Pekka Ikonen and Vesa Lunden earlier that they also have an interest to continue researching the topic and to test their software and technological solutions in the field of rescue services. Author of the thesis and Pekka Iko-

nen had previous experience working together during the Viksu 2014 camp preparations. During the planning of the operational exercise the cooperation was enhanced by Laurea's representatives visiting demonstration exercises in Hyvinkää with The Finnish Air Rescue Society (TFARS) and Tampere with Police University College (PUC) where Eye Solutions software's were tested in operational situations.

The representative of VideoDrone, Juhani Mikkola joined the conversations during January 2014. However, Mikkolas' interest regarding the operational exercise was confirmed earlier all ready in the two testing exercises, where VideoDrone participated as Eye Solutions cooperation partner.

Ultimately this thesis is conducted as part of the AIRBEAM (AIRBorne information for Emergency situation Awareness and Monitoring) project. The objective for AIRBEAM is to "develop a multi-platform approach to situational awareness for crisis management, especially utilizing Unmanned Aerial Vehicles (UAVs), aerostatic platforms and satellites" (Kämppi et al. 2014, 22).

2.1 Theoretical framework and research objective

Kananen (2013, 131) defines theoretical framework as the knowledge that all ready exists from the researched phenomenon. In this Thesis the framework refers to the general research objectives and concepts which influence in the development of knowledge base. The scientific approach is defined individually in chapter 3.2.

The central research objective of the study has developed during the overall research process. Depending on the research process section the objectives have always adjusted to correspond to the need of rescue service authorities. In the beginning of the research the objective of the research was to study how real-time video is used in rescue services. The objective had its foundation in the fact that real-time video wasn't actively used in the Viksu 2014 camp (Harvio, 27). The objective was confirmed from Laureas' project specialist Pasi Kämppi and project manager Kaci Bourdache.

Quickly after the planning for the operational exercise began, the objective of the study developed to research how real-time video affects the field leading process in rescue services. The adjustment was justified with two facts. The original approach was very close to Laureas' student Viktor Harvios' thesis "Utilization of real-time video in rescue operations". Other reason was that ESC suggested that the research should be narrowed down to the leading processes which would be more beneficial than an overall description.

In the final meetings with ESC before the operational exercise the objective adjusted last time to study how real-time video affects the leading processes in different levels of rescue service leading. The adjustment was highly emphasized by the representatives of ESC. Also after the exercise senior lecturer from ESC, Matti Honkanen confirmed that it will be much more beneficial for the research to focus on the impacts real-time video has in the different levels of rescue service leading (Honkanen, 2015).

2.2 Knowledge base

Kananen (2013, 131) describes knowledge base as the way for the researcher to show the readers the orientation to the subject and methodology. The knowledge base for this Thesis has developed during the planning process of the operational exercise, through first developing basic knowledge of the subject through literature and past research. The exercise planning meetings with research partners also acted as a way to confirm information from professionals in their own field. Also observation in different demonstration cases held by the research partners assisted in building up the authors' individual knowledge base.

2.3 Central concepts

Research is based on certain concepts which are clearly identified to correspond to the individual study. Hirsijärvi, Remes and Sajavaara (2013, 146) explain that in scientific research we always aim to conceptualize the phenomena's that are researched. This provides the understanding in general, theoretical level. This chapter explains the readers the basic concepts within emergency services, real-time video and situation awareness in this thesis.

As concepts emergency services and situation awareness are explained through The Finnish Security Strategy for Society from year 2010 which is written to give the guidelines for the safeguarding of independence, territorial integrity and basic values in Finland (SSS 2010, 3).

2.3.1 Emergency services

The Finnish Security Strategy for Society (2010, 93) defines *emergency services* as "an entity that encompasses the prevention of accidents, rescue activities and civil defence". *Rescue activities* are defined as "urgent tasks in response to an accident or the risk of an accident carried out to save people and/or property, to limit damage and mitigate the consequences". In this context *civil defence* is referred to "protection of people and property, the carrying out of rescue services in a emergency conditions, and to preparedness for these tasks". (SSS 2010, 93). This research is defined to focus on rescue services which is a sub category of emergency services.

2.3.2 Rescue services

In general *rescue services* is a sub category for emergency services, which are divided to three different responsibility areas. In short the ministry of the interior is responsible for leading and monitoring the rescue services in national level. Under ministry of the interior are different rescue service municipalities responsible for rescue services in rescue service regions. Finally the regional rescue services are responsible for the actual rescue service required tasks and mitigation of damages in emergency situations in specific geographical locations. (Kaukonen 2005, 8-9)

2.3.3 Rescue service authorities

The Finnish Rescue Act from (379/2011) defines the *rescue service authorities* as follows: "The Director-General of the Department for Rescue Services of the Ministry of the Interior and the public servants of the Ministry of the Interior and regional state administrative agencies appointed by him or her are the state rescue authorities". Also the Finnish Rescue Act from (379/2011) defines the *regional rescue service authorities* as "The highest-ranking public servant of the rescue department and the public servants of the rescue department appointed by him or her and the relevant multi-member body of the regional rescue services are the rescue authorities of the regional rescue services". (Finland, The Rescue Act 379/2011, section 26).

2.3.4 Situation awareness

The Finnish Security Strategy for Society (2010, 95) defines *situation awareness* as "the understanding of decision-makers and their advisors of what has happened, the circumstances under which it happened, the goals of the different parties and the possible developments of events, all of which are needed to make decisions on a specific issue or an entity if issues". In this thesis situation awareness refers to the understanding of rescue service officers. Situation picture and situation information are considered as sub categories for situation awareness.

2.3.5 Situation picture

A sub category of situation awareness is *situation picture* which The Finnish Security Strategy for Society (2010, 95) defines as "a presentation on a situation or capabilities, compiled on a basis of individual pieces of information, which provides the grounds for situation awareness". However, many times situation picture also involves information which is not in a presentable form, but in a mental level notified by the rescue service officer (Neuvonen, 2015).

2.3.6 Situation information

Situation information is referred to individual pieces of data that can be used to produce situation picture. The data can be filtered or non-filtered (Veneskari 2011, 15). A good example regarding situation information in this study is for example the proceeding of a given task by a rescue service officer. In this study the situation information is focused to be produced through real-time video, which is unfiltered information. Situation information acquired from real-time video can be considered as filtered if a person has analyzed it and passed the information onwards.

2.3.7 Real-time video

Real-time video in this thesis is addressed as video which is displayed from a specific point of interest in real-time. Past research regarding this concept uses different terms varying from just video to moving video and real-time moving video. However, in this study real-time video specifically means video that is transmitted through a production platform and displayed through a situation awareness platform in real-time with only minor technical delay. The amount of delay is always dependent on network coverage and overall connections in specific areas.

The sub-categories for real-time video is this study are static and dynamic video. These terms in this study refer to the physical state and angle of the video. Static is referred to a video production platform which remains at the same place and absolutely still for the time that the video is used. The real-time video received from rescue service vehicles is considered as static video in this study. Dynamic is referred to a video which production platform moves constantly and the physical angle of the video develops depending on situation. Real-time video received from an UAV and rescue service unit are considered as dynamic video in this study.

2.3.8 Distance leading

Distance leading refers to a situation where a rescue service officer leads an operational situation without being physically present at the area. Distance leading is more common in the areas where the distances and response times of rescue service units are high. In the past rescue service officers conducting distance leading have had to rely on filtered information which is achieved through radio network. However, in the future unfiltered situation information produced by real-time video makes it possible for rescue service leaders to conduct more accurate and efficient distance leading.

3 Research process and implementation

The process of the research work has been introduced in figure (figure 3). Actual process is divided to four different sections. The first section of the process includes the selection of the scientific approach of the work, planning of an operational exercise and building up the general knowledge base. The second selection of the process includes the implementation of an operational exercise as part of the KriSu exercise held in the Emergency Services College during spring 2015. The implementation of the exercise is followed by analysis of the acquired observation material. After analyzing the observation material from the exercise, the third section involves series of half-structured interviews and finishing the literature review. The fourth selection refers to the last part of the research process, analysis and reporting which brings together the results of literature review, observation and interviews.

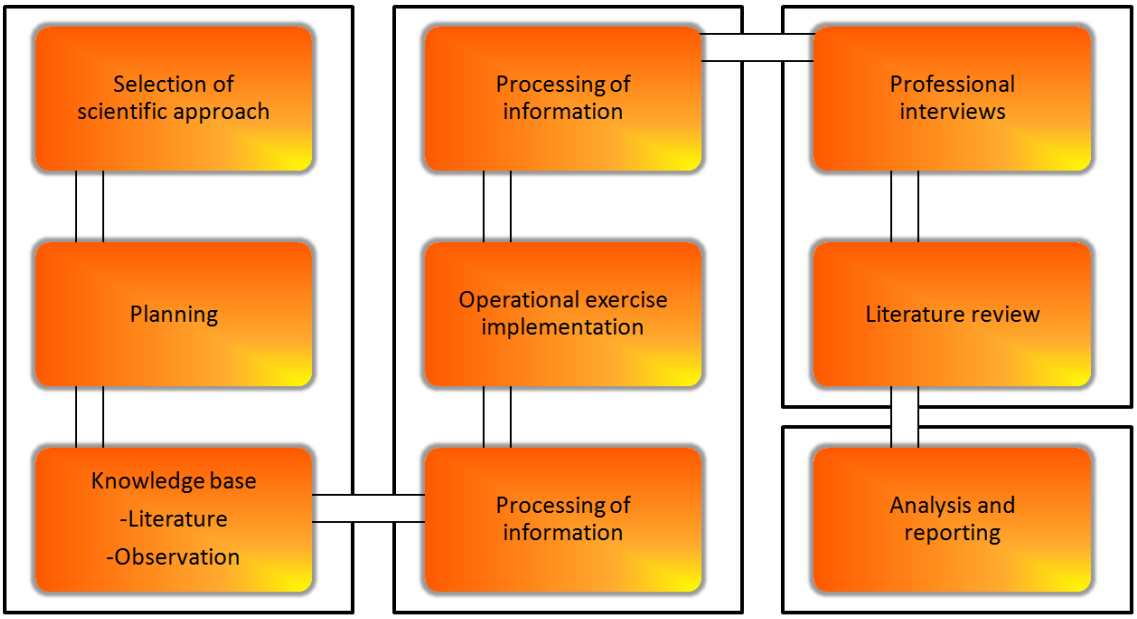


Figure 3: Research process presented in four different sections

In practice the research process is separated to four different sections described in figure (figure 3). General processes which were included in all sections of the research were discussions with research partners regarding the objectives, needs and validity of the research. The research partners were informed and involved in all sections of the research process which directed the results of the research to support rescue service authorities. The validity of the research has also been discussed with the partners through the whole process. The author of the thesis has also conducted validity evaluation in different forms throughout the process to justify the decisions made; overall validity and reliability are discussed in chapter 7.3.

The accurate planning process and detailed timetable of the thesis is introduced in the following chapter.

3.1 Timetable

The research process began on summer 2014 when the author of the thesis participated in the Viksu 2014 Young Voluntary Firefighters' camp and continued when the Laurea UAS thesis process begun on fall 2014. During fall 2014 and spring 2015 the author of the thesis was in close interaction with the research partners, through internet meetings, technology tests and interviews. The timetable with most important contact points is presented in table (table 1).

Date	Function	Participants	Material
30.6.2014	Viksu 2014 camp, major disaster exercise	Laurea, Eye Solutions Ltd., Ajeco Ltd.	MACICO publication, extended abstracts
2.9.2014	Beginning of Thesis	Laurea	Research plan
23.9.2014	Thesis guidance	Laurea	Research plan
24.9.2014	Thesis brainstorming	Laurea	Brainstorm 1
8.10.2014	Partner meeting 1	Laurea, ESC	Meeting 1 notes
14.10.2014	Thesis guidance	Laurea	Research plan
22.10.2014	Thesis guidance	Laurea	Research plan
23.10.2014	Partner meeting 2	Laurea, ESC	Meeting 2 notes
24.10.2014	Partner meeting 3	Laurea, ES	Meeting 3 notes
25.10.2014	ES / VD technological demonstration in Hyvinkää	Laurea, ES, VD, TFARS	Hyvinkää demonstration notes
18.11.2014	Partner meeting 4	Laurea, ESC, ES	Meeting 4 notes
2.12.2014	ES / VD technological operational demonstrations in Police University College	Laurea, ES, VD, PUC, rescue service authorities	Police University College demonstration notes
16.1.2015	Confirmation of KriSu dates	Laurea, ESC, ES, VD	-
20.1.2015	Partner meeting 5	Laurea, ES	Meeting 5 notes
30.1.2015	Partner meeting 6	Laurea, ESC, ES, VD	Meeting 6 notes
5.2.2015	Partner meeting 7	Laurea, ESC	Meeting 7 notes
9.2.2015	Operational exercise at ESC	Laurea, ESC, ES, VD	Exercise observation and record material
18.2.2015	Partner meeting 8	Laurea, ESC, ES, VD	Feedback meeting
5.3. - 11.5.2015	Thesis guidance's	Laurea	Guidance notes
19.5.2015	Thesis seminar	Laurea	Final presentation

Table 1: Research timetable with focus points on operational exercise planning

3.2 Scientific approach

Kananen (2013, 22) describes scientific approach, also called as research strategy, as a path which includes the typical information collection, analysis and interpretation methods. In the beginning of study the researcher justifiably selects the scientific approach of the work depending on the type of the research problem.

The scientific approach for this thesis is a case study. Case study as a scientific approach is based on qualitative research which attempts to understand a research phenomenon while explaining the entity and the affecting functions. Case study is used to provide a holistic view of a certain phenomenon by using multiple research methods and sources which is very close to triangulation. Triangulation refers to a combination of qualitative and quantitative research with different variations. (Kananen 2013, 23-33)

This research attempts to understand the use of real-time video in rescue services as a phenomenon, while using method-triangulation to provide a holistic overview of the research subject (Kananen 2013, 35). The research methods used in method-triangulation are literature review, observation and interviews. The end result is to provide a combined synthesis of the results, acquired by using the chosen research methods, which attempts to understand the phenomenon chosen in cooperation with the research partners.

3.3 Research methods

Kananen (2013, 9) states that case-study doesn't have its own methodology or research methods. The research is based on necessary information retrieval and analysis methods that are used to gather and process information. Kananen (2010, 79) also states that the skills and knowledge of the researcher are weighted in a case-study, because the research isn't limited to only one information retrieval or analysis method.

The fist information retrieval method in this thesis is literature review which the researcher began in fall 2014 in order to build up general knowledge of the subject. Literature review as part of the process was finalized during spring 2015. The second method used was semi-structured interviews, which were used to gather information from professionals in the rescue service field of expertise. All people interviewed were acquired through research guidance or research partners. Involved un-structured observation of the operational exercise was used as third method. Recorded video material from the exercise is used to reinforce the perceptions analyzed from the observation audio recordings.

3.3.1 Literature review

Literature review is used a research technique, a method to research all ready completed studies to build an overall entity of the research subject. The objective is to combine the results of other studies which will be the foundation for new research results Salminen (2011, 1-8). Also Kananen (2013, 85) writes that results of literature review can also be used to validate the results of new research if similar or supplementary remarks are found.

The objective for this study is to use narrative describing literature review. Salminen (2011, 6-7) refers describing literature review as a general review without strict and exact rules. Describing literature review is individual method, which allows the researcher to describe the researched phenomenon comprehensively while allowing the categorizing of phenomenon attributes. Narrative is one of the two orientations of describing literature review, which Salminen (2011, 7) separates to three different implementation categories; reporting, commenting and general overview. The narrative implementation method in this work is general overview which is used to summarize the results of past research of the phenomenon. The end result in this study for narrative describing literature review is a describing synthesis which is written in a concise form (Salminen 2011, 7).

3.3.2 Semi-structured theme interview

Interviewing is considered as the main research method in qualitative research, however Hirsjärvi, Remes and Sajavaara (2013, 205) state in their book that choosing interviewing as a method must still be justified. The most traditional aspect of interviews is that the interviewing situations offer great flexibility for information collection since the researcher in active interaction with the representative of the research phenomenon. When conducting research, interviews are commonly described as research interviews which are categorized to different groups depending on the approach. The typical way to categorize the types of research interviews is to separate, how structured and formal the interviews are. (Hirsjärvi et al. 2013, 206-208)

The research interview method in this study is semi-structured theme interview. Semi-structured interviews have questions which are planned beforehand, theme interviews have designed themes that direct the interview situation (Hirsjärvi & Hurme 2004, 47). The method is justified based on the characteristics of the conducted interviews, where the interviewed person received a guiding interview form with discussion directing themes and questions beforehand. Form was used to provide answers which were partly thought in advance and to provide flexibility for the interviewing situation. The approach was suggested by researcher Marko Hassinen from ESC. (Denscombe 2010, 175)

3.3.3 Observation

The ideology behind observation as a research method is that researchers can observe whether people act as they describe, separating talking from authentic actions. Observation as a research method is not only seeing, but close monitoring of a subject or situation. Hirsjärvi et al. (2013, 212-213) list in their book the common advantages and disadvantages for direct observation. Observation is often used as research method in qualitative research because it allows the researcher to reach authentic situations while acquiring direct information about the researched phenomenon (Hirsjärvi et al. 2013, 212-213).

There are different practices in how to use observation as a research method. Hirsijärvi et al. (2013, 214) explain that there are two different continuums in observing. First one of the continuums describes how formal and structured the observation is, when the second focuses on the role of the observer in the studied situation. In practice observation is separated to two different approaches based on the continuums. Systematical and involved observation. Systematical observation is performed formally and the observer doesn't act as part of the situation. Involved observation is very flexible in terms of the situation, the researcher doesn't have strict guidelines regarding what should be observed. Normally in involved observation researcher acts as part of the situation. The method used in this research is involved observation. The selection of the observation approach is justified with the fact that the author of the thesis participated in the operational exercise. (Hirsjärvi et al. 2013, 214)

4 Literature review

The first research method, literature review, used in this study is defined as narrative and describing, which implementation method is general overview (Salminen 2011, 7). The end result is a describing synthesis. The selection of literature review as one of the research methods is justified through the nature of the scientific approach. Case-study as a scientific approach uses past research to understand the researched phenomenon. Other justification for the use of literature review as a methodological approach is that it provides more holistic understanding from different sources to the method-triangulation which is used in this study to combine the findings from all research methods. (Kananen 2013, 33 & 103)

Past literature and research provides the sources for this literature review. In this study the sources are separated to two different categories. The first category involves literature and research which attempt to describe the emergency services leading process and to define the required parameters for the field research exercise. However, the first category is focused on the leading processes it takes into account the research problem. The second category focuses on describing real-time video and its production sources.

4.1 Introduction to literature and research used in this study

This chapter gives a general introduction to the research and literature used in this research. Roughly the publications can be categorized to two different groups. The first group defines rescue service leading and sets parameters for the operational exercise, while the second one focuses on real-time video and its production sources. The first group is primarily focusing the research angle of the study while the second group is used as material for the literature review.

4.1.1 Emergency service leading

The emergency service leading processes and leading levels are defined through a publication by Esko Kaukonen (2005) from ESC. The publication was used to describe the different functionalities and different leading levels in rescue services. The information from the book was reflected to knowledge acquired from planning meetings with ESC and interviews with the professionals. Kaukonen (2005, 34-37) clearly defines the rescue service leading structure in different levels ranging from rescue unit and rescue team to rescue company and emergency leading center. Based on the definitions given by Kaukonen (2005, 34-37) the research is focused to mentioned leading levels in chapter 1.2.1.

The observation part of this study is conducted from an operational dangerous chemicals accident. These parameters for the exercise were set by Lautkaski and Teräsmaa (2000). The writing of Lautkaski and Teräsmaa (2000) were used to develop basic knowledge regarding dangerous chemicals and the key principles that need to be taken in to account when handling chemicals as part of a operational rescue service situation. In the planning of the exercise the definitions assisted in the choosing of the type of the accident and in the operational exercise the strategical placing of rescue service vehicles.

4.1.2 Real-time video and situation awareness

Endslay and Jones (2012) address the concept of situation awareness and different types of interface designs. The objective of their book "Designing for Situation Awareness, An Approach to User-Centered Design" is to introduce the readers to situation awareness and to information that decisions makers in generally need to acknowledge. The book addresses the topics of unmanned aerial vehicles (UAV's), different types of situation awareness interfaces and challenges regarding too much or inaccurate information that is sent to decision makers.

Harvio (2014) addresses in his study the use of real-time video in rescue operations. The study is based on the communication demonstrations held in Viksu 2014 Young Firefighters' Camp as

part of the international MACICO project. This thesis can be seen as a continuum for Harvios' study in a sense that it also incorporates lessons learned in the Viksu 2014 demonstrations. The study defines partially the background information for this thesis.

Veneskari (2011) studies Unmanned Aerial Vehicles (UAV's) and Systems (UAS') and the usability of these platforms for building a situation picture for rescue authorities. The research is based on a Webpropol questionnaire which was answered by 201 rescue service leaders. The secondary objectives of the research were to find out the different types of emergency situations where information from air is beneficial for rescue authorities and how situation picture is produced. The study in combination with the interview of the author formed a crucial part of the knowledgebase regarding rescue service and situation picture for this thesis.

In addition to Endslay and Jones (2012) and Veneskari (2011) two other studies are used in this Thesis to achieve a comprehensive definition for the use of unmanned aerial vehicles in rescue services. Jäntti (2014) studies UAV's and UAS' for rescue service use from a technical point of view. Taponen (2014) studies in his research the use of thermal imaging in aerial photography conducted from an UAV. The UAV's used in the operational exercise were equipped with normal high definition camera and a thermal camera; therefore Taponen's (2014) study was used to attain more knowledge regarding the thermal video production possibilities for UAV's.

Last one of the studies used directly in this literature review is Jaakko Hannis' (2013) study regarding the requirements of the quality of information which is needed to lead operational emergency situations. Essential part of the study was to find out expert opinions on the amount and quality of the information for management in disasters. The study is used to describe the expert opinions regarding the use of different real-time production platforms.

4.2 Real-time video and situation awareness

This chapter focuses on describing the real-time video and the different levels of situation awareness as a phenomenon by using literature and research introduced in chapter 4.1.2. The focus of the chapter is ultimately on situation awareness because real-time video in producing situation information is a topic which hasn't been researched much in the past. Real-time video is more heavily incorporated to the study in observation and interview research methods.

In general Endslay and Jones (2012, 13) define situation awareness as "being aware of what is happening around you and understanding what that information means to you now and in the future". As described in chapter 2.3. situation awareness in this study is the overall awareness in rescue service leading levels. Situation awareness is separated to individual situation pic-

tures which are formed from different types of situation information. Veneskari (2011, 15) writes in his study that the forming of situation picture can be seen as a process which develops from the information acquired from many different sources. The situation information can be either filtered or non-filtered. Real-time video is one of the methods to acquire non-filtered situation information (Veneskari 2011, 15). The situation picture development process described by Veneskari (2011, 16) is illustrated more thoroughly in the following figure (figure 4).

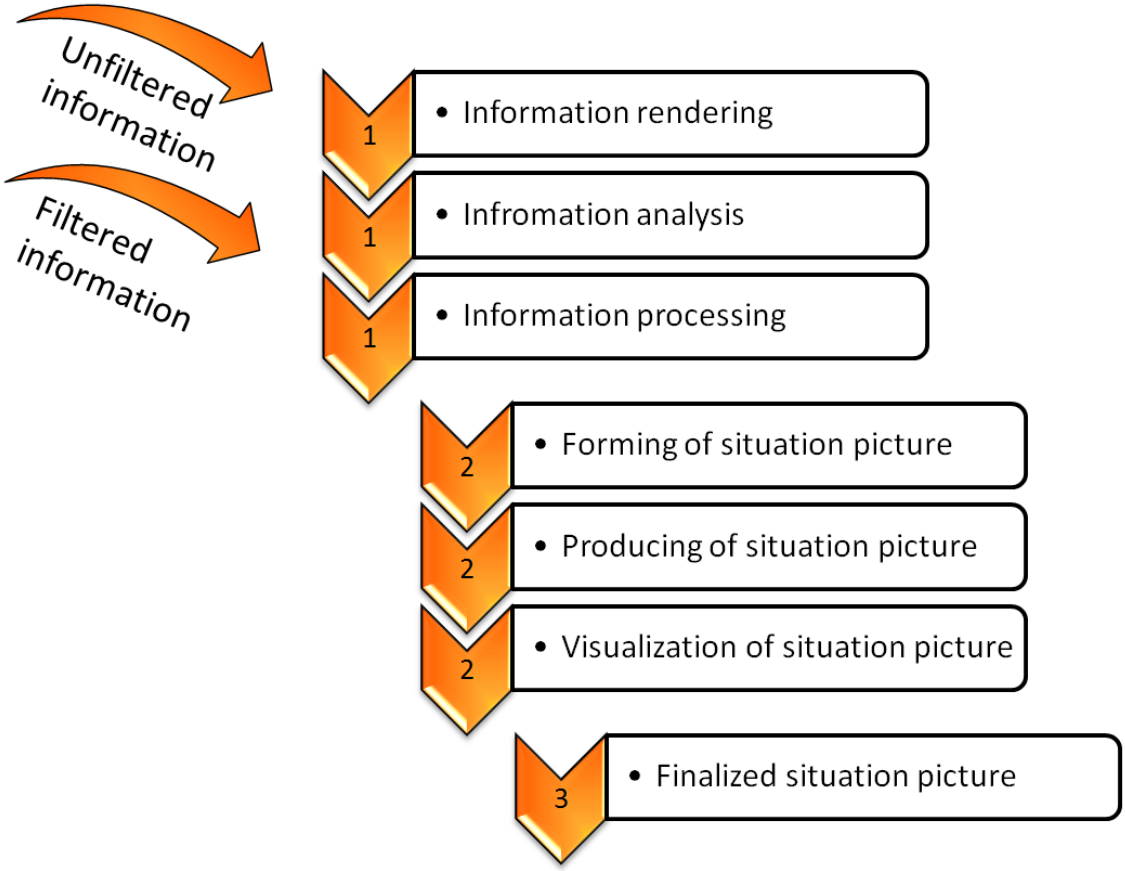


Figure 4: Situation picture development (after Veneskari 2011)

Veneskari (2011) has comprehensively gathered data regarding situation picture development from 201 rescue service professionals in his study. One of the more important remarks from his study regarding this thesis is that when he asked the professionals what supportive elements they use when building up situation picture, the answers were 164 out of 201 answered that they do the planning in their mind. Only 10 people answered that they take video in order to support the building of the situation picture (Veneskari 2011, 39). Real-time video in rescue services is still a new and not much used concept.

Other important remark from the study done by Veneskari (2011) is that he also asked the rescue service professionals that what they thought that what information situation picture

should include. The professionals put most of their emphasis on the locations of rescue service units, different types of maps and target information. Real-time video was rated by 112 out of the 201 leaders that it is extremely important or important to be incorporated to situation picture. (Veneskari 2011, 40)

Regarding the strengths and weaknesses of real-time video in the production of situation information Endslay and Jones (2012, 181) describe that decision makers are highly influenced by system information. System information creates another element for decision makers to take into account in order to make a decision. In worst situations an extra element can lead to a decrease in efficiency (Endslay & Jones 2012, 181). Regarding this study it is important to note that all research methods from literature review and observation to interviews recognize that too much information can lead to a decrease in efficiency.

4.2.1 The influence of different types of rescue service situations

Different types of rescue service situations have an influence how real-time video can be used in rescue services. Veneskari (2011, 54) describes that the contents of situation picture is entirely dependent on the type of the rescue service situation. In this literature review the influence of different situation types is only considered from an UAV point of view.

The study made by Veneskari (2011) focuses mostly on the use UAV's and the usability of real-time video which is produced from air. Veneskari (2011) asked the professionals in his survey that how beneficial they see the use of real-time video produced from air in different rescue service situations. The lining of the answers was that use of real-time video produced from air is extremely useful in wildfire, natural disaster or oil spill situations. (Veneskari 2011, 44)

4.3 Technology

Technology in this thesis is referred to the different real-time video production platforms defined more in depth at chapter 1.2.2. This literature review focuses on the past experiences attained through differed studies regarding the use, testing or studying of these production platforms. Hanni (2013) describes in the results of his study that involved professionals thought that the current information sharing and communication between authorities is currently insufficient. In future the challenges are in the developing of leaders' common situation awareness and communication. The study involved 21 different professionals from the expertise areas of rescue services, health care and police. One of the key results of the study regarding this thesis is that the professionals thought that the most important real-time video types used in the future are from air and from helmet or vehicle cameras. (Hanni 2013, 57)

Dynamic single cameras carried by rescue personnel in equipment or helmets are seen as one of the most common type of real-time video production platforms in the use of authorities. Harvio (2014) focuses in his study the use of single and vehicle cameras in rescue services. The interviews that Harvio (2014, 23) conducted in his study regarding real-time video show that majority of the people who were interviewed after Viksu 2014 communication demonstrations think there is no use for the officer in charge for the types of video that were used in the camp. However, Harvio (2014, 27) describes that real-time video is seen as a substitutive or complementary source of information.

Veneskari (2011) summarizes in the results of his study that based on the survey regarding the usability of real-time information produced from air in wildfire and natural disaster situations. The use of UAV as a real-time production platform from air supports the need of rescue service leaders to get a more comprehensive situation picture from wide-range situations. The study emphasizes that different UAS-systems will bring added value to the development of situation picture and production of situation specific tactical information (Veneskari 2011, 54). Also Harvio (2014, 28) states that based on his study results real-time video produced from air might have much higher added value for rescue services when compared to real-time produced from ground sources.

Jäntti (2014) also justifies the use of UAV's in rescue services. The study summarizes that real-time video from a emergency situation produced by an UAV can help the rescue officer in charge to do the right and safe decisions when beginning rescue actions. UAV's can also be used by the rescue officer in charge to do reconnaissance of operational situations in order to ensure occupational health and safety. Situation information produced from air brings the possibility to more efficiently detect endangering situations. (Jäntti 2014, 21)

4.4 Future possibilities

Veneskari (2011) analyzes in his research that it is very hard to evaluate all the possibilities regarding real-time video in rescue services without future research. In general the use of UAS-systems in the future for authority use requires clear instructions. Research is also needed regarding the use of real-time video in different rescue situation types. Veneskari (2011) also emphasizes that ESC trains most of the different rescue situation types annually and the training area is a very comprehensively build environment which would suit for efficient system testing. (Veneskari 2011, 61)

Also Harvio (2014) summarizes in his study that there is a lot research to be done regarding real-time video in the use of authorities. Most of all more authentic testing and research is required. Harvio (2014, 28) mentions that comparative research should also be done and men-

tal aspects regarding how rescue service leaders can individually use real-time video in decision making addressed.

Hanni (2013) summarizes in the discussions part of his study that the development of authorities situation picture systems should be seen as the top priority of research and development work in the future. Developed systems would make it possible to conduct controlled rescue service leading in different types of large scale emergency situations. Hanni (2013) also states that only technology doesn't raise the efficiency of systems also capable professionals to operate the systems are needed. (Hanni 2013, 77)

4.5 Literature review describing synthesis

Through literature and past studies it can be clearly seen that situation awareness is the holistic overview of a specific situation and situation picture is seen as a presentation of that situation. Situation information is data which is received from multiple different sources to produce situation picture. The remarks regarding situation view are the same from literature review, observation and professional interviews. Real-time video regarding the production of situation information is seen as a new phenomenon which needs to be researched more thoroughly. However, based on past research rescue service leaders value real-time video and feel that it would be very beneficial to be incorporated to the development of situation picture.

Through past research the use of individual rescue unit specific and vehicle cameras are seen as both beneficial and redundant. Past research gives controversial results. However, the controversial results can be addressed with the fact that different types of video-production platforms can be used more efficiently in other rescue service leading levels than others. These remarks are indentified more in depth at chapter 7.1. The use of UAV's or UAS' on the other hand are equally seen beneficial for rescue service use, especially in the fields of situation picture development and tactical information production.

The use of real-time video in the production of situation information poses challenges in terms of allocation of resources and overflow of information. Real-time video can drift the focus of the officer in charge away from the actual rescue situation. In addition the differences in rescue situation types are considered as a limiting factor for situation information production. Different situation types require varying video production sources. The challenges in past studies are addressed through the implementation of training, testing and raising awareness. However, the subject requires still a lot future research especially regarding different types of rescue situations and comparison testing.

5 Observation

The observation method used in this thesis is involved observation. The chapter is designed to first give an introduction to the planning and implementation of the exercise which is followed by analysis of observation material and combined results.

5.1 Operational exercise - dangerous chemicals accident

Operational exercise in this study is referred to planning, implementation and observing a dangerous chemicals accident exercise in cooperation with Laurea UAS, ESC, Eye Solutions Ltd. and VideoDrone Finland Ltd. The exercise was held in ESC premises at Petonen in 9.2.2015 as part of the KriSu exercise entity. KriSu is an abbreviation from Finnish word kriisisuunnittelu, which in English means crisis action planning. Dangerous chemicals accident was just one part of the entity, however the only one with operational situation.

The actual exercise situation was defined as sulfur dioxide leak from a movable gas tank. The operational situation was carried out in a staged loading area, where a fog machine visualized the sulfur dioxide leak. There were no real dangerous chemicals used in the exercise because the focus of the exercise wasn't to practice chemical diving, but to research the use of real-time video in situation information production. The intention to carry out the exercise was to observe 1) the ability of real-time video to produce situation information from an operational exercise 2) its' affect on the situation picture development of the rescue service officer in charge of the situation.

The next chapters are used to describe the planning and implementation processes of the operational exercise. The accident type of the exercise and implementation methods were chosen in cooperation with the research partners during the first section of thesis research process.

5.1.1 Planning and implementation

The planning for the operational exercise began during October 2014. The most important points of focus can be seen from the process timetable (table 1) presented earlier in chapter 3.1. The planning meetings were arranged through internet and more specifically, a meeting software called WebEx. Meetings were arranged with different combinations of the research partners, as not always everyone were able to participate. Critical matters, such as exercise dates and staff participation, were always agreed with the partners. The main intention of the planning process was to keep every research partner fully informed all the time.

Before the implementation of the exercise research partners met through internet for seven times with the author of the thesis. The last four meetings were guided by an agenda which included different interest points regarding the exercise. The meetings supported the author developing the knowledge base regarding situation picture and rescue service leading.

The implementation of the exercise was carried out in the way that all research partners had their own responsibility areas. ESC provided the facilities, rescue equipment and students acting in the operational situation. The dangerous chemicals accident exercise itself was also planned by the college based on the parameters defined in the research partner meetings. The team officer in charge of the exercise was an officer student with couple years work experience from rescue service leading.

Eye Solutions Ltd. provided the equipment and software to assemble the situation awareness platform, the technical setup is described more detailed in figure (figure 4). Eye Solutions' representative Pekka Ikonen and Vesa Lunden had their responsibilities also in the operational part of the exercise. Ikonen acted as a system operator and his responsibility was to analyze and direct the situation information from real-time video to the team officer in charge. Regardless of the system operator the team officer in charge also used the real-time video individually, the operator was a supporting function. During exercise Ikonen was located at the exercise area in Korvaharju. Lunden acted as a technical support at the college premises where company and emergency service leading centers were physically located.

VideoDrone Finland Ltd. provided the ability to take real-time high definition and thermal videos from air through an UAV. VideoDrones' representative Juhani Mikkola acted as the UAV operator during the exercise. Author of the thesis was the only representative from Laurea University of Applied sciences who attended the exercise. Authors' responsibility was to manage the exercise as a whole and observe the team officer in charge during the exercise. Author also tracked the development of exercise related use-cases which are described more in detail in chapter 5.1.4.

5.1.2 Objectives

After the demonstrations in Viksu 2014 it was clear that in the future the exercises needed to have clear objectives. The operational exercise in this study was focused around three main objectives:

1. Observe, how situation information from different real-time video production platforms affect the situation picture development of the team officer in charge.

2. Evaluate, what information and what real-time video platforms were used by the team officer in charge to develop situation picture.
3. Evaluate, how system operator served as a link between the information from real-time video and the team officer in charge.

During the demonstrations in Viksu 2014 it was clearly seen by the author that the situation awareness platform required an operator or a link to analyze and direct information produced by the real-time video to the situation leaders. The influence of the system operator to the exercise is discussed more detailed in chapter 5.3.2.

Photograph 1: Real-time video production platforms in operational exercise

5.1.3 Technical setup

The real-time video production platforms can be seen from photograph (photograph 1) and from figure (figure 5). The more specific details of equipment and connection paths are also described in figure (figure 5). The general idea of the technical setup was that information produced from the field through different sources is transmitted to Eye Solutions server. From the server the situation information could be viewed through the situation awareness platform software with different devices. In short the different types of cameras in the operational exercise included:

- Two static smart phone cameras mounted inside two different rescue service vehicles

- Dynamic micro-USB camera which was integrated to a rescue service unit
- Dynamic high definition camera from UAV
- Dynamic thermal camera from UAV

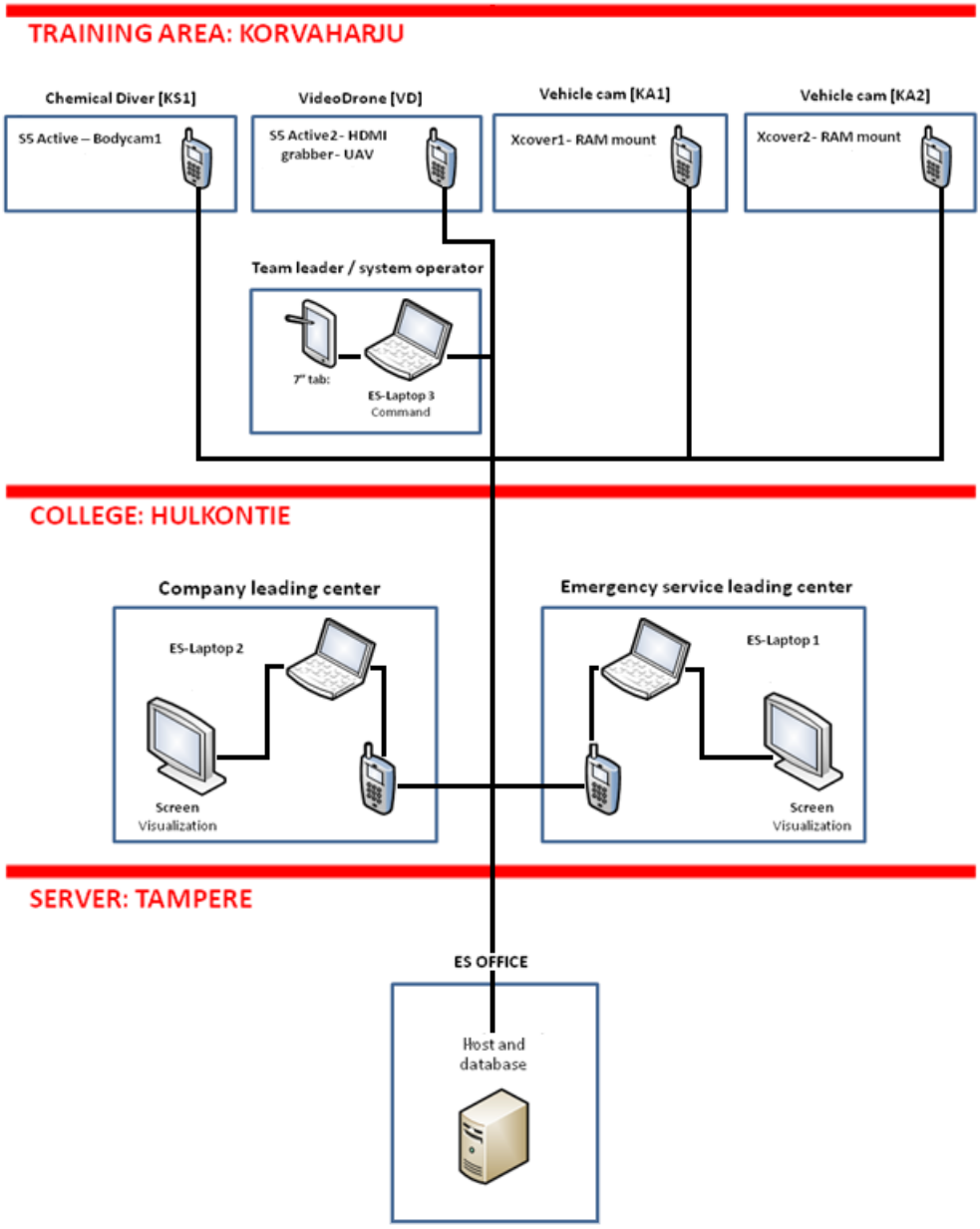


Figure 5: Eye Solutions and VideoDrone technical setup for operational exercise

The technical setup for operational exercise is illustrated in above figure (figure 5). The setup is separated to three different physical locations. The actual location where the dangerous chemicals accident exercise took place was the ESC training area in Korvaharju. In training area the most centric equipment were four different cameras installed to different real-time video production platforms. The cameras in vehicles and rescue service unit used Eye Solutions real-time video recording software. The video from the UAV operated by Juhani Mikkola

was transmitted to Eye Solutions system by using an HDMI grabber. HDMI grabber transmits the video of the UAV to the Eye Solutions software allowing the video to be viewed from the situation awareness platform. Team officer in charge and system operators were able to see the real-time videos transmitted by all production platforms from the situation awareness platform operated through Eye Solution laptop and tablet.

The second physical area illustrated in figure (figure 5) is the college premises located in Petonen. Company leading center and emergency service leading centers were established physically to the college premises around 15 kilometers away from the training area in Korvaharju. In company leading center Eye Solutions software was utilized to visualize the situation awareness platform to a television screen through a laptop. The platform was setup to view all four real-time video production sources to the company leading center. In the emergency service leading center the software was also utilized to show only the aerial real-time video footage from the UAV. However, the focus of the study doesn't include emergency service leading center and that's why the leading level is not addressed more thoroughly in this observation section.

The final of the physical areas is defined as the Eye Solutions server location in Tampere. The server includes the host and database that are used to operate the situation awareness platform. All the video produced in the operational exercise went through Eye Solutions server.

5.1.4 Use-cases

The operational exercise included four use-cases that were designed by the author of the thesis to involve the real-time video production platforms more heavily to the exercise. Use-cases were also used to ensure that the objectives set for the exercise are considered during the actual hectic operational situation. Use-case in this study is referred to a process within the exercise, which had a certain goal. The use-case related ideology was suggested by Pasi Kämppi from Laurea UAS during the planning of the operational exercise.

The use-cases in this study are numbered from one to four. The first use-case is labeled as "use-case one - reconnaissance from ground". The definitions for the use-case can be seen more comprehensively from appendix (appendix 1). In general use-case one was directed to rescue service unit to conduct reconnaissance from ground regarding the danger area. Use-case was conducted right at the beginning of the exercise and its objective was to evaluate, how the real-time video produced by the rescue unit affects the situation picture development of the team officer in charge of the situation.

The second use-case is labeled as "use-case two - reconnaissance from air". The definitions for the use-case can be seen more comprehensively from appendix (appendix 1). In general use case two was directed to UAV and situation awareness platform operators to conduct reconnaissance from air regarding the danger area. Reconnaissance was designed to include at least the observation of the physical leak direction of the chemical substance and to ensure there were no redundant people in the danger area. The UAV was designed to use thermal camera in this use-case. Objective of the use-case was to evaluate, how real-time video produced from air affects the situation picture development of the team officer in charge. The use-case was designed to be conducted simultaneously with use-case one, right in the beginning of the exercise.

The third use-case is labeled as "use-case three - situation monitoring from ground". The definitions for the use-case can be seen more comprehensively from appendix (appendix 1). In general use-case three was directed to the situation awareness platform operator to monitor the operational situation through two static rescue vehicle cameras. The situation awareness platform operator filtered the situation information to the team officer in charge. The use-case was designed to be conducted right after the reconnaissance from ground, use-case one, ended and continued to the end of the exercise.

The fourth use-case is labeled as "use-case four - situation monitoring from air". The definitions for the use-case can be seen more comprehensively from appendix (appendix 1). In general use-case four was directed to UAV and situation awareness platform operators to conduct monitoring of the danger area. The objective of the use-case was to produce situation information from air to update the team officers' situation picture. The UAV was designed to use normal high definition camera for this use-case. The use-case was designed to be conducted right after the reconnaissance from air, use case two, ended and continued to the end of the exercise.

5.1.5 Distance leading

During the planning phase of the operational exercise it was heavily emphasized by the representatives of ESC that a distance leading element could be included to the exercise. Distance leading as a concept is defined in chapter 2.3.8.

The distance leading situation was simulated to the exercise. When the exercise began on the training area, the team officer in charge of the situation was moved away from the danger area. In practice the officer lead the situation only relaying on the situation information produced by real-time video and audio from a TETRA (Terrestrial Trunked Radio) phone. The TETRA phones used in exercise operated in VIRVE (Public Authority Network) network.

5.2 Operational exercise - involved observation

Observation in this study as a research method is defined as involved observation. The author of the thesis participated the operational exercise situation by closely observing and recording the actions of the team officer in charge of the situation. The observation was conducted as semi structured. The author didn't use any strict observation form, but the use-cases defined in chapter 5.1.4 guided the observation during the exercise. The author was the only person conducting observation in the exercise, however the direct observation notes made by the author are reinforced through recorded material through different sources. Recorded sources are defined in the following 5.2.1 chapter and listed in appendix (appendix 2).

5.2.1 Recording

The author of the thesis used Olympus voice recorders to document the operational exercise situation. One voice recorder was used to record the actions and communications of the team officer in charge. Other device was used to record the VIRVE communication during the exercise. Two Canon HD (High-Definition) video cameras were used to record the operational situations in emergency service and rescue company leading centers. These videos also included audio from both centers. However, the emergency service leading center recording is not used in this study because of the defined focus of the research. The company leading center recording was used in the study only to reinforce the observation remarks regarding the team officer in charge of the situation.

In addition to the two Canon HD video cameras, video observation material was recorded through the real-time video production platforms defined in chapter 1.2.2. Eye Solutions AAR (After Action Review) software was used to attain video recordings from the production platforms.

5.3 Observation analysis

The operational exercise was designed to start 9.2.2015 on 9 pm. at Korvaharju area. However, due to technical problems in the company leading level the exercise began 45 minutes later than originally scheduled. The delay in the operation starting time caused many technical problems and drifted the focus away from the use of real-time video. In addition to the starting time delay problem another challenge rise regarding the authentication username of the rescue team. Wrong username ultimately caused that the rescue team was signed to wrong dangerous chemicals accident situation in the KriSu exercise entity. Regardless of the challenges the exercise was carried out to the end and the defined use-cases were executed as designed.

The operational exercise was designed to research the development of situation picture only in the rescue team leading level. Other leading levels were recorded to reinforce the observation remarks made from the team leading level. The problems in the starting time and username caused challenges also to the emergency and company leading levels. Therefore, the video and audio materials from these leading levels are used in this study only to make general remarks regarding the use of real-time video in the production of situation information.

5.3.1 Rescue team officer in charge

The recording and observation notes regarding the rescue team officer in charge made by the author of the thesis provides the basis for observation in this study. The results of the observation are defined through the analysis of designed use-cases and describing synthesis that summarizes the results.

Real-time video was produced from all platforms defined in chapter 1.2.2. during the whole exercise. Real-time video was accessible for the team officer in charge also during the whole exercise. Situation awareness platform operator was filtering the situation information to the team officer regarding important remarks or when asked by the team officer. Because of the design of the operational exercise the situation picture development of the team officer was based on the information produced by real-time video and VIRVE communications only.

5.3.2 Situation awareness platform operator

In addition to the rescue team officer in charge the other person observed during the exercise was the situation awareness platform operator. Operator was observed in order to evaluate, how well the operator serves as a link between the situation information produced by real-time video and the team officer.

An important remark from observation regarding the system operator is that the person filtering the situation information must have sufficient understanding of rescue service operations. Emergency service education is preferable in order to the system operator to understand the differences between different types of situation information. Not all situation information produced by real-time video is usable by the team officer in order to build up situation picture, therefore not all information should be processed. The same remark can be seen through the professional interviews. In general the one filtering situation information produced from an emergency service situation must have the knowledge how rescue service situations operate and technical capabilities which are determined by the used system or software.

5.3.3 Use-case one - reconnaissance from ground

Reconnaissance from ground was conducted by the rescue service unit right in the beginning of the exercise. The objective for the use-case was to investigate the danger area and amount of chemical leak. The reconnaissance was conducted successfully. The beginning situation and amount of leak could be seen from the situation awareness platform. In addition the produced situation information also included the chemical substance and danger numbers and symbol that can be seen from photograph (photograph 2). From observation audio recording it comes clear that the rescue team officer used the produced information to develop his situation picture.

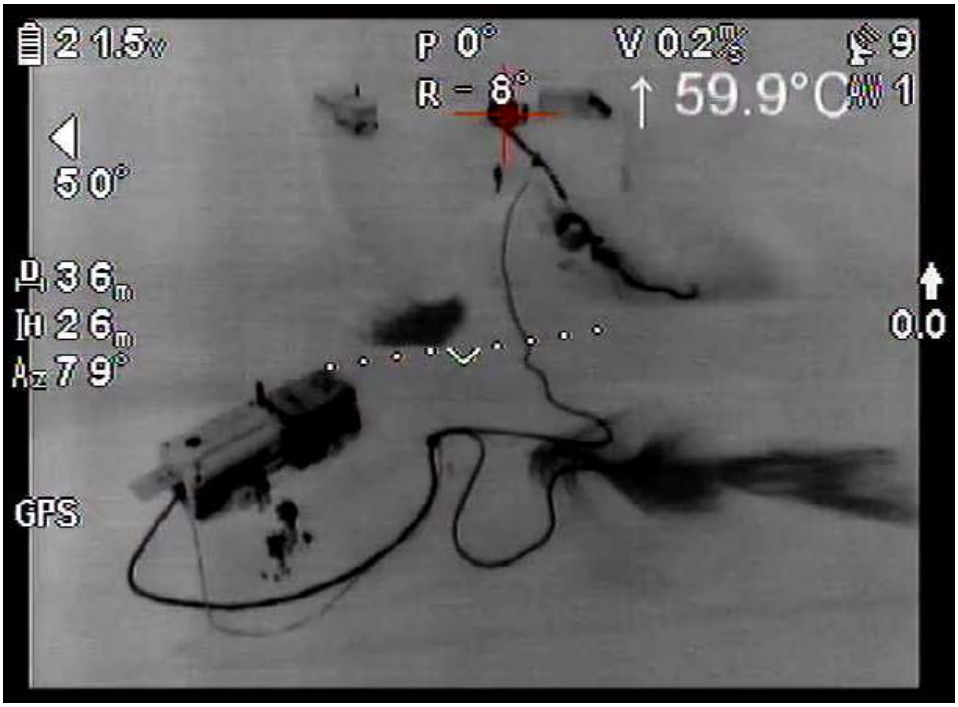
Photograph 2: Reconnaissance from ground - dynamic single camera

Seven minutes after the exercise was officially begun the team officer communicated to the company leading level that reconnaissance is currently carried out and we have the possibility to observe the situation through real-time video. Before this comment the team officer had only given the order for the unit officer to start reconnaissance. There had been no other VIRVE communication regarding reconnaissance before the team officers comment to the company leading level, therefore the team officer was using the situation information produced by the real-time video to develop his understanding of the ongoing situation.

During the exercise the chemical substance and danger numbers were clearly seen from the real-time video produced by the rescue unit doing reconnaissance. However, the information regarding the numbers was not used by the team officer because the information came much more efficiently and clearly through VIRVE communication. VIRVE communication and real-time video from rescue unit supplemented each other.

5.3.4 Use-case two - reconnaissance from air

Reconnaissance from air was conducted simultaneously with reconnaissance from ground. The primary objective for the use-case was to investigate the danger area and amount of chemical leak. The secondary objective was to observe the amount of the people in the area and direction where the chemical substance is leaking. The reconnaissance was conducted successfully. The UAV used thermal camera for easier recognition of humans in the danger area, an example can be seen from the following photograph (photograph 3). Situation information produced by reconnaissance from air was used by the rescue team officer to get a clear overall understanding of the danger area.



Photograph 3: Reconnaissance from air - dynamic single camera

Nine and half minutes after the exercise was officially begun the team officer communicated to the rescue unit conducting the reconnaissance. In the conversation the unit officer first tells reconnaissance information to the team officer. However, after the unit officer has finished the team officer replies back with situation information that weren't discussed in VIRVE. Team officer asked from the unit officer whether he has seen right from the real-time video that the danger area is focused around a loading bridge.

The reconnaissance from air produced the team officer overall information regarding the danger area. The amount of the people in the area was also easily calculated from the video with a quick glance. The reconnaissance information from both dynamic real-time production platforms supplemented each other, giving different points of view for the team officer to compare and base his situation picture development on.

5.3.5 Use-case three - situation monitoring from ground

Situation monitoring began effectively after the reconnaissance from ground had ended. However, the vehicle cameras had produced static real-time information during the exercise. The objective for the use-case was to monitor the operational situation from the danger area. The danger area was separated to two different sections which were both monitored by vehicle cameras. Both of the vehicles can be seen from photograph (photograph 5) and an example of the static video from the rescue vehicle one from photograph (photograph 4). The static video production platforms provided good quality real-time video throughout the exercise.

Photograph 4: Situation monitoring from rescue vehicle one - static single camera

After the reconnaissance the situation monitoring was focused through the static vehicle cameras and dynamic single camera from UAV. 13 minutes after the exercise was officially begun the team officer in charge described the danger area and operational situation to the company leading level using the information acquired through VIRVE and situation awareness platform. Vehicle camera one seen from photograph (photograph 4) gave a possibility for the team officer to monitor the carrying out of the tasks he had given to the rescue unit.

The situation monitoring from ground produced the team officer tactical situation information from the danger area. The team officer with the assistance of the situation awareness platform operator was able to be aware of the actions taken at the danger area all the time during the exercise. The use-case could have been carried out a little longer, but because of the technical issues regarding the exercise the focus started to drift away from the real-time video and the operational situation. The use-case ended when the exercise was put down.

5.3.6 Use-case four - situation monitoring from air

Situation monitoring from air began effectively after the UAV had ended reconnaissance of the danger area with the thermal camera. The UAV operator took down the UAV in-between the use-cases and changed the vehicle with thermal camera to a vehicle with a normal HD camera. The objective for the use-case was to generally monitor the danger area from air, giving holistic operational information for the team officer. An example of the dynamic real-time video is illustrated in the photograph (photograph 5) below.

Photograph 5: Situation monitoring from air - dynamic single camera

An important remark regarding the observation of the exercise is that after the UAV operator began use-case four with the HD camera, the dynamic video from air didn't provide any new information for the team officer in charge. All information that the UAV was able to provide was all ready seen from other real-time video production platforms. However, the real-time video from air provided the general tactical information which was designed in the use-case definitions to the rescue officer. The situation information didn't directly affect the primary producing of the situation picture of the team officer, but it made it possible for the team officer to modify his perception he had from the danger area.

As with use-case three the use-case four could have been carried out a little longer, but because of the technical problems regarding the exercise the focus started to drift away also from the real-time video produced from air. The delay also caused challenges with the battery life of the HDMI grabber transmitting the UAV real-time video to the situation awareness platform.

5.4 Describing synthesis - observation results

For the observation results, based on the operational exercise observation it can clearly said that the real-time video from all production platforms acted as a supporting function for the rescue team officer in charge. The main communication happened through VIRVE, however various operational situation information produced by real-time video supplemented the development and adjusting of the team officers situation picture.

From the results of the literature review it was defined before the operational exercise that too much real-time information might lead the focus of the team officer in charge to drift away from the actual leading of the situation. However, analysis of the observation material shows that rather than slowing down the decision making the situation information produced by the real-time video assisted the team officer to keep his actions more focused towards the operational situation. The capabilities for the use of real-time video as an information source are always dependent on the skills and expertise of the individual acting as the rescue service leader.

The situation awareness platform operator was seen as a working concept. Though it was also defined that the operator must have sufficient knowledge of rescue service operations to be able to assist the team officer in a right way. Operator without sufficient operational knowledge might direct the decision making of the team officer to wrong points of interest.

All the real-time video production platforms worked in the tasks defined before the exercise through the use-cases. All platforms provided tactical information that is needed by the team officer in order to conduct decision making. However, the least used by the team officer of the real-time video sources was the dynamic single camera view from the rescue unit conducting reconnaissance. The other production platforms provided in comparison better tactical information. The only valuable thing from the ground reconnaissance regarding the team officer was the danger and chemical numbers which were communicated through VIRVE immediately when they were also seen from the real-time video.

The observation of the exercise conducted for this study focused only on the team officer leading level. Based on the results of the observation it can be stated that team officer in charge of a dangerous chemicals accident situation can use real-time video produced from static vehicle cameras and dynamic aerial UAV camera to develop situation picture. In the exercise the quality of the situation information acquired through real-time video was also in the level that the situation could be lead from a distance using only VIRVE communications and the situation awareness platform. However, the quality of information is always emergency situation type and specific situation dependent.

6 Semi-structured theme interviews

Semi-structured theme interviews were used in this research to provide a deeper insight to people's opinions and own experiences from the rescue service field of expertise (Denscombe 2010, 173). Real-time video as the source for situation information is a much talked phenomenon, where every professional has their own views or opinions. This study selected six different rescue service professional from the fields of leading, teaching, researching and developing. All contacts interviewed were acquired through Thesis guidance or research partners. Four of the meetings were conducted as internet interviews using meeting program called WebEx, one through interview formal and one in person. All interviews took place during spring 2015 and all but one was recorded for after interview analysis.

6.1 Interview structure – operational exercise related approach

The interviews had two different approaches based on the professionals that were interviewed, but the basic concepts and major questions were equal. The first aspect included questions regarding the dangerous chemicals accident exercise and therefore was used as the basic guiding structure for Marko Hassinen (researcher, ESC) and Matti Honkanen (senior lecturer, ESC) who attended the exercise. The first two interviews took place on 19th of March 2015.

The themes used in the operational exercise related approach can be seen from the following figure (figure 4):

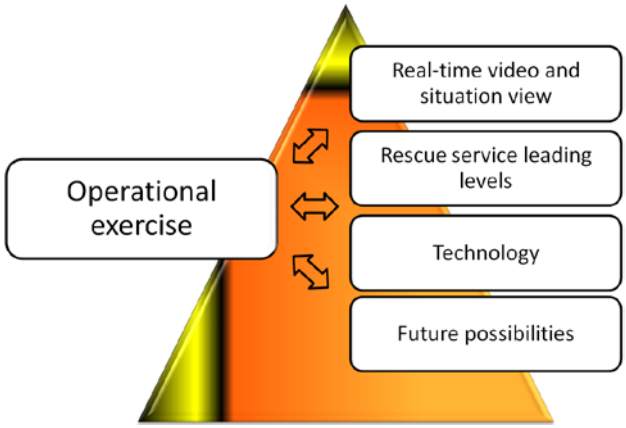


Figure 6: Operational exercise related approach interview themes

The themes were explained and focus points elaborated through defining interview questions. Questions were assigned a specific order from one to nine, but in interview situation the order was modified depending on the answers acquired from inside the specified themes. Interviewer also modified the format of the questions to get a deeper insight to the subject in situations where designed questions had been generally answered before in the same interview.

6.2 Interview structure – operational exercise describing approach

The second interviewing approach was abridged in terms of the questions related to the operational exercise. However, the interviewed professionals were given a short description of the operational exercise to elaborate the points of interest regarding real-time video (Denscombe 2010, 175). The description was conducted by the interviewer through operational exercise photographs, technological setup process chart and short video clips.

The themes used in the operational exercise describing approach can be seen from the following figure (figure 6):

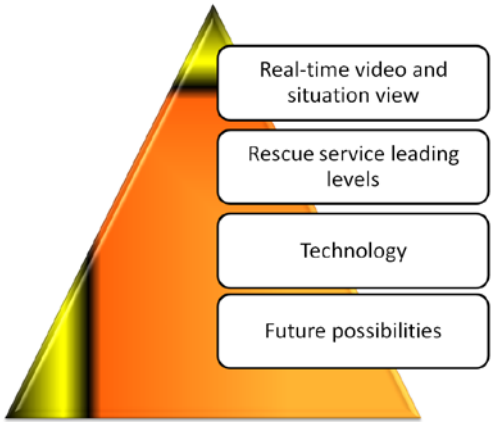


Figure 7: Operational exercise describing approach interview themes

The third interview took place on 10th of April in person with Teemu Veneskari (chief of development, Kymenlaakso Rescue department). Veneskari is the author of the thesis "Using Unmanned Aerial Vehicles to Build a Situation Picture for the Rescue Authorities, 2011", which this study uses in the literature review research method.

Fourth interview took place on 13th of April through internet meeting with Tapio Neuvonen (senior lecturer, ESC). The fifth interview took place on 15th of April through internet meeting with Ville Estlander (fire brigade chief, Helsinki Rescue department). The last one of the interviews was conducted only with the interview form with Risto Salonen (fire brigade chief, Pirkanmaa Rescue department) due to problems in internet connections. The answers to the interview form by Salonen are only used to improve general knowledge regarding the study.

The themes in both interview approaches provided answers to the research questions while also reinforcing the authors' knowledge regarding the subject. The different levels of situation leading were also involved within all the themes, since it's an essential part for all the questions provided to the interviewees beforehand. The questions were left open-ended and the emphasis in both interview approaches was that the interviewer elaborates different points of interest (Denscombe 2010, 175).

6.3 Interview analysis

The analysis and data handling process in this study started with dissembling the interviewing recordings. The recorded audio material was written to text transcription. Transcriptions were made from all interview material where the interviewed person had given permission to record the meeting. Transcription was followed by the author of the thesis categorizing different themes from the interviews. Themes were looked for similarities and relevant information regarding the research problem. (Hirsjärvi & Hurme 2004, 138)

Material from the interviews included similarities but also differences in opinions from all four themes and verified the author of the thesis remarks that were acquired through literature review and observation of the operational exercise. These remarks are described in the next chapter. The most important theme of the interviews was real-time video and situation awareness. The theme provided most of the information in relation to the research problem.

6.4 Interview results

Next the study will go through the most important remarks and ideas raised from the professional interviews. The two key concepts that the interviewed professionals felt most important were different types of real-time video production platforms and the rescue service leading levels in contrast to the provided video. Also an important remark is that all interviewed people agreed on the fact that the use of real-time video in producing situation information is very dependent of the type of the emergency situation.

6.4.1 Real-time video and situation awareness

First of the themes in the interviews was real-time video and situation picture. The interviewed people thought the subject through the different levels of emergency leading.

The very first remarks of situation awareness and picture were that real-time video alone can't be used as situation picture. Real-time video produces situation information which is then used by emergency service leaders in different levels to develop their situation picture. Tapio Neuvonen (Interview, 13 April 2015) refers situation picture as the "information entity where decision making and general situation awareness is based on". Teemu Veneskari (Interview, 10 April 2015) describes that "situation information is different types of data which are received from different sources". Situation information is used by individuals to produce situation picture, which is then used in different leading levels to develop general situation awareness of a particular emergency situation. Also an important remark

is that situation picture might also involve intangible information which is only held by one individual leader (Neuvonen, interview 13 April 2015).

The interviews clearly identified that real-time video in the production of situation information must be seen and used as a supportive function. One of the risks for using real-time video is that the "main interest in the situation might change to following the video, when decision making slows down" (Honkanen, interview 19 March 2015). Also Neuvonen (Interview, 13 April 2015) agrees that real-time video can direct the leading and decision making away from the actual emergency situation. The solutions for this remark were discussed through training and individual competence. The use of real-time video needs to be implemented to the training and everyday use for emergency service leaders to provide successful results. It is also one part of the professional expertise of the leaders to analyze the produced video in a way that the main focus remains in the emergency situation (Estlander, interview 15 April 2015).

Regarding the strengths of real-time video in producing situation information the interviews generated a lot of discussion. The most important remark was that real-time video can be used as a basis for information to implement decision making, which will result in a more accurate general awareness of emergency situations. In general the situation information would be more accurate through real-time video. Other key strengths worth mentioning could be listed as:

- No delay, information is provided in real-time
- Ability to observe operational rescue service situation. The affects of decision making can be seen in real-time and corrections are able to be done immediately
- The variety and broad selection of situation information sources provides more detailed and comprehensive situation picture

In addition to strengths also challenges and risks in the use of real-time video were identified. In cases where the situation information is not analyzed or categorized it is needed to consider what amount of and what types of real-time video become a hindrance for the leaders rather than a supportive function. "The problem is that we might end up with too much video that has irrelevant information and is sent to wrong leading level, which leads the decision makers to take wrong actions or slows down the entire process" (Honkanen, interview 19 March 2015).

In relation to leaders getting too much situation information through real-time video is that also too narrow or insufficient information equally leads the decision makers to take wrong actions or slow down the process. Neuvonen (Interview, 13 April 2015) describes that one challenge is that if leaders don't understand the limitations of the real-time video it might lead to wrong decision making. The physical location and angle of the platform providing the real-time information both have an influence on the quality and content of the video. Technical aspects are discussed more in chapter 6.4.3.

Ville Estlander (Interview, 15 April 2015) described in his interview that the challenges regarding the use of real-time video in Finland are also dependent on geographical location. In the Helsinki capital region one of the key challenges would be the pace regarding how fast real-time video could be produced from a particular emergency situation. Distances in the capital region are short and in order for the video to have an influence in the decision making it would be needed immediately when the emergency service leader arrives to the scene of action. Elsewhere in Finland the situations and challenges are totally different. (Estlander, interview 15 April 2015)

6.4.2 Rescue service leading levels

The study focuses on three different levels of rescue service leading which are described in detail at chapter 1.2.1. The interviews clearly stated that it must be clearly defined in advance what types of real-time video are directed to certain leading levels. The level is always dependent on the content of the video and not all information can be directed to all leading levels. Tapio Neuvonen (Interview, 13 April 2015) describes that when information reaches one leading level only a part of it is send onwards to another leading level. Otherwise the current leading system is not functional.

In the same context the functionality of the system operator described in chapter 5.3.2. was discussed. The general opinion was that real-time video requires a person in all leading levels to analyze the situation information. The person can be either an operator or the leader in that level. Depending on the content of video, expertise and training of the leaders the possibility is that they are able to analyze real-time video without an operator if it's comprehensively trained and implemented to the whole leading system.

The lowest leading level addressed in this study is the rescue unit officer. From interviews it was clearly seen that the type of information that an unit officer who is in charge needs is technical. Focused dynamic real-time video produced by an individual rescuer or dynamic aerial real-time video produced by an UAV were seen as the most important video production platforms for an unit officer. The content of the video must include clear and visible physical

technical elements in relation to the emergency situation in order for an unit leader to perform decision making based on the information acquired from the real-time video. The benefit of real-time video for rescue unit officer in producing situation picture is highly situation type dependent.

Team officer who is in charge coordinates multiple rescue service units on an emergency situation. The content of information sent to team-leader must be tactical. Dynamic aerial video from an UAV and static video from rescue service vehicles were seen as the most important real-time video production platforms for a team officer. Video from air produces information from the general operational state of the emergency situation which allows team officer to develop situation picture. In addition to video from air, the static video from emergency service vehicles produces more localized information from the operational units.

In large scale emergency service situations where a rescue company is needed the officer in charge of company level requires information that is operative. Dynamic aerial video from an UAV was seen as the most important real-time video production platform for the company leading level. An important remark is that in order for dynamic real-time video to have a real affect to development of company officers situation awareness must be received in very early state of the emergency. In cases where the video from air is acquired late from a situation it can be used to monitor the situation but it doesn't affect to the building up of the primary situation picture. The information is in general acquired from other sources.

6.4.3 Technology

The overall definitions to technology regarding the production of real-time video are described more in depth at chapters 1.2.2. and 5.1.3. The overall emphasis of the interviews was that regardless of the video production technology it is the content which is more important regarding the development of situation picture. Different production platforms have different uses for different leading levels but ultimately the content of the video, the actual situation information defines whether the information can be utilized to make the development of situation picture more efficient.

A dynamic single camera which is carried by a rescue unit in general wasn't really seen beneficial for any leading level in the interviews. The key challenge for the video type is that the information from a dynamic single camera must be analyzed very carefully, which is highly resource consuming. The video from a dynamic single unit can be very narrow, inefficient and hard to analyze. The only two situations where interviewed people saw a benefit for video produced by dynamic single unit were reconnaissance from ground, where a person is continuously searching the video for specific points of interest, or after action review. An important

remark also worth to mention is that the video produced by a dynamic single unit contains mostly technical information and therefore requires a lot of analyzing. Because of the content of produced situation information the video production platform can in general only be seen useful for the officer in charge of rescue service unit. After a comprehensive analyze, some of the information might develop to be usable also in other leading levels, however thoroughly analyzing a dynamic video is a very resource consuming task.

A static single camera installed to a rescue service vehicle provides a lot of possibilities for different leading levels. From interviews it was clearly seen that static vehicle cameras provide most important information for the officer in charge of a rescue team because the content of the information is mostly tactical. Vehicle cameras require a remote operation function so those can be directed to certain points of interest after tactical placing of the vehicles. The tactical placing of vehicles can't be limited by the cameras. Marko Hassinen (Interview, 19 March 2015) describes in his interview that vehicle cameras which can be remotely operated, have good resolution and require low amount of maintenance are technology which allows emergency service situations to be lead from distance. The key challenge with vehicle cameras is that they are very emergency situation type and location dependent.

The dynamic video produced by an unmanned aerial vehicle was seen very beneficial in the development of situation picture throughout the interviews. Ville Estlander (Interview, 15 April 2015) describes that a comprehensive real-time video from air gives a general overview and tactical information of emergency situations. UAV's as real-time video production platforms can be used in various outdoor emergency situation types with low risk, providing better occupational safety. It was agreed in the discussions that the availability time of dynamic aerial video is considered as the most limiting factor for the technology type in rescue services. Dynamic aerial video in the current state of emergency service in Finland was seen as the type of video that is able to be produced in a large scale and time consuming emergency situation.

In addition to video production platforms the interviews included also more general technical remarks. This study focuses on real-time video but is also worth to mention that most interviewed people saw the use for situation video to be used in the after action review process of emergency situations. Real-time video can be used to record the before and after stages of an emergency situation which provides information for development or analysis purposes. Another key remark was that map software's in combination with real-time video and operational audio would create a more controlled entity of real-time information for the leaders to build situation picture from. Technical camera units marked on a geographical map provides more holistic and accurate situation information.

6.4.4 Future possibilities

The possibilities for real-time video in rescue services weren't entirely seen anymore as the topic for future amongst the interviewed professionals. Technology at least regarding static real-time video is considered to be developed enough to be used in rescue service situations, now it is more a matter of implementation rather than technical development. Matti Honkanen (Interview, 19 March 2015) describes that future possibilities are good and there definitely is a use for real-time video in rescue services. Real-time video serves distance leading exceptionally well and makes decision making a lot easier because of more accurate situation information.

In general the emphasis between interviewed people was that static real-time video is considered to be a very present topic and aerial dynamic video from an UAV a topic for the near future. Teemu Veneskari (Interview, 10 April 2015) emphasized in his interview that the next steps in terms of research are that different rescue service situations need to be tested with and without the use of real-time video. The use of real-time video in rescue services is highly situation type dependent, therefore more situation specific research is needed.

7 Conclusions

The purpose of this thesis was to research real-time videos' affect to the development of rescue service leader's situation picture. Different rescue service leading levels were addressed throughout the study. The societal impact for the study is to raise the awareness of real-time videos' possibilities in rescue services. Based on the results of this study real-time video can be used for the production of situation information and the necessary technical equipment is available. However, more research needs to be conducted in order to identify the best possible practices regarding functional implementation to rescue services.

7.1 Answering research questions

The research aspect of the study is based around three central research questions that are derived from the research problem. This chapter attempts to answer those questions based on the results attained from the different research methods. The answers to research questions in combination with the method-triangulation synthesis form the conclusions for this study.

Research question: How situation information produced by real-time video affects the situation picture development of rescue service officers?

Comprehensive and valid situation information produced by real-time video makes the development of rescue service officers' situation picture more efficient and accurate. However, the development of situation picture shouldn't be based only on the information attained through real-time video. Real-time video is just one source of situation information which must be supplemented by other sources in order for a rescue service officer to develop a comprehensive situation picture.

The influence of real-time video produced situation information to the development of situation picture is situation and individual dependent. Different types of video-production platforms provide different information which can be used more efficiently in other rescue service leading levels than others, therefore the influence to situation picture development also varies.

Because of the variation in rescue service situations information produced by real-time video can also have a negative influence on the situation picture development. In cases where the officers are provided either too much or too narrow real-time video the situation picture development can in general become slower. Too narrow real-time video can also lead to false situation information and picture if the influences of technological limitations are not considered properly.

Research question: How situation information produced by real-time video affects rescue situation related decision making of rescue service officers?

In professional interviews it was defined that real-time video can be used as a basis for information to implement decision making because of more accurate general awareness of rescue situations. Real-time video can also be used to produce operational situation information which allows rescue service officers to maintain their situation picture and observe the influences of their previous decisions. Real-time situation information allows the rescue service officers to adjust their decision making immediately if the previous decisions have not achieved desired results.

The ability of rescue service officer to make decisions based on real-time video produced situation information is dependent of the information content. In order for an rescue service officer to conduct decision making the content of the information must correspond to the information needed on a specific leading level. Therefore the real-time video produced situation information's effect to decision making is dependent of the rescue service leading level where the officer operates on.

In general, the situation information rescue unit officer needs to conduct decision making is technical. Therefore if a rescue unit officer wants to conduct decision making based on real-time video produced situation information, the content of the video must include technical information. Likewise rescue team and company officers require tactical and operational situation information from the real-time video in order to be able to properly conduct decision making. Wrong information content might lead to inefficient or incorrect decision making. However, individual expertise of rescue service officers also affects how situation information provided by real-time video is interpreted.

Research question: What types of video production sources can be utilized to make the development of rescue service officers' situation picture more efficient?

Different real-time video production platforms provide situation information with different content. The content of the real-time video ultimately defines what production platforms can be used an in what leading levels to make rescue service officers' situation picture development more efficient. Figure (figure 8) illustrates the different rescue service leading levels and real-time production sources used in this study.

The rescue unit officer requires information which is technical. A dynamic rescue unit performing a task produces technical information and a dynamic UAV from air provides general overview information which can be both used by the unit officer to develop situation picture. Vehicle cameras are redundant because in typical situations the unit officer can see the areas where vehicle cameras produce the real-time video with own eyes.

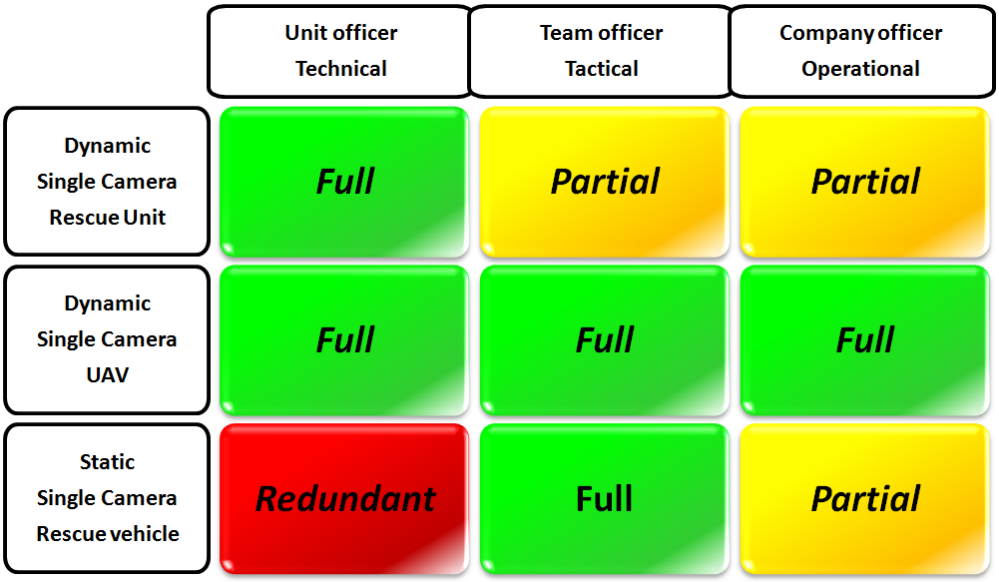


Figure 8: Usability of real-time video production sources to rescue service leading levels

The rescue team officer requires information which is tactical. Therefore only some specific parts from the technical information provided by the rescue unit is usable for the team officer. In other words the dynamic real-time video produced by rescue unit needs to be filtered before the information is sent to the team officer. The team officer can utilize the unfiltered information's from dynamic aerial and static real-time videos. However, both of these real-time video production sources are highly rescue situation type dependent. In rescue situations where the danger area can't be accessed with either UAV or vehicles the information attained through rescue service unit becomes more important.

The company officer requires information which is operational. The only real-time video production source that should be fully provided to the company leading level is the dynamic aerial provided by an UAV. Rescue unit and vehicles provide information that requires filtering before sent to the company officer. One of the key challenges with real-time video in the development of rescue service officer's situation picture is that too much information can slow down the whole process, therefore only information with the corresponding content should be sent to the right levels.

7.2 Method triangulation

Kananen (2013, 33-36) defines triangulation as a entity of situation dependent qualitative and quantitative research. In this thesis triangulation attempts to develop the understanding and reliability of the researched phenomenon by addressing it through multiple different research methods. Triangulation in this study is conducted as qualitative research method triangulation which end result is a synthesis of the results attained through all research methods.

7.2.1 Synthesis

Real-time video alone can't be used as a situation picture but it can be used to provide situation information. Situation information from multiple sources are ultimately combined by a rescue service officer to form a situation picture. Real-time video in rescue services must be seen as a supportive function which in combination with other information sources supplements the decision making and situation picture development of officers in charge.

The use of real-time video has potential to make the development of rescue service officers situation picture more efficient and accurate. Real-time video produces unfiltered situation information which is provided without a delay, providing the possibility for rescue service officers to conduct decision making and evaluate the successfulness of their previous decisions. The results of this study clarify that real-time video produced situation information with right content will allow rescue service officers to produce a more comprehensive situation picture.

However, with new concepts also new challenges are identified. The key issue with real-time video is the overflow of information. Too much or irrelevant situation information do not support the current rescue service leading system. Another issue with real-time video is that analyzing and filtering situation information is a very resource consuming process. The method how real-time video is implemented to rescue services must be developed in a way that the attaining of situation information requires as minimal resources as possible.

In a case where real-time video is implemented to rescue services the officers using it to produce situation information must understand that technology has limits. The physical locations and for example the angles where the real-time video is provided have an influence on the quality and reliability of the information. However, it is also seen as individual professional expertise of rescue service officers to be able to recognize the influencing elements and interpret information the right way.

Different real-time video production platforms provide different types of situation information. The content of the situation information defines the rescue service leading level where the information can be used. Based on the results of this study the production platforms and suitability in comparison to the different leading levels is presented in figure (figure 8). Ultimately whether real-time video can be used to produce situation information is rescue situation type dependent. Different rescue situation types require different video production sources and information.

7.3 The validity and reliability of the study

Yin (2009) introduces a four tests approach which can be used to "establish the quality of any empirical social research". The scientific approach of this study is a case study, which is a form of empirical social research. Figure (figure 9) illustrates the four different tests and case study tactics described by Yin (2009, 40) which this study uses to establish its quality.

The first one of the tests described by Yin (2009, 41) is construct validity. Multiple sources of evidence were used in this study to finally achieve method triangulation. The thesis used literature review, interviews and observation to collect qualitative data from multiple different sources. This study also forms a chain of evidence which Yin (2009, 122) describes as the traceability of information. This thesis is based on a clear structure which allows the reader to trace the research steps from the initial research question to the conclusions, and back if required. Finally, four out of the five comprehensively interviewed rescue service professionals reviewed the citations used by the author of the thesis.

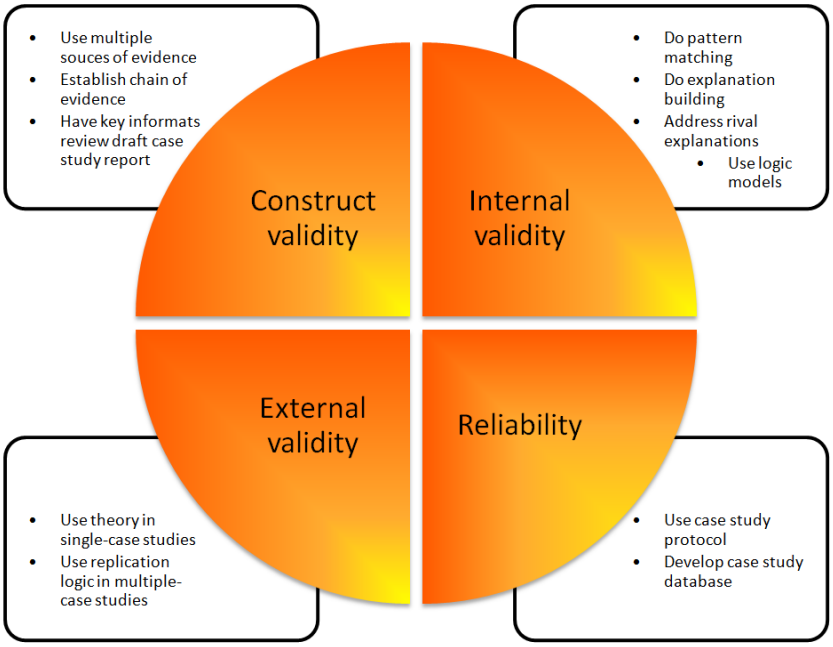


Figure 9: Case Study Tactics for Four Design Tests (Yin 2009, 41)

The second one of the tests described by Yin (2009, 41) is internal validity. Internal validity according to Yin (2009, 41) is "mainly a concern for explanatory case studies, when an investigator is trying to explain how and why event X led to event Y". Also, the concern of internal validity in case studies is the making of inferences (Yin 2009, 43). However, the topic of the study was discussed within the professional interviews and operational exercise planning phase. Study related issues were communicated and addressed with the research partners. Observation research findings were discussed more closely in the interviews and a feedback meeting arranged between the research partners after the exercise.

The third one of the tests described by Yin (2009, 41) is external validity. In general Yin (2009, 43) defines external validity as the "problem of knowing whether a study's findings are generalizable beyond the immediate case study". Yin (2009, 43) also defines the external validity as the main difficulty when conducting case study research. In general it is hard to compare one case to another. This study produces a basis for information regarding real-time video and its use in producing situation information and picture. Regardless of the authority which is addressed, the concepts of real-time video, situation information and situation picture remain the same. Therefore the remarks regarding these concepts are also generalizable beyond the original case study.

The fourth and final of the tests described by Yin (2009, 41) is reliability. The main objective for reliability is "to be sure, that if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions" (Yin 2009, 45). Yin (2009, 45)

addresses reliability with comprehensive documentation of the research process. Documentation is essential for another researcher to conduct the same study again. This thesis is focused on its clear structure and documentation of the entire research process. The thesis includes overall research process and observation material charts and a timetable which indicates the amount of meetings used for planning with the research partners. All used research methods are thoroughly documented and the interviewed people are named. However, an important part of the results of this study were acquired through the professional interviews and if the same study would be repeated, the same professionals should also be interviewed.

7.4 Future research

Real-time video in rescue services is a phenomenon which hasn't been studied much in the past. The research results of this thesis and the past studies open up a number of interesting research possibilities for the future.

The production of situation information through real-time information is heavily rescue situation type dependent. Situation types need to be identified and individually researched to provide more specified research results. Specific situation type research is also essential in order to provide more user experiences regarding real-time video production. The different rescue service situations need to be tested with and without the use of real-time video. The research partners of this study have expressed interest to keep studying the subject in a more detailed level. In addition the subject of distance leading in combination with real-time video should be researched more comprehensively in the future.

As the author of this thesis I believe that the use of real-time video by various authorities will develop significantly during next couple years. The concepts of real-time video and situation picture awake a lot of discussion amongst rescue service authorities and I think that it's just a matter of time when a larger initiative is taken to advance the development. During the research process I have learned to understand the potential that real-time video offers for rescue service leading and believe that one day it will revolutionize the whole development process of situation picture.

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Photographs

Figures

Tables

Appendixes

Appendix 1: Operational exercise use-case definitions

USE-CASE 1

- Use-case: Reconnaissance from ground
- Operator: Rescue unit
- Equipment: Dynamic single camera (KS1)
- Communication: VIRVE
- Time: t0:00 – t15:00
- Point of interest: Team officer in charge

- Objective: Reconnaissance from ground regarding the danger area and amount of chemical leak. Recording the beginning state of rescue situation.
- From a research point of view the objective of this use-case is to evaluate how an individual rescue unit performing a task and recording it to the situation awareness platform affects the development of team officers situation picture. Rescue unit (KS1) will be equipped with a smart phone, provided by Eye Solutions, that uses micro USB camera for real-time video production.
- Use-case is intended to be conducted as fast as possible when the exercise begins, simultaneously with use-case two.

USE-CASE 2

- Use-case: Reconnaissance from air
- Operator: UAV-operator & situation awareness platform operator
- Equipment: UAV with thermal camera
- Communication: VIRVE
- Time: t0:00 – t15:00
- Point of interest: Team officer in charge

- Objective: Reconnaissance from air regarding the danger area and amount of chemical leak. Observe 1) the physical spreading direction of the chemical substance and 2) the amount of people in the area.
- From a research point of view the objective of this use-case is to evaluate how dynamic video from air which is produced by an UAV affects the development of team officers situation picture. Use-case is conducted by UAV-operator from outside of the danger area. Situation awareness platform operator is used to filter the information to the team officer. UAV will use thermal camera for reconnaissance.
- Use-case is intended to be conducted as fast as possible when the exercise begins, simultaneously with use-case one.

USE-CASE 3

- Use-case: Situation monitoring from ground
- Operator: Situation awareness platform operator
- Equipment: Rescue service vehicle cameras (KA1 & KA2)
- Communication: VIRVE
- Time: t15:00 – end of exercise
- Point of interest: Team officer in charge

- Objective: Produce situation information from the danger area.
- From a research point of view the objective of this use-case is to evaluate how static real-time video produced from two different sections of the danger area affects the maintaining of team officers situation picture. The static real-time video is produced from smart phones, provided by Eye Solutions, that are mounted to the windscreens of two rescue service vehicles. Situation awareness platform operator filters the information to the team officer in charge.
- Use-case begins when rescue unit returns from reconnaissance and use-case one ends.

USE-CASE 4

- Use-case: Situation monitoring from air
- Operator: UAV-operator & Situation awareness platform operator
- Equipment: UAV equipped with thermal and high definition video cameras
- Communication: VIRVE
- Time: t15:00 – end of exercise
- Point of interest: Team officer in charge

- Objective: Produce situation information from the danger area. Ensure that there is no redundant people in the danger area.
- From a research point of view the objective of this use-case is to evaluate how dynamic real-time video of danger area from air affects the maintaining of team officers situation picture. The real-time video is acquired from the UAV which is operated from the outside of the danger area. Situation awareness platform operator filters the information to the team officer in charge.
- Use-case begins when reconnaissance from air is conducted and use-case two ends. The UAV is intended to be kept in air as much as possible during the exercise.

Appendix 2: Observation material

AUDIO	Source	Recorder	Length	Point of interest
Defining observation area	Researcher	Olympus voice recorder	16:02	Specific definition made by the researcher regarding the exercise area
Emergency service leading center	Technical support	Canon HD - Video camera	82:35	Recording from the emergency service leading center
Rescue company leading center	Technical support	Canon HD - Video camera	81:20	Recording from the rescue company leading center
Observing team officer	Researcher	Olympus voice recorder	84:20	Observing the team officer in charge of operational exercise
VIRVE communication	Researcher	Olympus voice recorder	82:25	VIRVE communication from the operational exercise
VIDEO	**Source**	**Recorder**	**Length**	**Point of interest**
Defining observation area	Researcher	Canon HD - Video Camera	21:02	Specific definition made by the researcher regarding the exercise area
Emergency service leading center	Technical support	Canon HD - Video camera	82:35	Recording from the emergency service leading center
Rescue company leading center	Technical support	Canon HD - Video camera	81:20	Recording from the rescue company leading center
Exercise - rescue unit	Rescue service unit	Eye Solutions situation awareness software	17:59	Exercise from rescue unit perspective
Exercise - vehicle camera one	Rescue service vehicle one	Eye Solutions situation awareness software	27:59	Exercise from rescue vehicle one perspective
Exercise - vehicle camera two	Rescue service vehicle two	Eye Solutions situation awareness software	31:59	Exercise from rescue vehicle two perspective
Exercise - UAV HD camera	UAV	Eye Solutions situation awareness software	8:59	Exercise from UAV with HD camera
Exercise - UAV thermal camera	UAV	Eye Solutions situation awareness software	18:41	Exercise from UAV with thermal camera

Appendix 3: Semi structured theme interview form

Haastattelurunko Laurea-ammattikorkeakoulu

Riku Leppänen
16.3.2015

Haastattelun tarkoituksena on kartoittaa reaaliaikaisella videokuvalla tuotetun tilannetiedon mahdollisuuksia pelastustoiminnassa ja tilannekuvan muodostamisessa.

9 kysymystä. Kohdan "KriSu" kysymykset koskevat ainoastaan niitä henkilöitä jotka osallistuivat harjoitukseen.

Reaaliaikainen videokuva ja tilannekuva:

1. Miten reaaliaikaisella videolla tuotettua tilannetietoa ja siitä muodostettua tilannekuvaa pystytään hyödyntämään pelastustoiminnassa?

2. Mitkä ovat mielestäsi reaaliaikaisen videokuvan vahvuudet ja heikkoudet tilannekuvan muodostamiseen liittyvissä asioissa?

3. Oletko nähnyt reaaliaikaista videota käytettävän tilannekuvan muodostamisen apuvälineenä aikaisemmin minkäänlaisissa tilanteissa? Minkälaisia käyttökokemuksia?

Teknologia:

Tällä hetkellä reaaliaikaista videokuvaa pystytään tuottamaan (perustuu laitteistoon jota hyödynnettiin KriSu harjoituksessa):

- Staattinen kuva maasta (pelastusajoneuvo)
- Dynaaminen kuva maasta (yksittäinen pelastaja)
- Dynaaminen kuva ilmasta (miehittämätön ilma-alus)

4. Mihin tarkoitukseen ja kenen näkisit hyödyntävän mitäkin kuvanlähdettä pelastustilanteen johtamisessa? Esimerkiksi, mikä taho hyötyy eniten liikkuvasta ilmakuvasta operatiivisessa pelastustilanteessa?

5. Millaisissa tapauksissa koet, että tilanteen johtajille reaaliaikaisesta videokuvasta saattaa tulla liikaa tilannetietoa?

Haastattelurunko

Laurea-ammattikorkeakoulu

Riku Leppänen
16.3.2015

KriSu:

Pelastusopistolla pidettyyn harjoitukseen liittyviä kysymyksiä.

6. Millainen vaikutus reaaliaikaisella videokuvalla oli pelastustoiminnan johtajan tilannetietoisuuteen?

7. Millä tavoin pelastustoiminnan viranomaiset (Hulkontiellä) käyttivät reaaliaikaista videokuvaa toiminnassaan?

Tulevaisuuden näkökulmat:

8. Reaaliaikaisen videokuvan avulla muodostettu tilannekuva ja etäjohtaminen, mitkä ovat mielestäsi toimintatapojen mahdollisuudet tulevaisuudessa?

Yhteystiedot:

Opinnäytetyössäni on vielä tarkoitus tehdä teemahaastatteluita loppukäyttäjille, hyödyntäen KriSu harjoituksessa kerättyä videomateriaalia. Tarkoituksena on kartoittaa mielipiteitä pelastustoiminnan viranomaisilta.

9. Tunnetko henkilöitä, jotka mahdollisesti haluaisivat keskustella opinnäytetyötä koskevasta aihealueesta? Onko mahdollista saada heidän yhteystietonsa haastattelukäyttöön?

Interview form
English translation for thesis

Laurea University of Applied Sciences

Riku Leppänen
16.3.2015

The purpose of the interview is to map the possibilities of situation information produced by real-time video in rescue services and situation picture development.

9 questions. The part labeled as "KriSu" is meant for the people only who participated in the operational exercise.

Real-time video and situation picture:

1. How situation information and picture produced by real-time video can be utilized in rescue services?

2. What do you consider as the strengths and weaknesses of real-time video in situation information production?

3. Have you seen real-time video being used as a supplementing function for situation picture development before? What kind of user experiences you have?

Technology:

Real-time video can be produced from (based on the equipment used the in the operational exercise):

- Static video from ground (rescue vehicle)
- Dynamic video from ground (rescue unit)
- Dynamic video from air (unmanned aerial vehicle)

4. For what purpose and who you would think that could use these specific production sources in rescue service leading? For example, what leading level benefits the most from dynamic aerial video in a operational situation?

5. In what situations you feel, that real-time video might produce too much situation information to rescue service leaders?

Interview form
English translation for thesis

Laurea University of Applied Sciences

Riku Leppänen
16.3.2015

KriSu:

Questions related to the exercise held in the Emergency Services College.

6. How real-time video affected the situation awareness of the rescue service officer in charge?

7. How rescue service authorities (at Hulkontie) used real-time video in their actions?

Future possibilities:

8. Situation picture produced by using real-time video and distance leading. What do you think that are the possibilities for these concepts in the future?

Contact details:

This thesis will still focus on doing more theme interviews to end users, by taking advantage of the video material gathered in the operational exercise. The objective is to map ideas from rescue service authorities.

9. Do you happen to know any rescue service authorities or other related people that would like to talk regarding the thesis subject? Is it possible to get their contact information for interview use?