Delft University of Technology
Faculty of Technology, Policy and Management
Engineering and Policy Analysis MSc

National Aerospace Laboratory–NLR
Helicopters & Aeroacoustics
Department

REMOTELY PILOTED AIRCRAFT SYSTEMS

Exploring the effects of human subjectivity on social acceptance and enhancing cognitive learning using Q methodology

Kalliopi Diliou
4185900
kal.diliou@gmail.com

Delft University of Technology
Faculty of Technology, Policy and Management
Engineering and Policy Analysis MSc

National Aerospace Laboratory–NLR
Helicopters & Aeroacoustics Department

Master Thesis
Author: Kalliopi Diliou
Student ID: 4185900
Program: MSc. Engineering and Policy Analysis

Contact Information
Telephone: +31683292055
Email: kal.diliou@gmail.com

Keywords
Remotely piloted aircraft systems, Q methodology, social acceptance, risk perception.

Remotely-Piloted Aircraft Systems: Exploring the effects of human subjectivity on social acceptance and enhancing cognitive learning using Q methodology

Graduation committee

	TU Delft	
Full Professor	Wil Thissen	*Head of Policy Analysis Section*
First Supervisor	Alexander de Haan	*Policy Analysis Section*
Second Supervisor	Ellen Jagtman	*Safety Science Group*
	NLR	
External Supervisor	Jan-Floris Boer	*Helicopter technologies & UAS regulations*

“Logic is not a body of doctrine but a mirror of the world. Logic is transcendental.”

— Ludwig Wittgenstein

“Scientists study the world as it is; engineers create the world that has never been.”

—Theodore von Kármán

PREFACE – ACKNOWLEDGEMENTS

This thesis finalizes my master studies at the MSc Engineering and Policy Analysis at the Faculty of Technology, Policy and Management of TU Delft. All started two years ago, when this wonderful journey begun; meeting interesting people, sharing ideas and getting new lenses to see the world. Therefore, first of all, I would like to thank my friends, in the Netherlands, in Greece and all over the world that made this journey a wonderful experience full of unforgettable moments of happiness and creativity.

This research that was conducted during a period of eight months at NLR and TU Delft would have never been of such quality and completeness without the help and support of some people. Firstly, I would like to express my gratitude to Alexander de Haan, the first supervisor of the thesis, for his enormous help, advice and encouragement throughout the project. Alexander, I have been extremely lucky to have you as a supervisor and I want to thank you for sharing your knowledge and thoughts during our extremely informative and inspiring meetings.

I would also like to thank the chair of the graduation committee, Wil Thissen, and the second supervisor of the thesis, Ellen Jagtman, for their constructive comments on improving my thesis. Moreover, I would like to thank the external supervisor of the thesis, Jan-Floris Boer as well as Henk Hesselink for giving me the opportunity to graduate at NLR and providing me a very interesting thesis subject in such an inspiring environment. I would also like to thank all the people at NLR and the others friends, who contributed to this research and participated in the Q-method, for sharing knowledge and experiences with me.

Last but not least, my deep gratitude to Vaggelis and Spyros, for their continuous love and their support in my decisions. Without you I could not have made it here.

Kalliopi Diliou
Delft, October 2013

EXECUTIVE SUMMARY

According to the European Commission (2012), RPAS constitute a very promising new sector in the aerospace field in Europe. The emerging technology of RPAS and the variety of their civil applications (corporate, governmental, commercial, non-military) that make them useful for the military as well as the civil sector are related to monitoring tasks for a long period or flights with high risk through which RPAS can be beneficial for the citizens. However, there are some barriers that prevent the smooth and fast implementation of the wide civil utilization of RPAS. The dilemmas are among others the extent to which the European citizens accept the civil use of RPAS. Privacy issues and safety for example, are considered to be a constraint for the social acceptance of RPAS operations in civilian airspace and may influence the public perception regarding the development of the civil RPAS market.

In this research the complex challenges related to SA of RPAS are studied through the identification of shared beliefs and perceptions among the citizens and through the understanding of their characteristics. A literature review as well as a critical reflection on it provides a definition of social acceptance of technological project that scientifically supports this research. Further literature review is used to address the problem, presenting the two polarized opinions; the supporters of the development of the civil RPAS market and the opponents. Moreover, a theoretical study of subjectivity related to risk perception merges the safety characteristics of RPAS with the issue of social acceptance.

Q methodology is the quantitative and qualitative tool that is used in this research to study human subjectivity and answer how and why people have a specific opinion about RPAS. Through focus groups, the participants provided a list with statements regarding civil RPAS and their applications, which give a first indication on the issues at stake regarding this emerging market according to the public. These statements are ranked by the participants in this study in order to identify the underlying values that drive their perception. The quantitative analysis showed three factors that share common perspectives, attributing high significance to the possibility of an infringement of privacy as well as improving the current technical safety level of RPAS. Other conditions under which the public is willing to accept the wide utilization of civil RPAS are identified and interpreted combined with the theoretical underlying values that may influence human subjectivity.

The analysis provides RPAS community insights on the shared perspectives of the public as well as a first comparison between the experts' and laypeople viewpoints and areas of consensus and disagreement among them. A constructive dialogue among the policy makers, RPAS managers and the public can be structured having certain reference or starting points. The outcome of the research can be utilized while developing the regulation regime of the civil RPAS market in Europe, during which opposing public opinions may appear. The results that this research has provided can be utilized as a basis for further studies in the field of SA of civil RPAS in order to further identify the market characteristics, their interrelations and the influence they have on social acceptance of civil RPAS.

ABBREVIATIONS

RPAS	Remotely-Piloted Aircraft System
RPA	Remotely-Piloted Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
EC	European Commission
SA	Social Acceptance
ICAO	International Civil Aviation Organization
INOUI	Innovative Operational UAS Integration
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
EDA	European Defense Agency
ESA	European Space Agency
SME	Small and medium enterprises
DG MOVE	Directorate-General for Mobility and Transport (European Commission)
ASD	Aerospace and Defense Industries Association of Europe
ERSG	European RPAS Steering Group
UAVS	Unmanned Aerial Vehicle Systems Association
SESAR	Single European Sky ATM Research
SESAR JU	SESAR Joint Undertaking

LIST OF TABLES

LIST OF FIGURES

CONTENTS

INTRODUCTION

According to ICAO (ICAO Circular 328 AN/190), a Remotely-Piloted Aircraft (**RPA**) is 'an aircraft piloted by a licensed-remote pilot situated at a remote pilot station located external to the aircraft (i.e. ground, ship, another aircraft, space), who monitors the aircraft at all times and can respond to instructions issued by ATC, communicates via voice or data link as appropriate to the airspace or operation and has direct responsibility for the safe conduct of the aircraft throughout its flight.'

A Remotely Piloted Aircraft System (**RPAS**) is 'a set of configurable elements consisting of a remotely-piloted aircraft, its associated remote pilot station(s), the required control links and any other system elements as may be required, at any point during flight operation.' (ICAO, 2005)

FIGURE 1: MARITIME RPAS

The term RPAS has been recently adopted by ICAO in order to highlight the not fully automatic nature of the systems involved, which have always a pilot in command for the flight. In contrary, the previous term **UAS** had been used for either remotely piloted or programmed and fully autonomous systems (ICAO, 1944). Additionally to RPAS, throughout this research different terms may be used such as UA (Unmanned Aircraft), UAV (Unmanned Air Vehicle), and UAS (Unmanned Aircraft System). This research focuses on the public perception of RPAS and not about fully automatic aircraft. Nevertheless, the reader will come across all the terms mentioned above, as they are part of the discussions among the participants of this study.

In order to give a glance on what are these aircraft like in Figure 1 and the difference between the terms mentioned above, we could say that RPAS and unmanned aircraft differ from ordnance and missiles in that the air vehicle is designed to come back and be re-used. UA and UAVs differ from RPAS and especially small hobby planes in that they operate out of line of sight and at altitudes where a person on the ground cannot readily see them. Like guided missiles, RPAS are sophisticated systems incorporating lightweight airframes, advanced propulsion systems, secure data links, and high technology control systems and payloads. These air vehicles still need a pilot who, rather than being seated in the aircraft itself, is located in a control center normally referred to as a Ground Control Station. The degree of sophistication now required to field an UAV is leading to people in the business referring to these systems as Unmanned Aerial Systems or UAS (UAVS, 2013).

As Venema (2013) described, unmanned aircraft are being deployed for an increasingly wide range of tasks. The rapid increase in their autonomy allows them to perform a growing variety of tasks without human intervention. These tasks might range from the collection of military intelligence by large robot aircraft flying at high altitudes (such as the Global Hawk) to the detection forest fires or the inspection of oil pipelines by small aerial vehicles (such as the Pelican quadrocopter).

PROBLEM STATEMENT AND RESEARCH OBJECTIVE

According to the European Commission (2012), RPAS constitute a very promising new sector in the aerospace field in Europe. The economic crisis enhances the need for identification and support of opportunities to stimulate industrial competitiveness and entrepreneurship leading to the generation of growth and jobs. EC believes that these objectives can be achieved by the emerging technology of RPAS and the variety of their civil applications (corporate, governmental, commercial, non-military). The applications that make them useful for the military as well as the civil sector are related to monitoring tasks for a long period or flights with high risk through which RPAS can be beneficial for the citizens (European Commission, 2012).

However, there are some barriers that prevent the smooth and fast implementation of the wide civil utilization of RPAS. The dilemmas are among others the extent to which the European citizens accept the civil use of RPAS. A possible negative perception for RPAS flying over populated areas due to privacy issues and safety for example, may create a tension in the implementation of civil RPAS applications. Moreover, other issues related to the regulatory policy regime at a European level are considered to be a constraint for the social acceptance (SA) of RPAS operations in civilian airspace and may influence negatively the public perception on civil RPAS (Pagallo, 2011).

Apart from the technical aspects, RPAS community is highly concerned about the issue of SA, on which they want to expand their knowledge, as they are interested in a wide utilization of RPAS in Europe the next years. They want to answer questions like 'Why people might have a negative perception regarding civil RPAS?' In this way they will get broader insights into the problem, taking into account not only the technocratic viewpoint but the one of the most important stakeholder, the public. The investigation of the public opinion about civil applications of RPAS is of high importance and may pave the way for its implementation at a European level.

This research is a study of the complex challenges related to SA of RPAS in the transition from the initial R&D and manufacturing phases to industrial or public sector utilization of RPAS. The analysis will be conducted using Q methodology. Q methodology is a tool that combines qualitative and quantitative analysis through which we can identify shared beliefs and perceptions among the citizens and through the understanding of their characteristics, we can ''map the public'' (Exel & Graaf, 2005). It is divided into five parts during which a variety of points of view of different stakeholders is reduced into a limited number of shared perspectives. This approach aims at a reduction of the complexity of the problem and questions like how and why people have a specific opinion about RPAS can be answered (Brown, 1980). A justification on the usefulness of the method will be provided in Chapter 3 and a reflection after the analysis will be presented in Chapter 8.

This analysis will provide the stakeholders with insights and will lead to the accomplishment of the **objectives** of this research, which are, first, to learn about social acceptance of civil applications of RPAS and, second, to evaluate Q methodologyregarding its usability for studying SA of civil RPAS.

RESEARCH QUESTIONS

The main research question this study answers is:

What can we learn about social acceptance of civil RPAS while applying Q methodology, and what is it worth?

In order to answer the research questions, the following sub-questions are defined:

1. ***What is social acceptance of technologies?***
2. ***What is social acceptance of civilian RPAS?***
3. ***Using Q methodology, what are the categories of people with the same way of thinking regarding civil RPAS?***

The first two sub-questions are general questions, while the third one is a combination of outcome and methodology-related question. This study focuses on the usefulness of the methodology, apart from getting insights on the social acceptance of civil RPAS, thus it is important to investigate the methodology step by step. Therefore, the third sub question includes questions like:

- ✓ How can we get a set of people in order to form representative focus groups of experts and laypeople?
- ✓ What are the statements that represent the different perceptions of the focus groups?
- ✓ How does a sorting of statements regarding civil RPAS look like?

The above are the steps that we follow in order to perform the Q methodology and investigate its added value in the case of social acceptance of civil RPAS. In other words, we could say that the third sub-question investigates what the application of Q methodology brings us if we want to know more about social acceptance, following the methodological steps. Therefore, the third sub-question includes both the steps of the methodology and the added value of Q methodology and through this, the main research question can be answered.

CHAPTER 1: SOCIAL ACCEPTANCE OF NEW TECHNOLOGIES (THEORETICAL APPROACH)

In this chapter, a conceptual (theoretical) representation of SA of new technologies will be drawn giving some characteristics of it in order to scientifically support our research. A review of prior literature showed a quite poor set of results, thus the definition of SA will be given by accumulating findings regarding SA of new technologies.

1.1 DEFINITION OF SA OF NEW TECHNOLOGIES

The integration of RPAS in the non-segregated airspace in order to widely utilize civil RPAS at a European level can be considered as an ambitious innovative technological project. Like in every new technology, the level of social acceptance (SA) can influence the techno-economic successfulness of it.

In a broader sense, social (or societal or public) acceptance is the field of research related to the preferences, opinions and beliefs of the citizens (Assefa et al., 2007). Although researchers have dealt with the phenomenon of social acceptance before, it is not definitely conceptualized in the literature. Therefore, there is no widely acceptable definition of it or a coherent picture of this issue. However we will try to present how SA is currently being discussed regarding technological projects and we will reflect on the points under discussion to provide a theoretical picture of how we treat SA in this research as well as a literature base for further studies.

Brohman et al (2007) refer to four main issues regarding the SA studies. These four not interdependent issues draw a conceptual model for SA of new technologies, into which we study the integration of civil RPAS. Through these, we explore the theoretical background which, with the addition of our reflection on each of them, will lead us to the formulation of our own practical and operational description of SA. So, according to Brohman et al (2007):

1. SA is commonly accepted as a concept that can be measured with public opinion surveys or analysis of the opinion of a stakeholder group related to the new technological project.

2. SA is a dynamic process and not a static representation of the opinion one group of people form and express in a specific time of the project conceptualization or implementation. Its dynamic features can evolve as the policy culture changes and the contextual framework adapts to the dynamics of the society.

3. SA is not a technocratic, one-way process in which people either support or reject a project. It is a mutual alignment of projects and stakeholders' opinions that result to a socially constructed process. This process very often results to project and context changes. The technocratic approach toward SA of a new technology has been presented by Sturgis et al. (2004) using the 'deficit model'. This model focuses in the representation of the public opinion as barrier in the implementation of a new technology. Some experts and policy makers tend to believe that public has a wrong judgment about new technology (Horlick-Jones et al., 2007), they cannot understand new technological concepts and tend to amplify its risks.

4. SA is not the only issue that is related to the successfulness of a project, but the identification of the level of SA in a project is of high importance. This means that if a

project is publicly acceptable, it does not automatically mean that it is successful, but SA is an important aspect for the determination of a successful project.

After the issues Brohman et al presented, we will reflect on them and through this we will form our definition of SA, based on which we will conduct our research.

Reflecting on the first issue, we could comment that in this research project, we consider SA as a broader range of opinions and views not only of experts and the policy community, but also laypeople that can be influenced by this technology.

Moreover, the second point is accepted and extended for our research. In our study SA cannot be defined as a static polarization towards 'support' or 'resistance'. It is presented as a dynamic phenomenon that gradually matures and co-evolves along with technology, as it is also dependent on the cultural, geographical, historical, economic settings – the context- that shape and are shaped by the technology. Therefore, in our research we can treat public, one of the most crucial stakeholders in a new technological concept, as a stakeholder that has its own dynamic position, which may change through negotiation and re-alignment of expectations along with context and project changes.

The third statement by Brohman et al can be considered a very important issue in the definition of SA. Based on this technocratic approach, the experts think that they have the ultimate solution, which has to remain intact as it is the 'right' one, while the opposing opinion is 'wrong'. Consequently, they believe that the obstacles towards the implementation of this (like public opposition) should be overcome. However, in our research, this approach seems inappropriate and it is rejected. A non-technocratic viewpoint will broaden the theoretical horizons of the research and it will contribute towards a widely accepted conclusion.

Last but not least, regarding the fourth statement, 'process successfulness' has to be taken into consideration and this is why social acceptance is of such importance in the introduction of a new technology. In our study we operationalize SA as the level of alignment between the stakeholders' expectations and the resources and demands of application context (Hodson et al. 2006). Therefore, we talk about a 'process successfulness', which is the one aspect of successfulness that defines the successfulness of the whole project (the other is the outcome successfulness). The coordination of the various interests of the different stakeholders involved determines the process successfulness.

In conclusion, in our research project, we will treat SA as an issue that, additionally to the above characteristics, shows the following relationship with technology: SA doesn't represent the acceptance or rejection of a project by society, but refers to the way in which technology is designed and introduced into the context (Green, 1999).

1.2 THEORY OF FRAMES

In our study, the concept of SA will be used to frame people's opinions and beliefs about the specific technological issue that we analyze. Schön and Rein (1995) and Fischer (2001) define framing as the constellation of beliefs, worldviews, assumptions and underlying values, which are the drivers of individual behavior through filtering of selecting and constructing information. In simple words, framing is the way each of us understand all the information given from the environment and helps us form a certain opinion about an issue. This opinion is not by default the same as the opinion of another person. Based on this, each of us acts in a specific way, without being certain that this belief is acceptable by someone else.

The main characteristic of the beliefs and opinions of people is their subjectivity and this is the issue that makes this approach interesting; beliefs and opinions can be based on facts and knowledge, so they can have an objective sense, but also on psychological issues, feelings, culture, social environment, religion etc.

FIGURE 2: THEORY OF FRAMES

For example, integration of the immigrants in a country is an issue that can be approached in a subjective way. Some people disagree with the integration of foreigners in their country, while others support it. These two opposing viewpoints can be interpreted based on each side's subjective argument and the individual's feelings or culture. A conservative opinion, for example, may come from the generalization of an incident: a foreigner robed someone, so the immigrants are dangerous and they should be deported. On the other hand, others believe that the immigrants can contribute to society with their different perspective and viewpoints, adding value to the existing way of living and thought. In this case, the level of danger that people fear or the contribution of the immigrants cannot precisely be quantified, therefore each of us interprets the limited incoming knowledge (news, discussions, articles in the newspapers etc) using his own cognitive system- subjectivity dominates people's mind!

Thus it can be assumed that each individual develops his own belief system, which is subjective. This individuality may lead to fundamental value conflicts, as there is a limit to knowledge and certainty regarding an issue. These two opposing opinions may have been formed not only due to facts and knowledge on the specific issue, but also due to psychological factors and cultural influence; people raised in closed and religious societies may tend to reject the different characteristics that a foreigner brings to their perception of how society should work.

Therefore, social acceptance is closely related to the 'schema of interpretation' of the individual, which, in social theory, helps people build their own mental filters according to their perception and culture (Goffman, 1974).

1.3 CONCLUSION

This chapter provided the reader with a number of characteristics of SA of new technologies that form a definition of this subjective concept. The main point that influences the rest of this report and is the issue that makes this approach interesting is the subjectivity of the beliefs and opinions of people. Beliefs and opinions can be based on facts and knowledge, so they can have an objective sense, but also on psychological issues, feelings, culture, social environment, religion etc. The expert, using a technocratic approach, think that they have the ultimate

solution, which has to remain intact as it is the 'right' one, while the opposing opinion is 'wrong'. Consequently, they believe that the obstacles towards the implementation of this (like public opposition) should be overcome. However, a non-technocratic viewpoint can broaden the theoretical horizons of the research and based on this, all the opinions and beliefs that are expressed should be taken into account and not be rejected as 'wrong'.

After defining SA of a new technologies as well as framing and before exploring the potential differences between the opinion of experts and laypeople, we will zoom in on how we will treat SA of the civil RPAS presenting the problem and the issues under discussion.

CHAPTER 2: PROBLEM DESCRIPTION: BRIDGE BETWEEN RPAS AND SOCIAL ACCEPTANCE

In this chapter we will approach the concept of SA of civil RPAS, giving an introduction to RPAS technology as well as an overview of the research that has already been done in the field of civil applications of RPAS. Moreover, we will address the benefits for society according to the stakeholders that support the project of civil RPAS, following by the arguments of the opposing parties that support issues that stand as barriers in the implementation of this emerging technology. Technical safety of RPAS will be discussed in association to risk followed by the transition to the social dimensions of it, bridging technology and SA. Finally, the current discussion about issues like privacy, liability and automation will be presented.

2.1 LITERATURE REVIEW: INITIATIVES AND 'UAS PANEL PROCESS'

From the World War I until now, RPAS are mainly deployed for military missions but a non-military market is emerging. RPAS are considered to be beneficial in a growing number of civil and non-military governmental applications. In general, employing RPAS is considered useful for dull, dirty or dangerous missions. These are missions putting a human pilot at risk, i.e. natural disaster reconnaissance. Remotely Piloted Aircraft Systems are therefore becoming increasingly important for non-military applications.

Nowadays civil RPAS are in use in the US and a number of countries worldwide. Currently, RPAS are utilized for a number of applications; from leisure activities (a camera following people from the sky during their holidays) to more professional and commercial applications (a camera is following sport events providing better quality than a camera on the ground). Regarding European countries like France, UK and the Netherlands the exact number of RPA flights is not known as there is no official data by governmental authorities.

Specifically for the Netherlands, it is not possible to find the total number of the RPAS possessed, because not all the RPAS are officially registered. The Netherlands Information Service (2012) claimed that the country possesses 75 Raven, which are lightweight (1.9 kg) unmanned aircraft designed for rapid deployment and high mobility for military and commercial operations. It can be operated in assisted mode or programmed for automatic operations, utilizing the system's advanced avionics and GPS navigation. Although, these systems are owned by the Ministry of Defence, they are also operated to support public services (mainly police).

FIGURE 3: RQ-11B RAVEN

Marketing research studies have shown that during the next decade the worldwide market for RPAS will exceed $89 billion and can lead to the creation of more than 100,000 jobs (UVS-info, 2012). Thus Europe is now at a crucial moment with regard to tapping the potential of RPAS services. A number of initiatives by a lot of stakeholders have been taken the last decade in Europe in order to reinforce cooperation among the industrial and the RPAS community representatives as well as the policy-makers of the EC in a difficult budgetary context.

FIGURE 4: NLR'S LIGHT UNMANNED ROTORCRAFT SYSTEM, DESIGNATED GC-201[1]

The first European RPAS initiative taken by the EC was the 'Hearing on Light UAS', which conducted on 8 October 2009 by DG MOVE. It was the first hearing dedicated to unmanned aircraft systems and especially the light RPAS, with the objective to 'understand the current European Light RPAS industrial base and the current Light UAS applications in Europe, to identify potential obstacles, enablers and best practices in Europe, to exchange directly with the European Light UAS community views and to assess the future potential role of the European Commission for the insertion of Light UAS'. (DG MOVE, 2012)

Following the conclusion of this high-level conference, an EU lead initiative was necessary in order to support the customer and industrial ambitions for a robust RPAS market. This highly ambitious step was taken by the DG Enterprise and Industry and DG Mobility and Transport in consultation with other Commission services. They launched the 'UAS Panel Process', on 23 June 2011 at the Paris International Air Show, with a broad stakeholders' consultation. The aim of the initiative was 'to contribute to the development of a Strategy for the development of civil applications of RPAS in Europe' (RPAS CivOps, 2012)

The "UAS Panel Process" was building on various initiatives already carried out by the European Commission in the past 7 years; The European Civil Unmanned Air Vehicle Roadmap (UAVnet/CAPECON/USICO, 2005), the INOUI study (Innovative Operational UAS Integration, 2007), the Policy Statement on Airworthiness Certification of UAS (issued by EASA in 2009), the Hearing on Light UAS (2009), the High-Level-Conference on UAS (2010).

The stakeholders that were involved in the "UAS Panel Process" consist of the most relevant organizations and agencies across Europe and they are: Eurocontrol, the European Civil Aviation Conference (ECAC), the European Aviation Safety Agency (EASA), the scientific community, European Civil Aviation Authorities, ICAO, JARUS, Ministries of the Interior (border surveillance,

[1] http://techmento.com/2011/06/30/geocopter-presents-unmanned-helicopter/

police forces), the European Defense Agency, Ministries of Defense, European Space Agency (ESA), international military organizations, non-governmental organizations, international stakeholders, European citizens and broad industry representation from SMEs to global players which manufacture and/or operate RPAS.

Moreover, the EC UAS Panel initiative highlighted the potential of civil RPAS for the development of a wide range of commercial and governmental applications with societal benefits, ultimately leading to the creation of a large market of innovative services to be provided by RPAS.

In addition, the EC has concluded that civil RPAS, as well as related technologies, offer significant potential for job creation in both the industry and services sector, and thus will promote entrepreneurship and generate economic growth. The latter has led to the conclusion that there is a need to accelerate the safe insertion of RPAS into European airspace. However, it has also been identified that liability, insurance, privacy, data protection, and public acceptance, are matters that have to be addressed to make this possible (RPAS-Aerial-Work).

An additional conclusion of the participants in the conference is the following: 'It is to be recognized today that UAS operation in non-segregated airspace are a need other than an opportunity. As matter of the fact, RPAS offer not only the possibility to reduce costs, but also to perform routine and high risk missions augmenting the performance and setting to zero the risk for the remote crews. A lot of results were already achieved, but now the decisive steps need to be performed by all the stakeholders involved in setting rules and standards to establish adequate requirements for the full deployment in Europe of the UAS potential (Finmeccanica, 2011)'.

As we can conclude, the EC and stakeholders from the industrial sector were among the supporters for a wide domestic RPAS utilization. On the other hand, a number of opposing statements were made from the public and refer to issues like safety, privacy, liability etc. These two viewpoints will be presented in the subchapter 2.3 as well as their argumentation.

Moreover, EC and specifically DG Enterprise and DG Transport initiated the preparation (in 2013) of the development of a 'Roadmap for safe RPAS integration into European Air System' (RPAS Roadmap), which will include a strategic plan for the RPAS integration into the European air system from 2016 as well as a plan with a span over 15 years (EC Enterprise and Industry, 2012).

The issues that were discussed in the workshops of the 'UAS Panel Process' and are the pillars of this roadmap are:

- Industry and market issues
- UAS insertion into airspace and radiofrequencies
- Safety and certification
- Societal dimension of UAS
- Research and development for UAS

The implementation and endorsement of this Roadmap, which cover the three main issues analyzed- aviation regulation, technology and societal impact- is supported by a European RPAS Steering Group (ERSG). Members of the ERSG are: ESA, EC, ECAC, EASA, EDA, EUROCAE, EUROCONTROL, JARUS, ASD, UVSI and SESAR JU (EC Enterprise and Industry, 2012; EASA, 2012).

2.2 BOUNDARIES OF THE STUDY

The next diagram shows the relation between all the issues regarding civil RPAS utilization in Europe today (Finmeccanica, 2011). This diagram is another way to present the issues under discussion in Europe regarding the development of civil RPAS market, which are the the pillars of this roadmap (see bullets in the previous page). In this research project, the boundaries are set in the *Societal dimensions of UAS* in relation mainly to *safety* as well as *industry and market*.

More in detail, the next diagram (Figure 5) is a mind/cognitive map. It shows the **qualitative** interdependences between the issues under discussion at European level (primary issues- in the boxes). The secondary issues by the arrows connect the primary issues. For example the *Societal dimensions of UAS* are related to *Safety of UAS* through *liability issues to be considered for safety purpose and technology domain (recovery functions*), while *acceptability issues that can limit the UAS benefits* are topics that RPAS industry is concerned about according to Finmeccanica's white paper.

This map shows the complexity of the issues under study and makes clear why the development of civil RPAS is a complex problem; there is interdependence between the main issues and not a clear way of problem solving in this case. We cannot say that there is an issue that has to be dealt with firstly and there is no sequence in the process of dealing with these issues. This is mainly the reason why RPAS community is struggling in finding an efficient way of dealing with it.

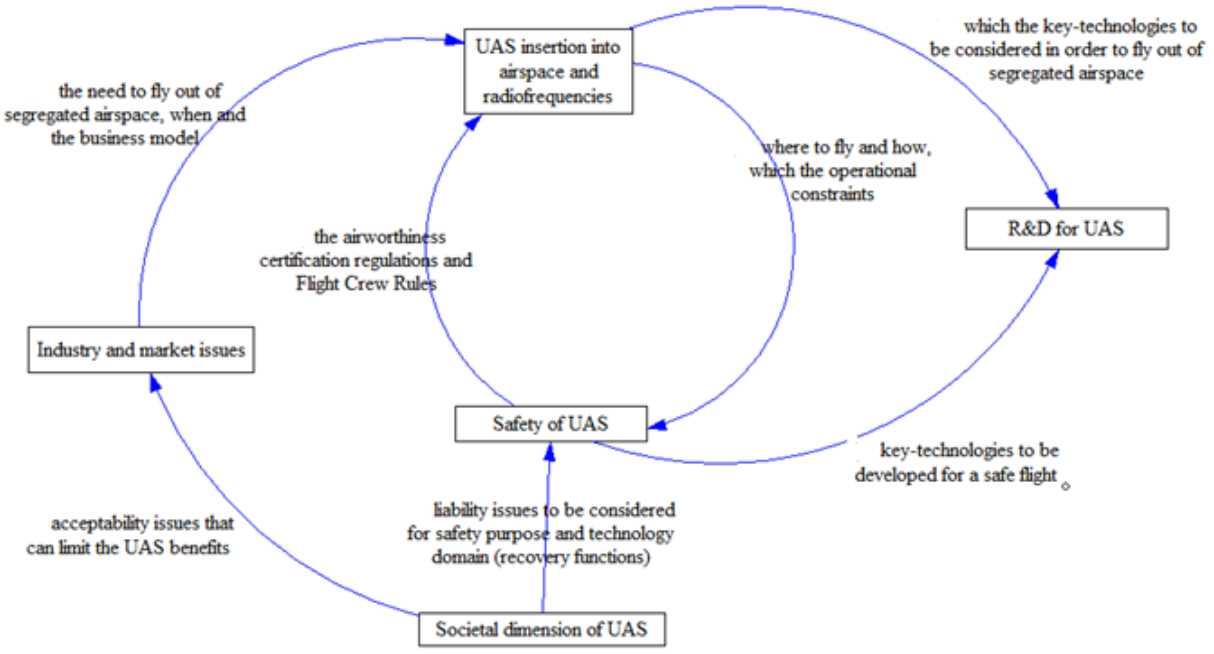

FIGURE 5: COGNITIVE MAP OF THE ISSUES UNDER DISCUSSION BY EC AND RPAS COMMUNITY (FINMECCANICA, 2011)

The arrows of this diagram do not show causality but represent the existence of an interrelation between the issues. The arrow, for example, that starts from the *Societal dimensions of UAS* and connects this to *Safety of UAS* could also be drawn in the opposite direction.

Specifically for our study, we can draw another diagram that represents better the boundaries of our research. The area of the interest is showed in figure 6.

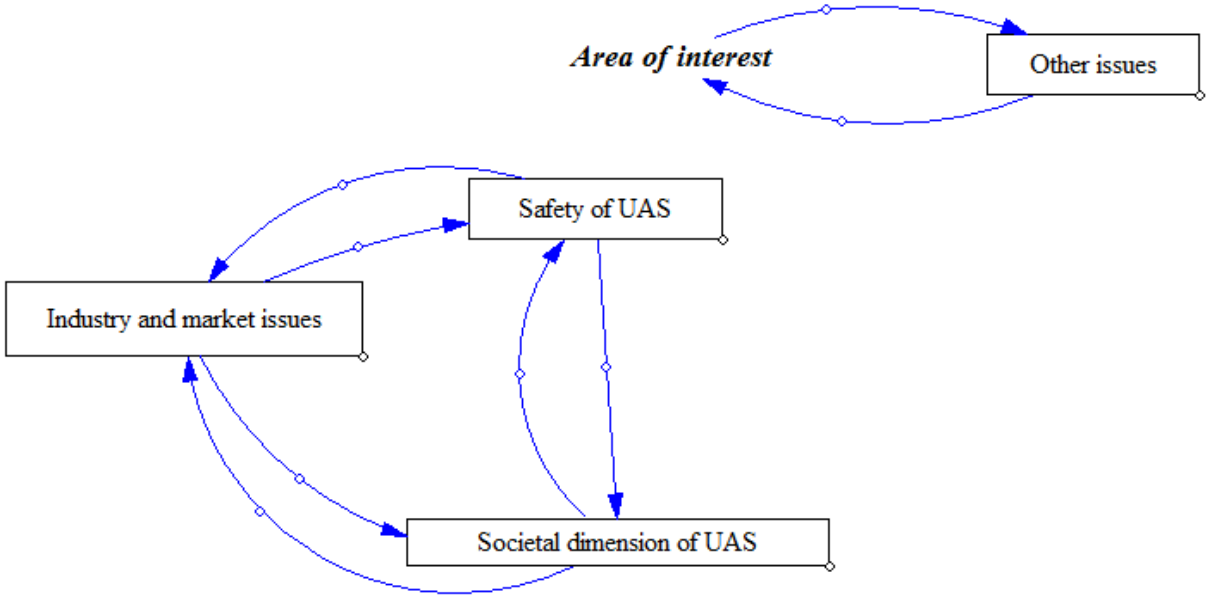

FIGURE 6: OUNDARIES OF THE STUDY

In figure 6 we can see the issues that this study will focus on. The double arrows between the issues shows the interrelation between them. Moreover, the secondary issues by the arrows remain the same as presented in figure 5[2]. Comparing figure 5 and 6, we see that the *Other issues* are R&D for UAS and UAS insertion into airspace and radiofrequencies. In Chapter 9 a reflection on this diagram will be presented in order to ''redraw'' it after the analysis with the additions of our research.

In Figure 5, we see that along with the societal dimensions of the problem, there are a number of technical issues, like the integration of civil RPAS into the non-segregated airspace, to be solved in order to fully exploit RPAS potentials, as well as its integration in the civil airspace with an air traffic insertion process. In order to identify the key-technologies to be developed for a safe flight (flight control, autopilot systems, human-machine interface, system architecture and integration, radio spectrum requirements, satellite communication etc. related to *R&D* and *safety* of RPAS in the above diagram), a number of initiatives from RPAS community and EC are in progress (EC, 2012). As stated by Aurora Flight Sciences Chairman and CEO John Langford at the Paris Air Show in 2013, "the technology under development will actually make the skies safer for everyone."

However, this requires a technical approach and they are out of the scope of this research project, as being included in the *Other issues.*

2.3 TWO DIFFERENT VIEWPOINTS

2.3.1 SUPPORTERS (BENEFITIAL APPLICATIONS OF RPAS)

According to the RPAS stakeholder community that supports the utilization of RPAS for civil and governmental purposes, there is little doubt that RPAS technology is here to stay; the commercial use of RPAS in civil, non-segregated airspace could create new challenges for the

[2] *Industry and market issues* and *Safety of UAS* are not directly interrelated but indirectly though *UAS insertion into airspace and radiofrequencies*.

aerospace sector. An interesting and brief description of the research in the field of civil RPAS includes the following (European Commission, 2010): the innovative civil applications of RPAS can be beneficial for a number of different sectors both economically and technologically. In order to explore the potentials of RPAS, they should be integrated in the state aviation industry and air system under a common European regulatory umbrella.

As part of the main application of the unmanned aircraft systems, the remotely piloted aircraft seem to constitute a very promising new sector in the aerospace field in Europe. The applications that make them useful for the military as well as the civil sector are related to monitoring tasks for a long period or flights with high risk (European Commission, 2012). They can be used in combination with the manned aircraft or satellites in order to accomplish tasks during crisis and real time control of the borders. With the infrastructure monitoring and inspection, they perform the Dull, Dirty, and Dangerous (DDD) missions, which sometimes cannot be performed through other means and thus reduce the exposure of humans in danger (European Commission, 2010).

FIGURE 7: QUADCOPTER

RPAS combine high performance and capability with low cost. Thus they have both civil/ commercial aircraft uses and state aircraft uses. The military use includes defense operations in war theatres or wars (Finmeccanica, 2011), while the commercial and state operations include the following missions:

- Missions related to Civil Protection: RPAS could be used in monitoring, preventing and alert system for natural disasters such as:
    - Floods
    - Storms
    - Earthquakes
    - Forest fires
    - Nuclear accidents
    - Volcanic eruption
    - Communication relay
    - Disaster prevention and post disaster relief
- Missions related to Security: RPAS could be used for coastal surveillance or sensitive sites (ports, airports, power plants) monitoring as well as coastal monitoring.
- Mission related to Environment Protection / Preservation: RPAS could be used in monitoring and protecting natural environment. RPAS could also ensure indirect benefits from the air vehicle platform by reducing carbon/noise footprint if compared to manned aviation.

FIGURE 8: RPAS IN EMERGENCY CASES

Moreover, a number of other applications could enlarge the spectrum of the benefits for society and industry according to RPAS community. These are related to:

- Real estate sales
- Sports photography
- Highway monitoring
- Wildlife research
- Atmospheric research
- Hunting — and anti-hunting
- Disaster relief
- Precision agriculture (monitoring crop health and spray pesticides)

FIGURE 9:ANOTHER RPAS APPLICATION

Furthermore RPAS can operate in diverse environments and high risk roles, such as atmospheric research (including weather and atmospheric gas sampling), scientific research, oceanographic research, geophysical research, mineral exploration, imaging spectrometry, telecommunications relay, police surveillance, border patrol and reconnaissance, survey and inspection of remote power lines and pipelines, traffic and accident surveillance, emergency and disaster monitoring, cartography and mapping, search and rescue, agricultural spraying, aerial photography, promotion and advertising, weather reconnaissance, flight research, and fire-fighting monitoring and management.

Moreover, according to RPAS community (ULTRA, 2013, not published yet), RPAS applications that make them technologically unique and beneficial for the citizens are the following:

1. RPAS can do what helicopters do for a fraction of the cost (operational, maintenance etc). The cost savings could be even greater as technology improves and regulations relax.

2. Many RPAS models are electrically powered, and thus significantly quieter than any helicopter. RPAS operation would reduce unwanted helicopter noise, which would be especially valuable to residents who live in designated noise-sensitive areas.

3. RPAS models for police expand either very little fuel or none at all, as opposed to fuel consumption by helicopters. While this difference in fuel consumption may not have a significant environmental impact, it might have a small effect on public attitudes towards police aviation.

4. Compared to helicopters, the consequences for the general public in the event of a loss of flight control of a small RPA is lower than of a manned helicopter.[3] Although no data exist yet on small RPAS accident rates, their small size and lightweight will translate to minimal collateral damage on the ground in the event of a crash.

5. RPAS flight could enable liberty, enhancing policy changes such as extending park hours at night, allowing citizens to feel safer in otherwise potentially dangerous conditions.

2.3.2 OPPONENTS (BARRIERS)

All of these applications have triggered the interest of the public and private sector that work towards the wide utilization of RPAS in Europe. However, not all the stakeholders agree with the wide utilization of RPAS for commercial and governmental purposes. A different approach to this emerging technology suggests some opposing arguments that are considered barriers for the RPAS community and obstacles that they want to overcome. Public acceptance is necessary for the promotion of trial flights and stepwise implementation of the project of civil RPAS utilization.

The opposing opinions that prevent the smooth and fast implementation of the plan of the wide civil utilization of RPAS that are of our interest are among others the safety issues related to the use of RPAS operations in relation to the main social dimensions of them (Pagallo, 2011). Another important issue is a possible negative perception for RPAS flying over populated areas due to privacy issues and data protection rights, adding an ethical layer in SA of civil RPAS.

The extent to which the civil applications of RPAS are beneficial for the citizens is one issue that can be related to social acceptance, while at the same time the perception of risk that people are willing to accept may be influenced by the importance and level of benefit that they may enjoy (ULTRA, 2013, not published yet). The complexity rises given the vagueness of the concept itself, as there is no global definition of “important benefits” for the citizens and the willingness to accept risks depends on the individual. Thus subjectivity is significant in the analysis of the behavior of the public regarding risk acceptance of civil RPAS.

RPAS community, including European Commission and the agencies and organizations that participated in the initiatives (see subchapter 2.1) wants to investigate the perception of safety as well as the social acceptance of them, which is divided into more specific issues regarding the

[3] Risk= (Probability of an accident)*(Consequences).

legislation and the psychological aspects that affect the acceptance of the unmanned aircraft. The identification of these issues that the public is concerned about is the analysis which will provide us with relevant information in order to identify what people have in mind when they talk about civil RPAS. The analysis of the sentiment of the crucial but often neglected stakeholder, the public, can then be used from the RPAS community and the EC departments in order to develop a strategy in order ensure the social acceptance of the RPAS operations.

2.4 CURRENT SITUATION

2.4.1 CURRENT MARKET SITUATION

The current situation at a European level shows that Europe is not yet open to the civil RPAS market as a result of the current regulatory context. Civil RPAS industry community is not really stimulating for civil RPAS manufacturers and not very conducive to the development of an RPAS aerial work market with fair competition in Europe.

One of the principal reasons for this situation is that, even though various initial (and limited) national regulations relative to the operation of civil RPAS are now in place or about to enter into force (Czech Rep., France, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, UK), these regulations have not been harmonized on a pan-European level. Consequently, it is currently not at all evident for an RPAS operator, registered in one European Union (EU) country, to be able to engage in an RPAS operation in another EU country; not to mention engaging in such activities outside of the EU.

On top of that, there is no noteworthy RPAS regulatory activity in a significant number of European countries (RPAS CivOps, 2012). This situation is planned to be reversed inside the context of the Europe 2020 Strategy (EC, 2012) and taking into account that over-regulation for RPAS could significantly reduce their full development (Finmeccanica, 2011).

Regulation (EC) No 216/2008 mandates EASA to regulate Unmanned Aircraft Systems (UAS) and in particular Remotely Piloted Aircraft Systems (RPAS), when used for civil applications and with an operating mass of 150 Kg or more. Experimental or amateur build RPAS, military and non-military governmental RPAS flights, civil RPAS below 150 Kg as well as model aircraft are regulated by individual Member States of the European Union (EASA, 2013).

An overview of the **market barriers** for civil and commercial applications is as follows (Rosenberg, 2009; Cavoukian, 2012):

- Incomplete or immature air space regulations that encompass UAV systems
- Liability for civil operations
- No secure non-military frequencies
- Negative consumer perception
- Lack of operator training/safety standards
- Limited payload capacity and space restrictions

2.4.2 CURRENT SOCIAL PERCEPTION

The current social perception of RPAS tends to be negative due to a number of limited but important issues like (SESAR Roadmap, 2012, not published yet):

1. They cannot fly in controlled airspace due to current regulation.
2. The specific missions and roles of RPAS in Civil Protection, Security and Environment protection are not yet addressed in a pragmatic and exhaustive way.
3. European citizens are not really aware of their capabilities and typically have a negative feeling of them.

However, a poll among citizens that was conducted by the Aerospace Industries Association (AIA), which was presented at the Paris Air Show in 2013 regarding SA of civil and commercial operations of RPAS worldwide, demonstrates a positive attitude towards them, both in the USA and internationally.

Posted on June 24, 2013**,** this poll (AIA, 2013) presents some interesting findings from the poll:

- Only 25 percent of the public is "very well aware" of current and potential non-military uses for RPAS
- Border protection, law enforcement surveillance and search and rescue are the top three perceived, non-military uses for RPAS
- 54 percent of the public supports increased non-military use of RPAS (20 percent neutral, 27 percent opposed)
- Privacy and safety are the top issues the public wants government to resolve relative to UAS in order to increase civil use

2.5 EXAMPLE

An example of the conflict over the acceptance of RPAS for security missions during crisis can be presented in the context of the aftermath of the terrorist attack in Boston on April 15, 2013 (UAS-Vision, 2013). Boston's Police Commissioner, Edward F. Davis, claimed that terrorist attacks, like the one in this year's Boston's Marathon, could be prevented using RPAS as an eye in the American sky. Davis said he wants to promote a partnership between businesses and the city in order to buy and monitor lower-mounted cameras that will be positioned strategically to capture people's faces and he considers the deployment of domestic reconnaissance RPAS for next Marathon.

On the other hand, the opposite opinion has been expressed by Glenn Reynolds, a law professor in the University of Tennessee and frequent critic of government surveillance, who believes that Davis may give cameras too much credit, as "the record of cameras in catching terrorists has really been pretty lousy" and "if in fact they caught these guys through the cameras, it's pretty much the first time."

2.6 (TECHNICAL) SAFETY/ RISK OF RPAS

In this subchapter, we present the technical aspects of the technology of RPAS, giving the safety framework that has been proposed, including the risks to be regulated and the hazards caused by the utilization of RPAS.

Safety and SA of civil RPAS are highly correlated and constitute an important issue under study. We will not assign it in one of the two viewpoints that were previously presented in this chapter,

but we will analyze it in this subchapter as an issue that concerns both the supporters and the opponents of the wide utilization of civil RPAS.

As in every technological project, safety seems to hold a central position regarding the way people perceive it. Before the implementation of every new project, it should be shown that the associated risks and hazards can be regulated and controlled, so, among others, the citizens will be able to assess its safety and its technical risk and formulate an opinion about this new technology. Therefore SA is highly related to technical risk that is addressed for the RPAS operations, whose state-of-the-art research will be shortly presented in this sub-chapter. Moreover, after presenting the most important parts of the regulatory framework that is being proposed, the main hazards that emerge from civil RPAS operations will be presented.

ICAO states that 'the key factor for safely integrating RPAS in non-segregated airspace will be their ability to act and respond as manned aircraft do' (Speijker et al., 2011). The objective of ICAO for safety[4] can be translated into 'ensuring the safety of any other airspace user as well as the safety of persons and property on the ground." (ICAO, 2011)

The Customs and Border Protection (CBP) estimated the accident rate at 52.7 accidents per 100,000 flight hours, which is more than seven times the general aviation accident rate and 353 times the commercial aviation accident rate (Kalinowski, 2010). However, these numbers are based on limited safety data and they may lack of representativeness (Kalinowski, 2010) as RPA till now are mostly fly in the segregated airspace[5].

Currently, a number of international working groups[6] are focusing on the development of a regulatory framework concerning the risk criteria and safety of civil RPAS, which has to be commonly accepted by all the stakeholders. The initial stage requires the creation of some proposals in order to identify the operational and technical hazards that may occur during civil RPAS operations.

Speijker et al. (2011) introduced a RPAS risk criteria framework, which contains:
1. Definitions of risks to be regulated
2. Definitions of appropriate metrics
3. Risk criteria for judging the acceptability of the risks.

2.6.1 THE RISKS TO BE REGULATED

The first part of the regulatory framework includes the hazards to be regulated. EASA suggests accounting for:

1) *collision with people on the ground*
2) *collision with other aircraft in flight' (*EASA (2010)

EUROCONTROL suggests:

1) *Risks to other airspace users*
2) *Third party risk*
3) *Potential new risks specifically related to unmanned aircraft (*EUROCONTROL, 2008)

[4] ICAO states "The principal objective of the aviation regulatory framework is to achieve and maintain the highest possible and uniform level of safety (Speijker et al. (2011)

[5] However, we should take into account that the risk of a new technology is somewhat higher.

[6] The regulatory authorities EASA and FAA, the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), the European Organization for Civil Aviation Equipment (EUROCAE) and the Radio Technical Commission for Aeronautics (RTCA) (Speijker et al. (2011).

2.6.2 RISK METRICS: QUANTIFICATION OF RISKS

In order to quantify the risks, the notion of metrics has been introduced in risk analysis. These are based on 'probability of an adverse event (or occurrence of undesirable events) per unit of exposure', without taking into account the possible consequences (Speijker et al., 2011). The metrics are:

- *Economic risk metric*[7].
- *Individual risk metric*[8].
- *Societal risk metric*[9].

Regarding RPAS, the suitable risk metrics are (Speijker et al., 2011):
a) Risk of collision with other aircraft,
b) Risk of collision risk with the ground (and/or the associated risk to persons/property on the ground).

Concerning third party risks to citizens on the ground, metrics are mainly based on individual risk metrics. As an example, we could mention that in the UK:

- Individual risks > 10^{-4} per annum: intolerable for the public
- Individual risks < 10^{-6} per annum: broadly acceptable.

In the Netherlands, in addition to criteria based on individual risk, criteria also exist for use of F-N curves (a way of presenting group/societal risk)[10].

2.6.3 RPAS RISK CRITERIA

Risk criteria for the risks to ***people on the surface***
NATO addresses (NATO,2007) that due to the fact that there are no passengers or crew in an RPA, the casualties should be considered in terms of people (third parties and operators) or property on the ground or on board other (manned) aircraft. The following matrix shows the possible combinations of effects of an accident of RPAS and their frequency are acceptable or not (Speijker, 2011).

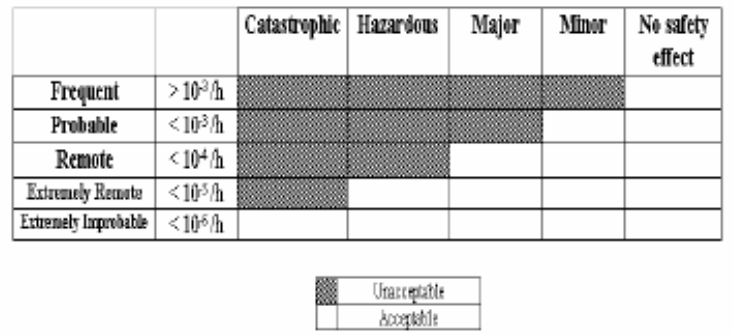

FIGURE 10: STANAG 4761 RISK REFERENCE SYSTEM (SPEIJKER ET AL., 2011)

[7] The sum of expected economic losses due to fatalities and loss of equipment, where the sum is taken per time period of exposure.
[8] The risk experienced by a single individual in a given time period, at a given location. It reflects severity of the hazard and amount of time the individual is in proximity to the risk. It takes no account of numbers of people affected by an event.
[9] The risk experienced by a group of people exposed to the hazard, often expressed as a relationship between frequency of, and the number of people affected by, an event. There are two societal risk metrics: an FN-curve and an expected disutility.

[10] It was applied in the expansion of Schiphol (5th Runway)

We have to note that this matrix applies to each individual failure condition of each RPAS subsystem forming the RPA System. Under specific conditions STANAG 4671 accepts as alternative that the combination of all catastrophic failure conditions has an occurrence of 10^{-5} per flight hour or less (NATO,2007).

Risk criteria for the risks to ***people in the air***

NATO sets very strict criteria regarding risks to people in the air in line with the need of safe insertion of RPAS into the non-segregated airspace and commercial operations**. According to** NATO (2008), **'the probability of a mid-air collision must be equivalent to, or better than, these criteria or 5 x 10-9 per aircraft flight hour'.**

RISK OF AN RPAS GROUND COLLISION

According to Ozuncer et al. (2011), the hazards of RPAS that may lead to a ground collision are shown in the next table.

TABLE 1: IDENTIFICATION OF HAZARDS AND CAUSAL FACTORS (OZUNCER ET AL., 2011)

- Operation of UAS by remote pilot inappropriate
- UAS takes off with contaminated wing
- Weight and balance outside limits (takeoff)
- UAS encounters performance decreasing windshear
- Fire on board UAS
- Remote pilot spatially disorientated
- Flight control system failure
- Remote pilot(s) incapacitation
- Anti-ice system not operating
- Flight instrument failure
- UAS encounters adverse weather
- Single engine failure
- Unstable approach
- Weight and balance outside limits (approach/landing)
- Wake vortex encounter
- UAS positional information system failure
- UAS data link failure
- Unnatural conditions in UAS Ground Control Station
- UAS midair collision
- A part of the UAS falls down

Speijker et al (2011) proposed a safety risk management framework for third party risk using a method of a combination of an accident probability model with an accident location model and an accident consequence model. The questions about risk of UAS ground collision that can be answered through this quantitative risk analysis are:

1. What is the chance that a UAS accident occurs?

2. What is the likelihood of a UAS accident occurring on a given location, given that a UAS accident occurred?
3. What is the consequence of a UAS accident, given that a UAS accident occurred at a given location?

RISK OF COLLISION OF A RPA WITH OTHER (MANNED) AIRCRAFT

Risk of mid-air collision may be related to the following factors of a RPAS:

- Performance characteristics and size;
- Detect and Avoid system performance characteristics;
- Command and control link characteristics;
- Procedures for contingencies and recovery procedures;
- Lateral or vertical separation minimum (standard)

Regarding *collision risk*, the RPAS pilot may not be able to control the flight at all times due to a failure in the ground-air data link.

Regarding *risks to other airspace users*, Speijker proposed a safety risk management framework comparing 'the collision risk for a baseline of commercial air traffic versus a traffic mix that includes UAS, using the ICAO unified framework for collision risk modeling'.

To conclude with, this sub-chapter was an engineering approach to the issue of safety and risk of RPAS that adds to the understanding of the context in which our research is applied. It is an interesting way of drawing the full picture and it makes the interpretation of the results (Chapter 7) easier. After digging into the technical aspects of risk, we can focus on the interrelation of risk perception and SA that is presented in the next subchapter.

2.7 RISK ACCEPTANCE/PERCEPTION IN RELATION TO SA

Risk acceptance is an issue of great importance in the analysis of public acceptance of a technological project and it can be related to the broader category of risk perception, which will be analyzed in this subchapter, both theoretically and specifically for civil RPAS operations.

The probability of a hazardous event can be measured and quantified using an appropriate method of the safety analysis. On the other hand, according to the risk managers responsible for the integration of civil RPAS into the non-segregated European airspace, perceived risk is the criterion for the public towards the acceptance of a technological project. The differences between the measured and the perceived risk, as well as the multidimensionality of perceived risk, which will be further explained, prove that risk perception is a phenomenon hard to be defined and explained (ERSG, 2013).

A risk perception research conducted by Starr (1969) showed that risk acceptance can be highly related to **technical estimates** of risk. Some studies suggest that real risk is a very important determinant of perceived risk in some contexts (S. Lichtenstein *et al.*, 1978), mainly among people that have a direct or indirect experience with the specific type of risk (Thompson et al., 1991). However, it has also subjective dimensions such as **voluntariness** (Starr, 1969).

In a technological project like the development of civil RPAS market, that could potentially kill a lot of people at once (more than 100), we could claim that the magnitude of the consequence may concern the public more than the actual likelihood of occurrence. An event that has massive

consequence like a mid-air collision of RPAS and a manned aircraft with passengers is highly possible to concern the public more than the actual probability of occurrence.

In a nutshell, ULTRA (2013, not published yet) summarizes the social dimensions of **risk acceptability** regarding the civil applications of RPAS as they are presented in previous literature. These are the following:

- **Voluntary versus involuntary**: Voluntary risks are more tended to be taken than involuntary risks.
- **Controllability versus uncontrollability**: Once the risk is under personal control (e.g. travelling as a passenger), it is more acceptable than when the risk is posed or controlled by other parties.
- **Familiarity versus unfamiliarity**: When people are familiar with risk involved in an activity they are more willing to accept it.
- **Short versus long-term consequences**: Many people continue smoking, being aware of the fact that they will not be affected immediately and the long-term consequences are difficult to assess.
- **Presence of existing alternatives**: If there are no alternatives, many risks are tolerated by people, given their benefits which are acknowledged.
- **Type and nature of consequences**: Risks due to events causing more damage and fatalities are more difficult to accept.
- **Derived benefits of society and the individual** play significant role in risk acceptance.
- **Presentation in the media**: Verbal and visual presentation of an adverse event in mass media has some influence on risk acceptability.
- **Personal involvement**: If the societies' vulnerable groups (e.g. children, elderly or disabled) are exposed to risk or if a specific person is presented rather than some statistics, the risk acceptance will be affected. For people having their personnel property in risk there may be different acceptable risk levels than having others' property.
- **Information availability**: Informed societies can have better preparedness for natural hazards, while societies having frequent natural disasters have fresh memories about the consequences.
- **Level of automation**: people may be less accepting the risks related to use of automated systems.

Public awareness and familiarity with RPAS technologies is an important aspect regarding SA of the technology. People's risk perceptions are based on a combination of subjective judgment and limited knowledge of the true risks imposed by a new technology[11]. According to a recent study into RPAS credibility with the public, there is a tendency by the public to overestimate small probabilities and to underestimate large probabilities, and that the public tends to focus on risk and how they can protect themselves from those risks (ERSG, 2013).

Conversely, experts tend to perceive risks within their competence area as much lower than the public. As a result, public trust seldom conforms to expert assessments of hazards associated with technologies, particularly when the technology is new to the public.

In most cases, society has opposed any new technology that has associated risks. Such examples include nuclear power generation and fly-by-wire commercial jet aircraft. In the case of RPAS technologies, it is expected that the public will place higher demands on the safety of RPAS operations than that of manned aircraft operations (ERSG, 2013).

[11] Although there is a lack of data as mentioned in subchapter 2.6.

This is because the public places a higher demand for protection from involuntary risks as opposed to voluntary. Aviation is also considered involuntary; crushes may have casualties on the ground. The **nature of risk exposure** is therefore an important issue in the risk acceptance study. It is worth noting that the question relates to the public's acceptance of the risks associated with a new technology and not the public's acceptance of a new technology.

Another interesting part of risk perception research investigated the role of **subjective probabilities**: do heuristics and biases influence risk perception? Fischhoff et al. (1982) underlined in their research that one of the factors related to risk perception is subjective probability. Moreover, as a general principle, we can accept that people tend to see mostly good properties in concepts that they like and mostly bad properties in concepts that they don't like (Sjöberg et al., 1983). Beliefs and values are often strongly correlated and interdependent (Sjöberg et al., 1999).

An interesting finding (ERSG, 2013) regarding risk perception is the importance of **risk target;** people don't estimate in the same way the risk when they rate it to their family, to people or to themselves This phenomenon has been studied in comparison to non-target conditions, which introduce an uncertainty regarding the target that faces the risk under study.

Moreover, **risk denial** is another issue that may be related to risk acceptance; people believe that they are less subjected to risk than others (ERSG, 2013). This phenomenon is called unrealistic optimism (Weinstein, 1987). Finally, **risk sensitivity** is also another issue that may be related to risk acceptance; people's attitude towards hazards may vary from indifference to very high concern (ERSG, 2013). This concept can be explained using the conventional attitude theory (Fishbein et al., 1975).

The quantification of an acceptable level of risk, although an important factor, is only one component characterizing the public's acceptance of a technology. Other complex and often immeasurable factors such as morals and the economic and political climate are equally as important.

The basic theory behind the acceptance of risk is the subjective assessment between:

- Society's perception of the level of exposure to the hazard (rather the consequences than the probabilities)
- Society's perception of the benefits due to the hazardous activity

The perceived benefit from a hazardous activity directly influences an individual's willingness to accept risk. It has been shown that the level of benefit awareness is directly proportional to the acceptable level of risk (ERSG, 2013). For human-piloted aviation, the benefits are easily identifiable to the general public, in terms of efficient transportation of people and freight. However, this was not always the case. In the early periods of human-piloted flight, the immediate benefits of aviation to the general public were not so clear, as it was a new and unknown technology. This holds nowadays for RPAS.

A crucial issue according to RPAS community in the relation between social acceptance and civil utilization of RPAS is benefit awareness. Are people aware of civil RPAS beneficial applications and to what extent? Like in every new technological project, people are not fully informed and aware of the benefits that they may enjoy by the new technology, which make them reluctant as anyone can conclude. The same happens with the wide civil utilization of RPAS. RPAS community claims that, for example, the advantages of RPAS against the manned aircraft may enhance the positive perception the public formulates.

2.8 ANALYSIS OF PRIVACY/DATA PROTECTION, LIABILITY AND AUTOMATION IN RELATION TO SA

After the analysis of the interaction of risk acceptance and risk perception with SA, other issues that the public are dealing with and the RPAS community wants to investigate are data protection and privacy, liability issues and ethics of civil RPAS applications.

2.8.1 PRIVACY AND DATA PROTECTION

One important issue that seems to work as a stalemate in the implementation of civil UAS and its SA is the privacy issues that arise during their operation. It is commonly accepted among the members of the RPAS community that RPAS may be a threat to privacy (ERSG, 2013). This concerns mainly applications involving video surveillance/monitoring activities. EC (2012), while highlighting the potential of civil RPAS, 'recognizes the importance of privacy as an issue under investigation in the applications of RPAS. All actions related to the development of the RPAS must respect the rights and principles enshrined in the Charter for Fundamental Rights of the EU, and in particular the right to private life and family life (Article 7) and the protection of personal data (Article 8). The Lisbon Treaty recognizes that the rights, freedoms and principles set out in the Charter shall have the same value as the Treaties. Article 16 of the Treaty on the Functioning of the European Union enshrines the right to the protection of personal data.

Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on "the protection of individuals with regard to the processing of personal data and on the free movement of such data" sets out the data protection legal framework. It applies to the processing of personal data in the European Union. It sets out the principles for the processing of personal data and the rights of data subjects over their personal data. It applies also to RPAS, because RPAS do in principle not add new features to already available information collection systems such as manned aircraft, satellites or cameras.

The Commission recognized in 2009 that rapid technological developments have brought new challenges for the protection of personal data. A revision of the Directive was therefore launched and two draft legal instruments were presented on 25 January 2012 by the Commission[12] .

The General Data Protection Regulation will apply to data processing by private or commercial RPAS operators. National rules might impose restrictions on the use of RPAS by states, for example for public video surveillance. The future adoption of the new Police and Criminal Justice Data Protection Directive, would, if adopted, define the benchmarks for data processing carried out by state authorities.

Roma (2012, not published yet) in his article about privacy concludes that: ''despite RPAS exist since nearly a century, they have had, until recently, little impact on the society. No specific law and regulatory framework for RPAS exist to deal with their military or civil use. Now it is easy to construct RPAS. The world regulatory framework of privacy and data protection is quite vast. In some circumstances RPAS could offer a unique system, different from any other, to collect information that may widely infringe the right to privacy. Such possible future scenario has to be

[12] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of individuals with regard to the processing of personal data and on the free movement of such data; COM/2012//0011 (COD); Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of individuals with regard to the processing of personal data by competent authorities for the purposes of prevention, investigation, detection or prosecution of criminal offences or the execution of criminal penalties, and the free movement of such data; COM/2012/010 final.

carefully monitored by the State authorities evaluating the possibility to set up a specific set of rule for RPAS. Moreover, a debate on the need for a specific legal framework regarding the privacy implications of the use of RPAS would provide an invaluable opportunity to reconsider the logical underpinnings of EU privacy law.''

2.8.2 AUTOMATION AND LIABILITY

Regarding the relationship between automation and liability, the technological changes that the highly automated systems like RPAS introduce require the identification of the extent to which humans intervene in the operation of the automated systems. The allocation of liability among the different parties requires a critical revision of the actual human contribution to the performance of Air Traffic Management (EC, 2012).

Moreover, in the 'UAS Panel' a number of issues regarding liability and insurance in case of an accident that involves an unmanned aircraft were defined. Firstly, the participants stated that the use of RPAS can only be allowed if the responsibilities for the operation and the liability in case of damage to third parties are clearly defined and RPAS activities covered by adequate insurance schemes.

The participants in 'UAS Panel Process' agreed that third party liability for damage caused by RPAS should be developed on the basis of the principles for manned aviation. Automation creates an additional level of complexity to the question of responsibility and liability. In case of an accident, is the operator or the manufacturer responsible? Legal experts concluded that strict liability will fall on the operator of the RPAS. The competent authorities have to ensure that the operators comply with the applicable national and/or European rules and regulations.

As in the case of manned aircraft, a pre-condition for the issuance of an operating license by Member States should be the proof of insurance. Insurance requirements for air carriers and aircraft operators are defined by *Regulation (EC) No. 785/2004* which covers the liability of the operator for passenger, baggage, cargo and third parties. The Regulation also covers the risks related to acts of war, terrorism, hijacking, acts of sabotage, unlawful seizure of aircraft and civil commotion. The Regulation applies to the commercial utilization of all kind of RPAS. It does not apply, however, to state aircraft. RPAS operated by public authorities are therefore exempted from insurance requirements (EC, 2012).

Issued 8 years ago, this regulation does, however, not take into account the specificities of RPAS. It requires some adaptations to better address the real risks related to the commercial and corporate exploitation of RPAS (i.e. limitation to third parties damage, introduction of further categories to accommodate different classes of RPA below 500 kg, adaptation of risk levels to the flight characteristics of the very light RPAS, etc.), as highlighted by the recent fitness check performed on this regulation (ERSG, 2013).

2.9 CONCLUSION

The development of Remotely Piloted Aircraft Systems originated in a defense context. Regarding their civil future, RPAS community claims that their utilization for civil and security purposes has significant commercial potential. Although there are a number of benefits that the civil RPAS applications can offer, there is no harmonized regulatory European framework in order to enable RPAS to fly in civil airspace. Moreover, public opinions vary from supporters of the civil uses of RPAS to the ones that are reluctant and show opposing arguments against the

domestic utilization of RPAS. These contradictory approaches are under investigation in this research in order to identify and present the public opinion about civil RPAS. SA is highly related to safety and risk perception, which is influenced by a number of subjective issues. In order to investigate this link and frame public opinion, Q methodology has been used. An assessment about its usability and the steps to be followed are presented in the following chapter.

CHAPTER 3: THEORETICAL BACKGROUND OF Q METHODOLOGY

As mentioned in the introduction, the first goal of this research project is to get insights on what is the public opinion about civil RPAS applications. Now that the state-of-the-art of the research in civil RPAS has been presented and SA is definitively drawn, the next step of the analysis is the selection of the tool that will help us reach this objective.

The main requirement of our methodological tool is the extent to which it can ''map the public''. Q methodology can be used to explore and understand the public opinion about civil RPAS as it is a quantitative tool that identifies shared frames and perceptions among the citizens while trying to understand their characteristics.

Advanced knowledge of the shared frames or categories of perspectives is not required in advance for applying Q methodology, which is one of the strengths of this method (Donner, 2001). In order to identify shared frames and perceptions, a number of methods have been used, such as interviewing (e.g., Denzin and Lincoln, 2000), cognitive mapping (e.g., Eden, 1988; Ridder et al., 2005), and card sorting (e.g., Pahl-Wostl and Hare, 2004; Rugg and McGeorge, 1997). These methods have been used for elicitation of expert knowledge and for experiential knowledge (Evans, 1988). In order to identify conflicts of interest and knowledge gaps, Q methodology is the appropriate tool according to Raadgever et al. (2008).

Q methodologyhas been selected among other methods as mentioned above because of the freedom that gives to the participants to express their opinion, making the methodology very realistic and interesting enough to be studied. Moreover, purely quantitave tools, such as questionnaires or surveys, seem inappropriate for studying SA of such a technology which is unknown among laypeople that will participate in our research.

Furthermore, through Q methodology we can answer the following questions (Stricklin & Almeida, 1999):

- What is the range of communicated ideas in a particular discourse?
- What are the prevalent variations in it?
- How do these variations logically relate to each other?

Therefore, all these characteristics lead us to the conclusion that with Q methodology we can reach the objective of getting deeper insights into the public opinion about civil RPAS, thus Q methodology seems a suitable method that meets the requirements of our research. We don't claim that Q methodology is the only method to explore SA of civil RPAS, but it seems a suitable and interesting tool. Its limitations will be presented in Chapter 8 as well as the extent to which these limitations affect the reliability of the results. In that chapter, the second objective of our research, which is the evaluation of Q methodology regarding its usability for studying SA of civil RPAS, will be investigated and the relevant research question (*Using Q methodology, Using Q methodology, what are the categories of people with the same way of thinking regarding civil RPAS?)* and specifically the added value of Q in the investigation of social acceptance of civil RPAS will be answered.

Before diving into the different parts of Q methodology and the way we can apply it, it is worth analyzing a question that may arise, as the engineers tend to frequently use stakeholder analysis in order to deal with problems like the one this research tries to tackle.

3.1 IS Q METHODOLOGY A STAKEHOLDER ANALYSIS TOOL?

In this subchapter the relation of Q methodology and stakeholder analysis is presented through which the extent to which Q methodology is a stakeholder analysis tool is investigated.

Reed et al. (2009) provided a typology of stakeholder analysis methods, which is shown in Figure 10.

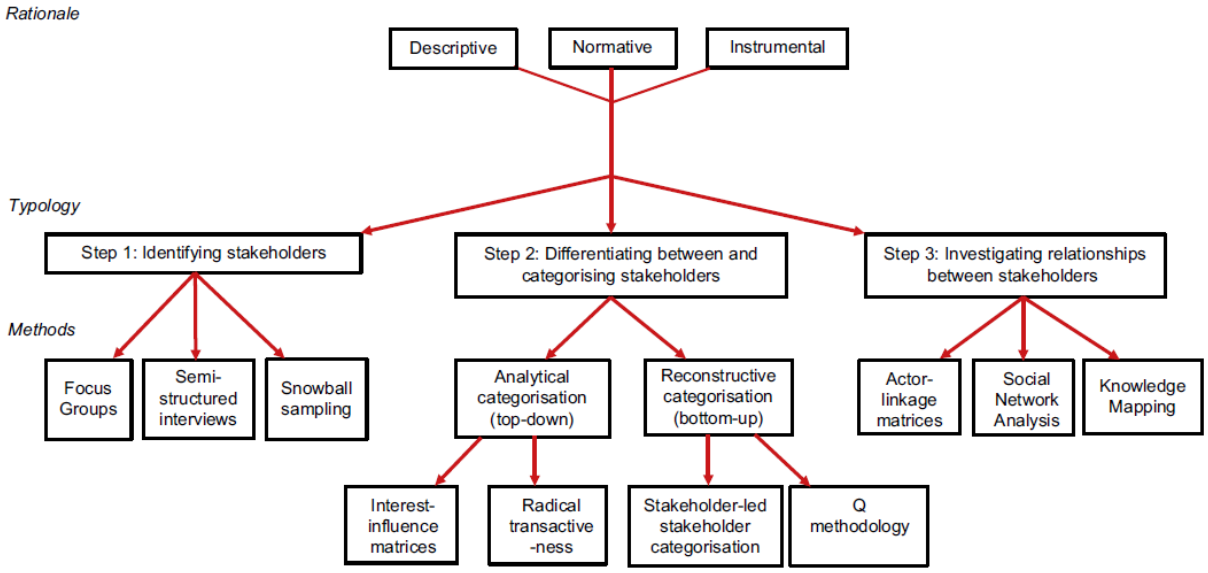

FIGURE 11: SCHEMATIC REPRESENTATION OF RATIONALE, TYPOLOGY AND METHODS FOR STAKEHOLDER ANALYSIS (REED ET AL., 2009)

In Figure 10 we can see that Q methodology is a method that is used to differentiate between and categorize stakeholders.

Moreover, as Cuppen (2011) claims in her research, the analysis with Q methodology cannot be perceived as stakeholder analysis, but as a tool that facilitates problem structuring in constructive conflict that is used in the participatory policy discourse as well as for stakeholder selection.

More specifically, Q methodology is one of the social scientific methods that are used to design the stakeholder dialogue on wicked problems. It can be used to construct the variety of stakeholders' perceptions about a topic, taking into consideration a variety of perspectives, even marginal and dissimilar opinions that can be then be included in the dialogue in a balanced way.

The large number of fields of social sciences that Q methodology has been applied, like environmental policy, citizenship and public interest, show the relevance of this method to stakeholder dialogue. The three characteristics of Q methodology that are related to stakeholder analysis are the following:

- Openness regarding the boundaries of the discussed problem.
  In Q methodology, the construction of the perspectives derives empirically without a predefinition of categories. "By allowing the categories of the analysis to be manipulated by respondents, the researcher loses the exclusive power to signify the reality of the

researched'' (Robbins and Krueger 2000). This is the main difference of Q methodology with questionnaires or surveys in which pre-defined variables are measured.

- Room for diversity in stakeholders' perceptions.
  The three properties of diversity that are addressed through Q are variety, balance and disparity. The aim of Q methodology traditionally is to present the variety of viewpoints, rather than the analysis of the level of support for those viewpoints as in surveys and questionnaires.
- Statistical link of stakeholders to perspectives.
  Through this method, the stakeholders with extreme opinions or multiple perspectives can be identified, so Q methodology is useful for the selection of the stakeholders to participate in the discourse about the issue under consideration.

Now that a justification of the utilization of Q methodology in this research has been drawn, the different parts of the methodology have to be presented. It is divided into five phases that are presented in this chapter. During these phases individuals express a variety of points of view, from which a limited number of shared perspectives is produced. This reduces the complexity of the problem and answers the questions of ''how'' and ''why'' people have a certain perception towards civil RPAS.

3.2 Q METHODOLOGY FOR STUDYING SUBJECTIVITY

William Stephenson (1902-1989), a British that studied physics (Ph.D., 1926), psychology (Ph.D., 1929) and psychometrics was the primary inventor and developer of Q Methodology. Currently the pioneering work of Dr. Stephenson is being continued by the International Society for the Scientific Study of Subjectivity (ISSSS)[13].

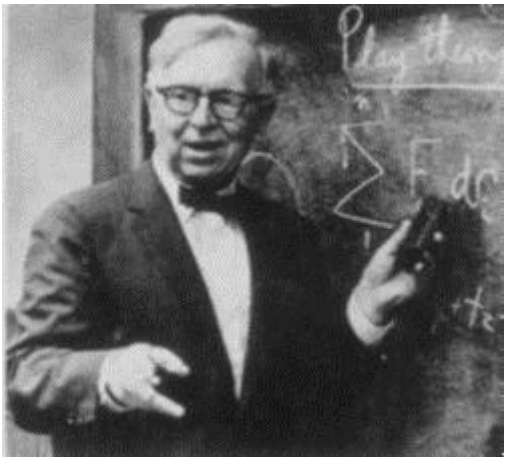

FIGURE 12: DR. STEPHENSON

The typical Q methodological study includes the presentation of the Q-set, which is a sample of statements about the topic under study, to the respondents, known as P-set. The participants have an individual point of view, expressing feelings and subjective opinions about the issue under study according to which they are asked to order the Q-set. This sorting, known as Q-sorting, reveals the subjective viewpoint of the P-set (Smith, 2001) and their profile of the individual (Brouwer, 1999).

[13] http://qmethod.org/about

A Q methodological study includes the following steps (Exel & Graaf, 2005):

(1) definition of the concourse
(2) development of the Q sample
(3) selection of the P set
(4) Q sorting
(5) analysis and interpretation

Exel & Graaf (2005) comprehensively explains the most important parts of these steps:

3.2.1 DEFINITION OF THE CONCOURSE

The first step of Q has to do with the collection of the statements and opinions about an issue. In Q, according to Brown (1993), concourse is the technical concept that means "the flow of communicability surrounding any topic" in "the ordinary conversation, commentary, and discourse of everyday life". There are a number of ways that we can obtain a verbal concourse, which we will use in our research: interviews, observation of the participants or even literature, like media reports, newspapers, magazines, novels as well as scientific papers, essays, and books. In our research a number of focus groups will be used to derive the statements of the participants.

3.2.2 DEVELOPMENT OF THE Q SET

The next step includes the development of the statements about the Q-set that the participants will be asked to sort. Q-set is a subset of all the statements retrieved from the concourse and it usually consists of 40 to 50 statements, but less or more statements are certainly also possible (e.g., Van Eeten, 1998). In order to select the statements that will be included or excluded from the Q-set, the researcher may use a structured Q-set or an unstructured Q-set, but either way the Q-set should be a representative miniature of the concourse (Exel & Graaf, 2005), which is not easy as 'the selection of statements from the concourse for inclusion in the Q set is of crucial importance, but remains "more an art than a science" (Brown , 1980).

The characteristics of the two ways of development of the Q-set are presented in Table 2.

TABLE 2: COMPARISON BETWEEN A STRUCTURED AND AN UNSTRUCTIRED Q SAMPLE[14]

Structured Q sample	Unstructured Q sample
Statements are selected purposefully according to categories.	Statements are selected at random from a "parent-universe" presumed to be relevant to the topic at hand.
The structure is achieved by applying Fisher's (1960) methods of experimental design to samples.	Statements are selected without an excessive effort to ensure coverage of all possible subissues.
It provides conciseness, clarity and representativeness of the concourse and overcomes bias and preference.	A bias of some sort could be incorporated unintentionally into the final Q sample.
Subjective points of view are communicable and always advanced from a position of self-reference.	Subjective points of view can be compromised with an external frame of reference provided by the researcher.

After ensuring that the statements cover a wide range of the existing beliefs about the topic under study, the researcher is possible to edit them and assign a number in each of them. Finally, he prints each statement on a card building the Q-deck. Now the Q-set is ready to be sorted.

In our study, the selection of the statements that will be included in the Q-set was based on the unstructured procedure described in Table 2 in order to have a more realistic representation of reality in the research; even the Q-set represents the public opinion of the participants about civil RPAS. In this way we ensure the minimum interference of the researcher in the selection of the Q-set. Moreover, the 'parent- universe' had the form of focus groups. The reasoning behind this will be presented in Chapter 4.

3.2.3 SELECTION OF THE P SET

According to Exel & Graaf (2005), a Q methodological study requires only a limited number of respondents: "all that is required are enough subjects to establish the existence of a factor for purposes of comparing one factor with another P sets, as in the case of Q samples, provide breath and comprehensiveness so as to maximize confidence that the major factors at issue have been manifested using a particular set of persons and a particular set of Q statements" (Brown 1980). Eventually, the number of persons associated with a factor is of less importance than who they are (Brown 1978).

Regarding the small P-set, Brown (2002a) characterizes a very large P-set ''counter-productive'' as ''large numbers of Q sorts can smoother operant factors that cannot get out from under the pile''.

In our research, we will use an intensive P-set with the characteristics that are showed in the next table. We used a relatively small number of participants-21- and we provided them with a number of instructions on how to apply Q method for our study.

[14] http://uir.unisa.ac.za/bitstream/handle/10500/2271/05chapter5.pdf

TABLE 3: COMPARISON BETWEEN AN INTENSIVE P-SET AND AN EXTENSIVE P-SET

Intensive person-sample	Extensive person-sample
Participant(s) are given many conditions of instructions.	Participants are given only one condition of instruction.
A small number of participants or even only one person can be examined in depth.	Typically uses 40 to 60 participants but fewer in some instances.

3.2.4 Q SORTING

According to Brown (1993), the general procedure can be described as follows: The Q set is given to the respondent in the form of a pack of randomly numbered cards, each card containing one of the statements from the Q set. The respondent is instructed to rank the statements according to some rule – the condition of instruction, typically the person's point of view regarding the issue - and is provided with a score sheet and a suggested distribution for the Q sorting task. The score sheet is a continuum ranging from "most disagree" on the one end and "most agree" on the other and in between a distribution that usually takes the form of a quasi-normal distribution. The kurtosis of this distribution depends on the controversiality of the topic: in case the involvement, interest or knowledge of the respondents is expected to be low, or a relatively small part of the statements is expected to be salient, the distribution should be steeper in order to leave more room for ambiguity, indecisiveness or error in the middle of the distribution; in case respondents are expected to have strong, or well-articulated opinions on the topic at issue, the distribution should be flatter in order to provide more room for strong (dis)agreement with statements. The range of the distribution depends on the number of statements and its kurtosis. More often the distribution is symmetrical in the middle.

In the forced-choice condition of instruction, the participants are forced to place the statements according to their opinion in a Q sort diagram, for example like in Figure 12. There is a symmetrical distribution about the middle and it is often smoother than the normal distribution.

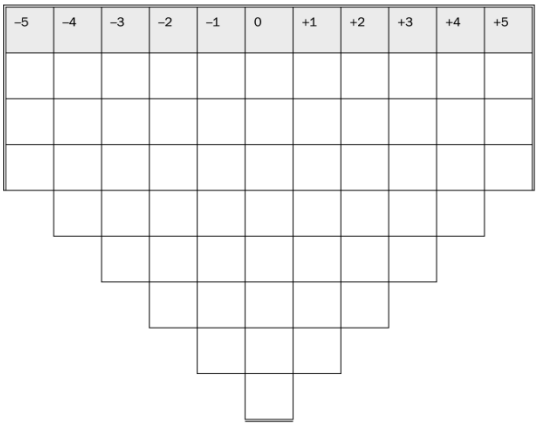

FIGURE 13: EXAMPLE OF DISTRIBUTION IN THE Q-SORTING

In our research, we used forced-choice condition of instruction, because it is then possible to conduct a factor analysis and compare the rankings in a quantitative, thus more reliable, way. Moreover, as it is mentioned in the following table, in this way we ensure that the participant pays close attention to the statements due to the fact that he has to make a decision on their placement.

TABLE 4: COMPARISON BETWEEN A FORCED AND A FREE DISTRIBUTION (MCKEOWN ET AL., 1988)

Forced-choice condition of instruction	**Free-sort condition of instruction**
The researcher determines in advance the number of piles to be used for the Q card sorting.	Participants are allowed to determine how many piles or categories are needed for the specific research problem.
Statement sortings are more stable and discriminating.	Statement sortings are less stable and discriminating.
Participants become frustrated because they are forced to place the Q sort cards on specific places under the distribution markers.	Participants' frustration is lowered because they are free to place the Q sort cards at any place under the distribution markers.
A participant is compelled to pay close attention to the statements or items since he or she has to make decisions on their placement.	A participant does not pay as close attention to the statements since he or she can place them anywhere under the distribution markers.

The respondent is asked to read through all of the statements carefully. In this way he gets an impression of the type and range of opinions at issue. The respondent is instructed to begin with a rough sorting while reading, by dividing the statements into three piles: statements he generally agrees with (or likes, finds important, et cetera), those he disagrees with and those about which he is neutral, doubtful or undecided.

FIGURE 14 : PARTICIPANT DURING A Q-SORT

The number of statements in each pile is recorded to check for agreement-disagreement balance in the Q set. Next, the respondent is asked to order the statements according to the condition of instruction and to place them in the score sheet provided. It is recommended to have the Q sort followed by an interview. The Q sorter is invited to elaborate on her/his point of view, especially by elaborating on the most salient statements - those placed at both extreme ends of the continuum on the score sheet. This information is helpful for the interpretation of factors later on (Exel & Graaf, 2005).

3.2.5 ANALYSIS AND INTERPRETATION

The above four phases help in the formal comparison of the arrangements of the statements using factor analysis. This analysis will be theoretically explained in this section.

Factor analysis is used in order to provide an ''orderly simplification'' of some statements that are interrelated in the chaos of the environment (Child, 1990). Using the technique of correlation we can discover the relation between this set of variables with a computational process. These correlations are known as ''factor loadings'' (Kline, 1993).

The analysis of the Q sorts is a purely technical, computer- based, objective procedure – and is therefore sometimes referred to as the scientific base of Q. First, the correlation matrix of all Q sorts is calculated. This represents the level of (dis)agreement between the individual sorts, that is, the degree of (dis)similarity in points of view between the individual Q sorters. Next, this correlation matrix is subject to factor analysis, with the objective to identify the number of natural groupings of Q sorts by virtue of being similar or dissimilar to one another, that is, to examine how many basically different Q sorts are in evidence (Brown 1980; 1993). People with similar views on the topic will share the same factor. A factor loading is determined for each Q sort, expressing the extent to which each Q sort is associated with each factor. The number of factors in the final set depends on the variability in the elicited Q sorts. It is however recommended to take along more than the number of factors that is anticipated in the next step of the analysis – factor rotation – to preserve as much of the variance as possible: "experience has indicated that 'the magic number 7' is generally suitable" (Brown 1980).

This original set of factors is then rotated to arrive at a final set of factors. Rotation may be either objective, according to some statistical principle (like varimax), or theoretical (or judgmental), driven by theoretical concerns, some prior knowledge or preconceived idea of the investigator, or an idea that came up during the study (e.g. from a salient Q sort or during a follow up interview). By rotating the factors, the investigator muddles about the sphere of opinions, examines it from different angles. A judgmental rotation looks for confirmation of an idea or a theory, a theoretical rotation for an acceptable vantage point by statistical criteria. Rotation does not affect the consistency in sentiment throughout individual Q sorts or the relationships between Q sorts, it only shifts the perspective from which they are observed. Each resulting final factor represents a group of individual points of view that are highly correlated with each other and uncorrelated with others.

The final step before describing and interpreting the factors is the calculation of factor scores and difference scores. A statement's factor score is the normalized weighted average statement score (Z-score) of respondents that define that factor. Based on their Z-scores, statements can be attributed to the original quasi-normal distribution, resulting in a composite or idealized Q sort for each factor. The composite Q sort of a factor represents how a hypothetical respondent with a 100% loading on that factor would have ordered all the statements of the Q-set. When the factors are computed, one can look back at the Q sorts and see how high their loadings are on the different factors. When a respondent's factor loading exceeds a certain limit (usually: $p < 0.01$), this called a defining variate (or variable). The difference score is the magnitude of difference between a statement's score on any two factors that is required for it to be statistically significant. When a statement's score on two factors exceeds this difference score, it is called a distinguishing statement. A statement that is not distinguishing between any of the identified factors is called a consensus statement.

Factor scores on a factor's composite Q sort and difference scores point out the salient statements that deserve special attention in describing and interpreting that factor. Usually, the statements ranked at both extreme ends of the composite sort of a factor, called the characterizing statements, are used to produce a first description of the composite point of view represented by that factor. The distinguishing and the consensus statements can be used to highlight the differences and similarities between factors. Finally, the explanations Q sorters gave during the follow-up interview can be helpful in interpretation of the factors, in ex-post verification of the interpretation, and as illustration material.

3.3 CONCLUSION

In a nutshell, Q methodology has been chosen as the qualitative tool that will address the beliefs of experts and laypeople through the focus groups that will be formed. It includes the following steps: (1) definition of the concourse, in which people discuss about civil RPAS (2) development of the Q sample, in which the statements are drawn (3) selection of the P set, in which we select the participants that will do the sorting of the statements (4) Q sorting by them and (5) analysis and interpretation. Moreover, the analysis with Q methodology cannot be perceived as stakeholder analysis, but as a tool that facilitates problem structuring. In the following chapter the first step of Q methodology will be presented as well as a description of the focus groups and some comments on the discussion.

CHAPTER 4: APPLYING Q METHODOLOGY FOR CIVIL RPAS: DEFINING THE CONCOURSE THROUGH FOCUS GROUPS

In this chapter, we will apply the first steps of Q methodology as it has been theoretically described in the previous chapter, answering the methodological questions that will lead to the answer of the third research sub-question. The initial step of the methodological process is the definition of the concourse. In our research, the verbal concourse is obtained by focus groups aiming at producing the statements (Q set) that will be sorted by the set of participants (P set). A critical reflection on the focus groups will be conducted with information on the selection of the participants (who are they and how did we find them) followed by an analysis of the main topics under discussion.

Given the facts that Q method needs a variety of points of view for the issue under study (according to the previous chapter) and not necessarily a huge number of participants, focus groups seem a suitable way to retrieve the list of the statements that will be used as the input to Q methodology. According to Wilkinson (1998), the purpose of focus groups are to "elicit people's understandings, opinions and views, or to explore how these are advanced, elaborated and negotiated in social context".

FIGURE 15: FOCUS GROUP

This method has been employed within an unstructured methodological strategy ('grounded theory approach'), which produces greater ranges of responses from the participants (Creswell, 2003). Thus, new data and concepts are generated from the participants. Additionally, we are not aiming at testing a predetermined hypothesis, thus deductive research cannot be employed here. In our case, the participants of the focus groups were asked to answer the open question: ***What is your opinion about civil RPAS?*** This question was aiming at triggering their interest and initiating a discussion between all the members of the focus groups.

In order to increase this variety of the perspectives and ensure the validity of the concourse, it has been decided that two different kinds of focus groups will be formed regarding the characteristics of the participants:

- Laypeople (LP): they may not be familiar with unmanned aviation and they don't have any information about the specific issues that the RPAS community is currently facing. Right before the initiation of the discussion in the focus group, they were informed by the researcher with the definition of RPAS and their most common civil applications (see subchapter 2.3.1).
- Experts (EX): engineers, working at NLR in the department of aerospace vehicles, members of the international RPAS community.

Through these focus groups the participants express their opinions and beliefs about civil RPAS. The different background of them as well as the variety inside the focus groups will give us the opportunity to expand the research into a comparison between the opinions of experts and laypeople, which will be presented in chapter 7. Questions like: *Do citizens 'see' different issues regarding RPAS than the experts? Do the experts miss critical information about issues that concern the citizens?* are answered in that chapter.

4.1 FOCUS GROUP PARTICIPANTS AND TOPICS UNDER DISCUSSION

In order to avoid the issue of the 'observer dependency' as much as possible, the researcher invited the participants letting them know only that they are supposed to express their viewpoint regarding RPAS and their civil applications.

LP focus groups:

Three focus groups of laypeople, with 4 participants in each of them, were conducted, all in the faculty of TBM in TU Delft. The participants are engineers and friends that were selected because of their availability and willingness to participate in the research. They are Greek, Dutch, Italian, Romanian and German. Given the European context, other nationalities were not selected. The fact that they are all friends of the researcher made the process of selection easier and quick, which is something considerable within the limitation of time. On the other hand, it has the disadvantage of a possible informal attitude during the discussion. For example a participant may want to sound funny or impress the others, thus he doesn't fully express his opinion, something that was observed in the first focus group.

In the beginning of the laypeople focus groups, they were provided with the definition of RPAS, a list of their applications as in subchapter 2.3.1 of this report, the Figures 6 and 7 and they were asked to answer the question: *what is your opinion about civil RPAS?* The setting in all the focus groups was a lunch break at TBM building in TU Delft, with no pressure of time.

We can say that the two requirements for the participants regarding their characteristics were satisfied in terms of variety and (not) knowing the subject. The variety of the focus groups was high, as the participants generally covered the whole spectrum of acceptance of RPAS, expressing interesting opinions, disagreeing with each other and sharing common perceptions in a lot of cases in every focus group.

The topics that were covered by them were issues regarding technical safety of RPAS, safety of people on the ground, privacy and data protection, legislation and regulation, automation, trust of the operator and the authorities, psychological issues and phobia regarding aviation and automation, comparison between UAS and RPAS and between automation in the air and on the ground as well as how, according to them, people perceive all of these issues. They also expressed their general opinion about the usefulness of civil RPAS applications and the future of the civil RPAS market.

Worth mentioning is the following; after an intense conversation between two participants in the first LP focus group that initially expressed opposing opinions which they were defending strongly, the one changed his opinion; from a completely negative opinion towards civil RPAS, he claimed at the end that it is a promising technology, showing one of the main characteristics of focus groups; human interaction can influence the opinion someone draws.

EX focus groups:

Two focus groups of experts conducted. In the first focus group, three experts participated, while in the second one, six experts were willing to express their opinion on civil RPAS. All the experts are Dutch and they are working in the Aerospace Vehicles division of NLR. They were asked to answer the initial question in an office at the NLR building in Amsterdam.

The topics that were covered by the experts were almost the same as the topics that were raised in the LP focus groups. Issues under discussion were: technical safety of RPAS, safety of people on the ground, privacy and data protection, legislation and regulation, automation, trust of the operator and the authorities, psychological issues and phobias regarding aviation and automation, comparison between UAS and RPAS and between automation in the air and on the ground as well as how, according to them, people perceive all of these issues. As in the LP focus groups, they expressed their general opinion about the usefulness of civil RPAS applications and the future of the civil RPAS market. In addition to these subjective topics, they shared part of their expertise in all the issues mentioned above, providing some statements that are scientifically proved regarding mostly technical safety of RPAS, something that was not the case in the focus groups of laypeople.

4.2 CONCLUSION

To conclude, the first step of Q methodology provided us with the definition of concourse through the conduction of focus groups with laypeople and experts. Twelve laypeople and nine experts expressed their opinion on civil RPAS and their applications. After giving the main characteristics of the participants of the focus groups and analyzing the topics under discussion we can now proceed to the following step of Q methodology, which consists of the data that was provided and the development of the final Q-set.

CHAPTER 5: DESCRIPTION OF THE CONCOURSE AND DEVELOPMENT OF THE Q-SET

In this chapter the statements that will be used as an input in Q methodology will be drawn from the discussion among the focus groups' members, making the opinions' of the participants explicit as well as the process of how we ended up in this list, which is our Q-set.

It is worth mentioning that in order to achieve the objective of getting insights in the public perception about civil RPAS, the Q-set consists of statements that were produced by the participants in our focus groups and they are not a product of literature review or an interview with some people or experts. In this way, the Q-set provides by itself, before the analysis, a first look at the viewpoints that the public may have regarding civil RPAS.

5.1 FROM THE DISCUSSION TO THE FINAL STATEMENTS

The steps that have been followed in order to filter the information from the discussion and end up with the Q-set are:

1. Description of the concourse with raw information and editing: writing down the opinions of the participants, the first filtering of information from the discussion.
2. Sampling of the concourse: Categorization of overlapping opinions.
3. Validation and Transformation into statements: 2 people independently create their own list with the final filtering.
4. One final list of statements (Q-set) ready to be used in Q methodology.

The concourse produced 114 statements on which the MECE (mutually exclusive collectively exhaustive) principle applied. Through this process, a possible overlap of the statements has been avoided and only mutually exclusive statements have been included in the Q-set.

For example, two participants stated the following:

- RPAS are a perfect alternative for places where manned aircraft or helicopters cannot fly.
- RPAS are useful in places that the manned aircraft cannot reach.

These two sentences express the same opinion, thus they will be categorized into one that reflects the shared viewpoint (here, the first statement). This is a way to reduce the number of the statements into a manageable set that can be sorted by the participants in the next step of Q methodology (Q-sorting). Moreover the statements were edited and presented in a way that minimizes the possibility of a misunderstanding of their meaning by the participants. It is very important that the Q-set is unambiguously defined, so the ranking of the statements is based on equal information.

Before the Q-sorting, a review of the final statements took place in which 2 researchers that did not participate in the focus groups validated the final Q-set. The initial 114 statements were presented to them and each of them created two lists of the final statements, deleting overlapping statements. Then the two lists were compared to the list of the researcher and the final Q-set was produced taking into consideration the opinion of two other researchers. In this way we ensure the validity of the research.

After the definition of the concourse, the sampling and the validation, the final Q-set is ready to be drawn. In our case, the final Q-set consists of 71 statements. This number of statements can be considered satisfactory as it fulfills the requirement that 40 to 80 statements can be

considered sufficient (Curt, 1994; Stainton Rogers, 1995). The final Q-set is produced by the participants of the focus groups thus it can be characterized as naturalistic.

5.2 FINAL Q-SET

The final statements derived from the focus groups are presented in Table 5. The first overview of the public opinion regarding civil RPAS and their applications can be provided by this list of statements.

In order to get a first glance on the SA of civil RPAS as presented in this research, the issues under discussion that the 71 statements represent are: technical safety of RPAS, safety of people on the ground, privacy and data protection, legislation and regulation, automation, trust of the operator and the authorities, psychological issues and phobias regarding aviation and automation, comparison between UAS and RPAS and between automation in the air and on the ground as well as how, according to them, people perceive all of these issues. As in the LP focus groups, they expressed their general opinion about the usefulness of civil RPAS applications and the future of the civil RPAS market.

TABLE 5: LIST OF THE FINAL STATEMENTS

Nr	Statements on SA of civil RPAS
1	There is no human factor that can act in case of mechanical failure, so I don't trust RPAS technologically.
2	A pilot on board is more useful and effective than a pilot on the ground.
3	I don't trust automation; systems fail.
4	Most of the accidents are caused due to human factor and not due to a failure of the system.
5	RPAS are used for a long time, so the safety issues are solved.
6	RPAS meet the technical requirements, so safety issues are taken care of.
7	When the planes are flying above us, we don't have any safety concern; so why should we have with RPAS?
8	My only concern about civil RPAS is regulation.
9	A mid-air collision with other aircraft is possible due to a disruption in the control system of the RPA.
10	Safety and regulation issues will be a stalemate in the development of the civil RPAS market in Europe.
11	Applications related to security and emergency issues will be used sooner than the others due to looser regulation.
12	Technically RPAS are very safe.
13	There is a long way to prove which one is safer; autonomous or remotely piloted aircraft
14	In order to be able to accept them, people need a roadmap as a proof that RPAS are technically safe.
15	The only way to deal with the privacy concern is strict regulation.
16	Hardly anybody knows the current regulation for civil RPAS.
17	UAS are safer than RPAS.
18	It is very difficult for the police to enforce the rules on flying RPA.
19	Legislation has to be developed regarding privacy and safety issues.
20	I disagree with allowing everybody to buy an RPAS.
21	Technical safety issues (like safety factors etc) should be further investigated.

22	The operator may not care if an RPA crushes as there are no people on board.
23	RPA can be a potential terrorist tool, like a bomb.
24	Terrorists will not use such high technology as a weapon itself.
25	Security operations of RPAS are useful only in small scale incidents.
26	RPAS surveillance will not have a deterrent effect on terrorists.
27	Privacy is an issue as long as there is no crush; then safety will become the major issue.
28	The safety standards should increase, so eventually only the safe RPAS will commercially survive.
29	If people know who is responsible for an RPA accident, they will accept it easier.
30	People will always be afraid of the autonomous vehicles.
31	A lot of people have wrong perception about the level of safety in aviation.
32	For most of the people, safety is greater issue than privacy.
33	Social acceptance will degrade if a crush takes place.
34	RPAS will be socially accepted like manned aircraft.
35	Everybody will accept RPAS if they meet the same requirements as manned aviation.
36	Civil RPAS may be illegally used for non-authorised purposes.
37	RPAS should be monitored in case of flying outside of the authorized airspace.
38	I want to know who the operator of the RPA that is flying over me is.
39	I would never go inside any air or ground vehicle with no pilot on board because I am scared.
40	I would go inside autonomous trains/trams because I feel safe on the ground.
41	I would fly with an RPA or an UA.
42	My only concern about civil RPAS is privacy.
43	I don't like the idea of RPAS flying over me because of the cameras they carry.
44	I am concerned about who is able to have access to data from RPAS cameras.
45	Everything that we do or say can be recorded by satellites, why should I be concerned about RPAS cameras?
46	Privacy is the only issue for SA; people don't want a spy above their heads.
47	RPAS are a promising technology but it is very early to discuss about it.
48	RPAS is the future.
49	Civil RPAS market will boom due to the high interest of the industry in their applications.
50	The civil RPAS market growth depends on the level of regulation and the cost.
51	In the future there will be autonomous flights of commercial aircraft.
52	I don't like RPAS; they bombard people.
53	RPAS applications are very useful and people shouldn't have a problem.
54	I totally approve a wide utilization of civil RPAS.
55	I will not have a specific personal benefit from a wide civil RPAS market.
56	I wouldn't care a RPA to fly over me if I knew that they fulfil the safety and regulatory requirements.
57	I don't mind RPA flying over me if they are on emergency or security operations.
58	RPAS are useful only for emergencies.
59	I don't like the fact that RPAs are not noisy because I may not notice them.
60	It will be annoying if an RPA passes above me all the time.
61	Civil applications of RPAS (e.g. infrastructure inspection or agriculture) will cause unemployment.
62	The driver behind the development of the civil RPAS market is mainly economic.
63	I want the policy maker to ask the citizens whether they agree with civil RPA utilization.
64	I want transparent information regarding civil RPAS (e.g. liability issues, the number of accidents etc).

65	There will be guided information flow regarding RPAS to convince people that they are useful.
66	For technology development and ethical reasons, I want a black box in every RPAS to monitor the system and the pilot's actions.
67	Most aircraft can fly autonomously but the pilot is used for psychological reasons.
68	RPAS is an innovative technology with a lot of breakthroughs.
69	Refuelling of civil aircraft in the air using RPAS will become reality in the future.
70	RPAS are a perfect alternative for places where manned aircraft cannot fly.
71	An RPAS operation is cheaper than the same manned operation.

CHAPTER 6: THE Q-SORTING PROCEDURE

In this chapter the Q-sorting procedure will be presented. Firstly, we will elaborate on the definition of the P-set, that is, the participants that will conduct the ranking of the statements. The main characteristics of the P-set will be shown as well as the criteria for its selection. The next subchapter presents the procedure of conducting a Q-sorting using the application FlashQ, which was used by the P-set in this research. Finally, a reflection on the Q methodology will be presented in order to justify some choices made in designing the Q-sorts that may affect the results.

6.1 DEFINING THE P-SET

The first step of the Q-sorting is the identification and the selection of the people that will form the P-set who will be asked to order the Q-set according to their opinion.

As mentioned in Chapter 3, the importance of a large number of participants is much less present in a Q study as the aim of Q methodology is the identification of the discourse patterns regarding the issue under study (Brown, 1986). According to McKeown & Thomas (1988), a typical P-set size can range from 20 to 45 participants. In our research study, this requirement has been met as the P-set comprises of 21 respondents, which can be an adequate minimum number in order to present a stable factor structure (Brown, 1980; McNaught & Howard, 2001).

In order to gather all the perspectives regarding civil RPAS, a representative sample of the public is important. Therefore the initial decision was the development of two groups of participants; laypeople and experts on RPAS technology. The final P-set includes 8 experts and 13 laypeople. For privacy reasons the names of the participants are not mentioned.

The participants were selected based on their interest on the subject and the high possibility of producing diverse results covering the whole spectrum of frames on civil RPAS. Based on the fact that I know all the participants in the LP group, I had drawn an impression about their attitude towards new technological projects by personal conversations. Furthermore a crucial criterion for the selection of the P-set was availability; Q-sorting is time consuming. Nevertheless, forming the P-set was not established accidentally but it has to be considered carefully.

Regarding the **EX group**, they are stakeholders that –most of them- work in the Aerospace vehicles and Air Traffic Management divisions of NLR, in which they have different functions (control engineers, software engineers, designers, regulation managers etc). Four of them have participated in the focus groups that produced the Q-set. A variety on the age of the participants is significant (25-60 years old). They are all male as a variety in sex was impossible due to the very small percentage of female engineers in these divisions. Two of the experts that were asked to perform the Q-sorting rejected the invitation for an interview. It is worth mentioning that the participants are among the stakeholders that either develop the technology being used for RPAS or they currently participate in the policy discourse regarding the development of the civil RPAS market in Europe.

The participants from the **LP group** are engineering master students of different disciplines (mechanical, electrical, civil engineering and designers), applied scientists (mathematics, chemistry) and a political scientist. All the LP participants are from 25 to 31 years old. 7 of them are male and 6 female and their nationalities are Dutch, Greek, Turkish and Spanish. We cannot claim that they form a representative set of society. However they constitute part of the stakeholder group of the public that will be affected by the development of the civil RPAS market

and they can be considered as a subset, with specific characteristics (e.g. high educational level), of the general public. Nonetheless, the criterion of using laypeople have been met, thus the sample can be considered representative. However the high homogeneity of the group can raise discussions among scientists and in this case another research can be done in order to achieve higher heterogeneity as well as variety of opinions.

6.2 Q-SORTING USING FLASHQ

After establishing the P-set, the next step is the Q-sorting. Instead of a 'traditional' Q-sorting interview, in which the participants would sort real cards with the statements like in Figure 12 and as it was described in Chapter 3, we decided to use an online tool, the FlashQ application[15].

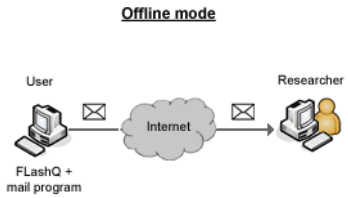

FIGURE 16: FLASHQ APPLICATION

This is a java-based, user friendly application that facilitates the data collection process, turning a time-consuming process into an interesting way to interview people (from the researcher's point of view) or to express opinions and beliefs (from the participants point of view). Most of the rankings were conducted with the researcher's presence and a short interview was held, additionally to the questions of FlashQ.

In this application, the participants follow exactly the same steps as in the traditional Q-sorting. In each step instructions are given to them. After the sorting of the Q-set, they are asked to argue on their choices about the statements that they agree/disagree the most. After that, they declare if they are experts or laypeople and they provide us with some personal information.

The first step of the Q-sort (Figure 16) was requiring each participant to place each of the 71 statements into 3 boxes: 'agree', 'disagree', or 'neutral'. In this way, the participant reads all the statements at least once before the actual Q-sort that follows.

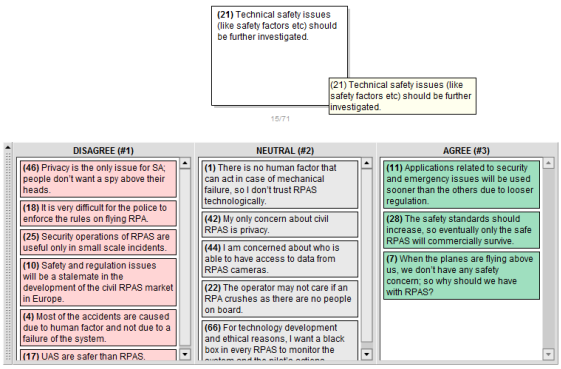

FIGURE 17: 1ST STEP OF FLASHQ

[15] It can be found: http://www.hackert.biz/flashq/home/).

After that, the participant had to rank the statements according to their own perspective and preference from -5 (mostly disagree) to 5 (mostly agree) under no time pressure. The statements should be placed in a quasi-normal distribution, which ensures that consideration of the relationships of the statements while the participant cognitively compares them. The places that a statement can be put are fixed and in our study there were 4 places for -5 and 5, 5 for -4 and 4 etc (Figure 17).

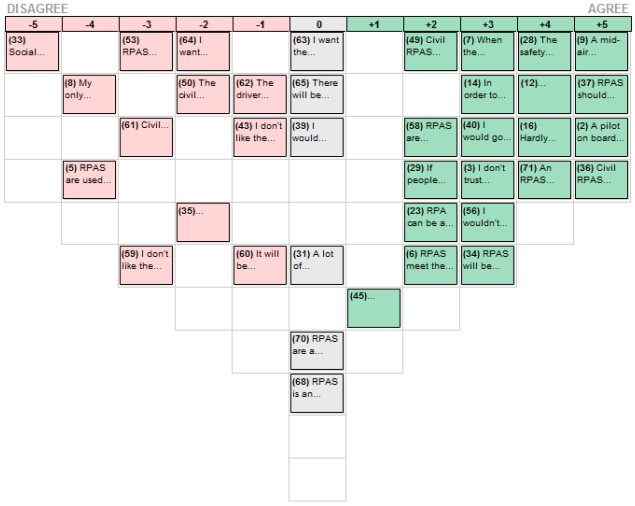

FIGURE 18: 2ND STEP, Q-SORTING

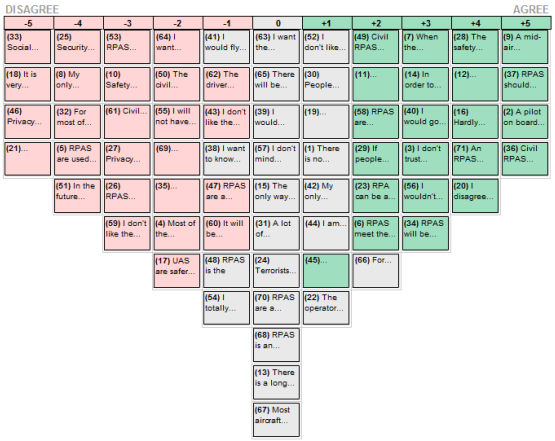

FIGURE 19: A FINAL Q-SORT

A final Q-sort may be presented as in Figure 18.

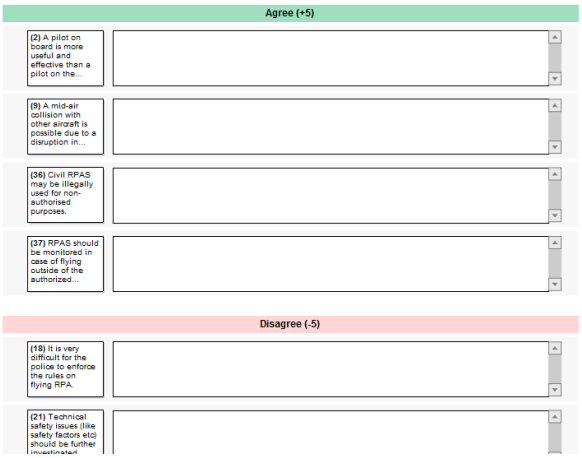

FIGURE 20: CARD FOR COMMENTS ON EXTREME SORTS

The next step of the Q-sort consists of open questions (Figure 19) regarding the statements that the participant mostly agrees and disagrees with. He is asked to elaborate on his extreme choices in order to be able for the researcher to farther analyze the Q-sort and understand the viewpoint of the specific participant.

Moreover, demographics, such as age, gender and nationality were gathered through a short questionnaire (which can be found in Appendix I). Each participant was also asked to mention if he is an expert in the field of RPAS and address the level of understanding on how civil RPAS are

used today. Finally he was asked to mention the level of support on the development of a civil RPAS market.

This data can be used in order to further investigate the issue of SA of civil RPAS. Such post hoc analyses ordinarily investigate how the participant has interpreted the statements given especially high or low rankings in their Q sort, and what implications those statements have in the context of their overall viewpoint (van Eeten, 2001). Such open-ended comments are a vital part of the Q methodological procedure, for they will aid the later interpretation of the sorting configurations (and viewpoints) captured by each of the emergent factors (Watts & Stenner, 2005).

Finally, the participant was asked to send the Q-sort to the researcher through email or print the data (see Appendix II). About 30 minutes were needed for each participant to conduct the sorting.

6.3 CONCLUSION

In this chapter, the Q-sorting procedure was presented as it was designed by the researcher and executed by the participants. Firstly, the P-set was selected based on the interest, the availability and the specific characteristics of each one on the level to which he/ she can contribute to the variety of the perceptions for civil RPAS. After the rejection from two experts, the final number of the P-set was 13 laypeople and 8 experts. The participants executed the Q-sorting using the java-based application, FlashQ, which minimized the time-consuming data gathering process for the researcher. Finally, an interview was held in the form of a short questionnaire and additional information was asked to make the reasoning of the ordering procedure more clear. The 21 Q-sorts form the raw data that will be used in the statistical analysis that will be presented in the next chapter.

CHAPTER 7: STATISTICAL ANALYSIS WITH Q METHODOLOGY- DATA ANALYSIS AND RESULTS

In this chapter the next phase of the Q methodology, which is the statistical analysis of the Q sorts, will be presented, providing us with the shared frames regarding civil RPAS. The third research sub-question will be answered in this chapter, having followed the methodological steps in the previous chapters.

Factor analysis is utilized in order to analyze the 21 Q-sorts and identify the common frames among them. These common frames, or shared perspectives or factors are presented and interpreted in the second subchapter as well as the commonalities and differences among them, while a deeper analysis follow in order to explain the underline values of them in relation to the previous chapters.

Regarding the terminology of this chapter, it is worth mentioning that the scoring patterns that the software identifies are called factors. In other words, the factors that are produced by the statistical analysis are the collective perspectives of the participants. From now on, the terms 'factor', 'shared perspective' and 'shared frames' will be used interchangeably in this report. Moreover, we can say that participants with common viewpoint regarding the civil RPAS *load* in the same factor (Venables et al., 2009).

7.1 EXTRACTING THE FINAL FACTORS

After the participants ranked the 71 statements expressing their subjective feeling regarding the civil RPAS, the 21 Q-sorts were used as an input to the PQMethod software (version 2.33, Dec 2012)[16], particularly designed for Q methodology (Schmolck & Atkinson, 2002).

Firstly, the software constructed a 21 x 21 **correlation matrix** (Table 6), in order to show the degree of similarity among the Q-sorts. This matrix is a reflection of each Q-sort configuration with the others. When two participants of the P-set have similar opinions and thus rankings, they show similar item configurations and they load onto the same factor (Watts & Stenner, 2005).

TABLE 6: COREELATION MATRIX BETWEEN SORTS

SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 LP1	100	52	51	42	41	24	20	32	26	28	0	62	43	27	63	30	39	9	51	41	13
2 LP2	52	100	49	45	41	49	43	51	42	41	-20	59	47	45	60	59	58	43	48	44	0
3 LP3	51	49	100	38	52	28	19	24	27	24	8	39	52	23	42	33	30	11	34	48	14
4 LP4	42	45	38	100	42	53	35	42	21	17	-18	49	42	31	51	40	39	50	56	38	6
5 LP5	41	41	52	42	100	33	20	29	43	47	-13	43	73	23	42	37	33	13	39	25	7
6 LP6	24	49	28	53	33	100	49	51	25	34	-17	41	36	48	43	46	49	57	55	37	7
7 LP7	20	43	19	35	20	49	100	39	14	13	-3	49	18	57	43	65	56	44	46	42	5
8 LP8	32	51	24	42	29	51	39	100	25	21	-14	50	24	40	48	48	45	39	36	38	13
9 LP9	26	42	27	21	43	25	14	25	100	74	-15	31	43	21	32	24	33	13	24	15	10
10 LP10	28	41	24	17	47	34	13	21	74	100	-18	22	51	25	22	12	24	1	28	3	5
11 LP11	0	-20	8	-18	-13	-17	-3	-14	-15	-18	100	-3	-14	2	-2	-20	-13	-9	-8	4	35
12 LP12	62	59	39	49	43	41	49	50	31	22	-3	100	43	30	73	57	59	28	58	64	23
13 LP13	43	47	52	42	73	36	18	24	43	51	-14	43	100	20	43	36	34	15	41	25	5
14 EX1	27	45	23	31	23	48	57	40	21	25	2	30	20	100	28	43	42	36	39	19	2
15 EX2	63	60	42	51	42	43	43	48	32	22	-2	73	43	28	100	51	57	29	56	66	21
16 EX3	30	59	33	40	37	46	65	48	24	12	-20	57	36	43	51	100	66	50	54	48	7
17 EX4	39	58	30	39	33	49	56	45	33	24	-13	59	34	42	57	66	100	45	68	57	17
18 EX5	9	43	11	50	13	57	44	39	13	1	-9	28	15	36	29	50	45	100	44	28	1
19 EX6	51	48	34	56	39	55	46	36	24	28	-8	58	41	39	56	54	68	44	100	42	13
20 EX7	41	44	48	38	25	37	42	38	15	3	4	64	25	19	66	48	57	28	42	100	25
21 EX8	13	0	14	6	7	7	5	13	10	5	35	23	5	2	21	7	17	1	13	25	100

[16] It can be freely downloaded from Peter Schmolck's Q Method page. (http://www.pcqsoft.com/)

Then factor analysis, using the centroid method, utilized this matrix to identify common item configurations, that it, common perspectives. The centroid method produced the unrotated factor matrix, which can be found in Appendix III. The 'magic number of 7' factors was decided to be extracted (Watts & Stenner, 2005). According to Brown (1980), the centroid method produce relatively similar results compared to principal component method (PCA), but it is preferred for its computational ease.

According to this matrix, the first factor explains the 37% of the variation, which means that 37% of the participants share this viewpoint.

Identification of the factors

The unrotated factor matrix (Appendix III) indicates how many factors should be extracted for interpretation based on two requirements. The interpretable factor must have (Stenner et al., 2003; Watts & Stenner, 2005):

1. eigenvalue greater than 1 and
2. at least two Q sorts that load significantly on it.

These requirements are met by three factors that are selected as the most appropriate and theoretically informative for interpretation.

Looking at this matrix, we can say that three factors are identified and they consist of shared frames or perspectives expressed by the participants that 'load' on each factor. The limited number of factors is an advantage that facilitates the identification of the internal logic of the factors by the analyst.

These factors were subjected to **rotation**, a process that aims at making inherent relationships more relevant and clear without changing the individual Q-sorts. During the rotation process, the varimax procedure was considered preferable than the hand-rotation. The advantage of the variman rotation is that it seeks for the mathematically superior solution in the problem of maximization of the variance that is explained by the extracted factors. As a result of the rotation, PQmethod produced the **factor matrix** (Table 7) showing the Pearson's correlation coefficients (for forced distribution data like in our research) between individual Q sorts and the resulting factors, which are the factor loadings.

TABLE 7: FACTOR MATRIX WITH AN X INDICATING A DEFINING SORT

		Loadings		
QSORT		1	2	3
1	LP1	0.2316	0.4250	0.5096X
2	LP2	0.5978X	0.5347	0.1007
3	LP3	0.1635	0.4793X	0.4020
4	LP4	0.4768X	0.3443	0.2906
5	LP5	0.1301	0.7664X	0.2436
6	LP6	0.6788X	0.2594	0.0843
7	LP7	0.7365X	-0.0063	0.1207
8	LP8	0.5849X	0.2274	0.1376
9	LP9	0.2346	0.6103X	-0.1248
10	LP10	0.1645	0.6951X	-0.2336
11	LP11	-0.1657	-0.1524	0.2618X
12	LP12	0.5139	0.3472	0.6005
13	LP13	0.1156	0.8119X	0.2251
14	EX1	0.5709X	0.1836	-0.0445
15	EX2	0.4775	0.3686	0.6091X
16	EX3	0.7071X	0.2368	0.1676
17	EX4	0.6970X	0.2506	0.2698
18	EX5	0.6546X	-0.0388	0.0562
19	EX6	0.5937X	0.3078	0.3244
20	EX7	0.4471	0.1444	0.5314X
21	EX8	0.0553	-0.0513	0.3288X
% expl.var.		24	17	10

The next step includes the decision by the analyst on the ***significant*** **loadings** and for this Table 7 is very important. The significant loadings indicate which individual Q-sort defines each factor and it is indicated with an X after each significant coefficient in the factor matrix.

We can observe from Table 7 that Q-sort 1 (LP1) loads on the 3rd factor, Q-sort 2 loads on the 1st factor etc. Moreover, factor 1 is determined by 10 Q sorts, which are LP2, LP4, LP6, LP7, LP8, EX1, EX3, EX4, EX5 and EX6. In other words, the above participants share common perspectives, which are different from the ones expressed by the 2nd factor. In the same way, we can identify the participants and their perspectives that determine each factor. The significance of the loadings derives from the following calculations.

According to Brown (1980) and van Exel and de Graaf (2005), factor loadings that exceed $\pm 2.58 * SE$ are statistically significant at the 0.01 level, while factor loadings that exceed $\pm 1.96 * SE$ are statistically significant at the 0.05 level. These formulas are used in the reversed t-test.

SE is the standard error that is calculated using the following formula:

$SE = \frac{1}{\sqrt{\mathrm{N}}}$, where N is the number of the statements in the Q-set (71 is our research).

Thus, in our research: *SE*= 0.12.

- Loadings larger than $\pm 2.58 * 0.12 = \pm 0.31$ are statistically significant at the 0.01 level.
- Loadings larger than $\pm 1.96 * 0.12 = \pm 0.23$ are statistically significant at the 0.05 level.

In our research, we consider statistically significant loadings larger than ± 0.23 ($p < 0.05$).

Observing the factor matrix (Table 7) we can see that there is no *non-loader*, that is, a participant who is not loaded on a factor. This means that we can use the all of the raw data of our research in the next step of the analysis, in which the factors are merged into factor arrays. Moreover, participants LP7, LP8, LP11, LP13, EX1, EX5 and EX8 load significantly only to one factor, while the rest show a hybrid view (they load on more than one factor) and they are called confounders. In order to use the data from the confounders in the analysis and to make sure that we take into consideration their perceptions, we decided to include their Q-sorts in the factors on which their loading is larger (Webler, et al. 2009). However, the large number of the confounders deserves a further mention in the reflection and it is a possible limitation of the study in the part of the interpretation of the results of factor analysis. Moreover, there is one Q-sort (LP12), which significantly loads in all the three factors, which means that this participants did not present a distinguished viewpoint that could led him load in one of the three factors. Due to this, LP12 has been decided to be excluded from the next phase of the analysis.

7.2 RESULTS

Focus groups of laypeople and experts regarding civil RPAS and statistical analysis of Q methodology have distinguished three factors or in other words three categories of people with shared perspectives. In this subchapter the identification of each factor will be followed by the interpretation of the perspectives shared among each factor. Through the interpretation process, the subtleties of the viewpoints that each factor communicates will be captured fulfilling the interpretative task of Q methodology.

The information that has been used, which derives from the PQMethod software, includes the factor arrays, the factor scores and consensus/disagreement statements, based on which the analysis will be structured in the following subchapters.

The following figures show the distribution of the participants (experts and laypeople) among the perspectives (=factors) as an absolute value (Figure 20) and percentage (Figure 21).

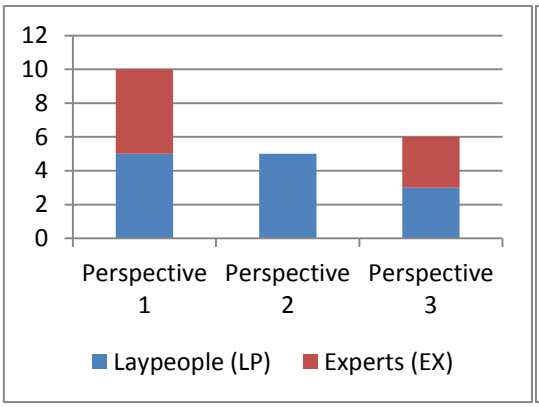

FIGURE 21:ABSOLUTE VALUE OF PARTICIPANTS

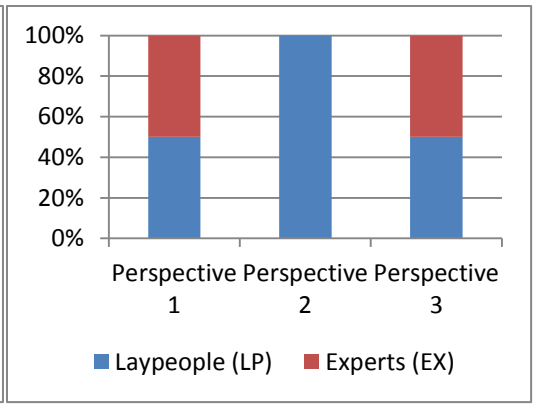

FIGURE 22: PERCENTAGE OF PARTICIPANTS

7.2.1 INTERPRETATION OF THE FACTORS

This subchapter consists of the next phase of the analysis, which is the description and interpretation of the final set of factors, based on salient statements that deserve special attention. The special characteristics of each factor will be analyzed, as well as the differences and similarities of them. Moreover, as our participant group consists of both laypeople and experts, the differentiations between them will be presented.

The interpretation of the final factors is based on the factor scores (z-scores), that is, the score of the statements within each factor that are used to point out certain viewpoints. The tables of the full scores (normalized) of the statements for each factor can be found in Appendix II.

The factor scores are used by PQMethod in order to produce the factor arrays, which are presented in Table 8. This table shows the ideal Q-sort for each factor, revealing the shared frames of the three categories of people that are identified in our research. In other words, it represents the Q-sort that a hypothetical participant with 100% loading on the specific factor would have produced.

The interpretation of each factors' internal logic will be based on the factor arrays and significant statements, will be pointed out. The significant statements are the ones that have the highest agreement among the participants of a factor or in other words, the participants on a specific factor agree on the specific statements that are called significant. The 'information rich' statements usually lie in the poles of the composite distribution or in the neutral zone, with rankings around zero. However, the special characteristics of the frames each factor expresses can be found through a close reading of the distinguishing[17] statements. Moreover, qualitative comments that have been gathered from the participants will be stated in order to verify the interpretation and reinforce the salient viewpoints.

[17] ''The difference score is the magnitude of difference between a statement's score on any two factors that is required for it to be statistically significant. When a statement's score on two factors exceeds this difference score, it is called a distinguishing (or distinctive) statement. A statement that is not distinguishing between any of the identified factors is called a consensus statement.'' (van Exel and de Graaf, 2005)

TABLE 8: FACTOR ARRAYS

Nr	Statements on SA of civil RPAS	Factor Array 1	Factor Array 2	Factor Array 3
1	There is no human factor that can act in case of mechanical failure, so I don't trust RPAS technologically.	4	4	0
2	A pilot on board is more useful and effective than a pilot on the ground.	-4	-4	1
3	I don't trust automation; systems fail.	-3	-3	-2
4	Most of the accidents are caused due to human factor and not due to a failure of the system.	5	4	3
5	RPAS are used for a long time, so the safety issues are solved.	2	-3	-5
6	RPAS meet the technical requirements, so safety issues are taken care of.	-3	-3	-2
7	When the planes are flying above us, we don't have any safety concern; so why should we have with RPAS?	5	4	5
8	My only concern about civil RPAS is regulation.	-4	-4	-5
9	A mid-air collision with other aircraft is possible due to a disruption in the control system of the RPA.	-3	-3	1
10	Safety and regulation issues will be a stalemate in the development of the civil RPAS market in Europe.	1	5	2
11	Applications related to security and emergency issues will be used sooner than the others due to looser regulation.	-4	1	-4
12	Technically RPAS are very safe.	-3	-3	-2
13	There is a long way to prove which one is safer; autonomous or remotely piloted aircraft	3	3	3
14	In order to be able to accept them, people need a roadmap as a proof that RPAS are technically safe.	-3	-3	3
15	The only way to deal with the privacy concern is strict regulation.	-3	-3	-2
16	Hardly anybody knows the current regulation for civil RPAS.	1	0	5
17	UAS are safer than RPAS.	0	0	-5
18	It is very difficult for the police to enforce the rules on flying RPA.	-3	-3	0
19	Legislation has to be developed regarding privacy and safety issues.	1	1	2
20	I disagree with allowing everybody to buy an RPAS.	0	-5	-3
21	Technical safety issues (like safety factors etc) should be further investigated.	-3	-3	1
22	The operator may not care if an RPA crushes as there are no people on board.	3	2	2
23	RPA can be a potential terrorist tool, like a bomb.	2	0	-1
24	Terrorists will not use such high technology as a weapon itself.	-3	-3	-3
25	Security operations of RPAS are useful only in small scale incidents.	0	2	-1
26	RPAS surveillance will not have a deterrent effect on terrorists.	1	-3	-3
27	Privacy is an issue as long as there is no crush; then safety will become the major issue.	-3	-3	-1
28	The safety standards should increase, so eventually only the safe RPAS will commercially survive.	5	2	4
29	If people know who is responsible for an RPA accident, they will accept it easier.	-3	1	4
30	People will always be afraid of the autonomous vehicles.	-3	-3	-1
31	A lot of people have wrong perception about the level of safety in aviation.	4	2	4
32	For most of the people, safety is greater issue than privacy.	-5	-5	-4
33	Social acceptance will degrade if a crush takes place.	-3	-3	0
34	RPAS will be socially accepted like manned aircraft.	2	3	4
35	Everybody will accept RPAS if they meet the same requirements as manned aviation.	-5	-5	-5
36	Civil RPAS may be illegally used for non-authorised purposes.	-3	-3	0

37	RPAS should be monitored in case of flying outside of the authorized airspace.	3	1	5
38	I want to know who the operator of the RPA that is flying over me is.	0	-4	-4
39	I would never go inside any air or ground vehicle with no pilot on board because I am scared.	-3	-3	-2
40	I would go inside autonomous trains/trams because I feel safe on the ground.	2	1	1
41	I would fly with an RPA or an UA.	2	0	4
42	My only concern about civil RPAS is privacy.	-3	-3	-3
43	I don't like the idea of RPAS flying over me because of the cameras they carry.	1	3	0
44	I am concerned about who is able to have access to data from RPAS cameras.	-4	1	-4
45	Everything that we do or say can be recorded by satellites, why should I be concerned about RPAS cameras?	-3	-3	-2
46	Privacy is the only issue for SA; people don't want a spy above their heads.	3	1	2
47	RPAS are a promising technology but it is very early to discuss about it.	1	-4	1
48	RPAS is the future.	-3	-3	0
49	Civil RPAS market will boom due to the high interest of the industry in their applications.	4	1	1
50	The civil RPAS market growth depends on the level of regulation and the cost.	0	-4	-1
51	In the future there will be autonomous flights of commercial aircraft.	-3	-3	0
52	I don't like RPAS; they bombard people.	3	4	-3
53	RPAS applications are very useful and people shouldn't have a problem.	1	5	3
54	I totally approve a wide utilization of civil RPAS.	-3	-3	-1
55	I will not have a specific personal benefit from a wide civil RPAS market.	3	2	3
56	I wouldn't care a RPA to fly over me if I knew that they fulfil the safety and regulatory requirements.	-4	4	0
57	I don't mind RPA flying over me if they are on emergency or security operations.	-3	-3	-1
58	RPAS are useful only for emergencies.	5	2	0
59	I don't like the fact that RPAs are not noisy because I may not notice them.	0	-5	1
60	It will be annoying if an RPA passes above me all the time.	-3	-3	-1
61	Civil applications of RPAS (e.g. infrastructure inspection or agriculture) will cause unemployment.	1	3	2
62	The driver behind the development of the civil RPAS market is mainly economic.	-5	3	-4
63	I want the policy maker to ask the citizens whether they agree with civil RPA utilization.	-3	-3	-2
64	I want transparent information regarding civil RPAS (e.g. liability issues, the number of accidents etc).	4	5	3
65	There will be guided information flow regarding RPAS to convince people that they are useful.	-3	5	2
66	For technology development and ethical reasons, I want a black box in every RPAS to monitor the system and the pilot's actions.	-3	-3	0
67	Most aircraft can fly autonomously but the pilot is used for psychological reasons.	2	2	2
68	RPAS is an innovative technology with a lot of breakthroughs.	-5	3	-3
69	Refuelling of civil aircraft in the air using RPAS will become reality in the future.	-3	-3	0
70	RPAS are a perfect alternative for places where manned aircraft cannot fly.	2	0	5
71	An RPAS operation is cheaper than the same manned operation.	4	-3	1

Factor 1

TABLE 9: STATEMENTS WITH MOST AGREEMENT FOR FACTOR 1

Factor Scores -- For Factor 1

No.	Statement	No.	Z-SCORES
58	RPAS are useful only for emergencies.	58	1.803
4	Most of the accidents are caused due to human factor and not	4	1.738
7	When the planes are flying above us, we don't have any safet	7	1.513
28	The safety standards should increase, so eventually only the	28	1.404
64	I want transparent information regarding civil RPAS (e.g. li	64	1.379

TABLE 10: STATEMENTS WITH MOST DISAGREEMENT FOR FACTOR 1

8	My only concern about civil RPAS is regulation.	8	-1.666
68	RPAS is an innovative technology with a lot of breakthroughs	68	-1.989
32	For most of the people, safety is greater issue than privacy	32	-2.272
35	Everybody will accept RPAS if they meet the same requirement	35	-2.409
62	The driver behind the development of the civil RPAS market i	62	-2.425

TABLE 11: DISTINGUISHING STATEMENTS FOR FACTOR 1[18]

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
58	RPAS are useful only for emergencies.	58	5	1.80*	2	0.75	0	-0.01
71	An RPAS operation is cheaper than the same manned operation.	71	4	1.34*	-3	-0.81	1	0.12
49	Civil RPAS market will boom due to the high interest of the	49	4	1.24*	1	0.26	1	0.33
22	The operator may not care if an RPA crushes as there are no	22	3	1.24	2	0.59	2	0.35
37	RPAS should be monitored in case of flying outside of the au	37	3	1.15*	1	0.39	5	1.89
41	I would fly with an RPA or an UA.	41	2	0.89	0	-0.41	4	1.56
5	RPAS are used for a long time, so the safety issues are solv	5	2	0.88*	-3	-0.63	-5	-3.00
70	RPAS are a perfect alternative for places where manned aircr	70	2	0.85*	0	-0.25	5	1.90
23	RPA can be a potential terrorist tool, like a bomb.	23	2	0.85*	0	-0.24	-1	-0.30
53	RPAS applications are very useful and people shouldn't have	53	1	0.47	5	1.66	3	1.09
16	Hardly anybody knows the current regulation for civil RPAS.	16	1	0.34	0	-0.32	5	1.65
26	RPAS surveillance will not have a deterrent effect on terror	26	1	0.12	-3	-0.57	-3	-0.93
20	I disagree with allowing everybody to buy an RPAS.	20	0	0.02	-5	-2.07	-3	-0.65
65	There will be guided information flow regarding RPAS to conv	65	-3	-0.47*	5	2.14	2	0.34
29	If people know who is responsible for an RPA accident, they	29	-3	-0.50*	1	0.52	4	1.30
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-4	-1.19*	4	1.28	0	0.02
68	RPAS is an innovative technology with a lot of breakthroughs	68	-5	-1.99*	3	1.21	-3	-0.66
62	The driver behind the development of the civil RPAS market i	62	-5	-2.43*	3	1.16	-4	-1.73

The first factor explains the 24% of the total variance and consists of 10 people, as indicated in the factor matrix (Table 7). It is made up of both (see Figures 22, 23) laypeople and experts (LP2, LP4, LP6, LP7, LP8, EX1, EX3, EX4, EX5, EX6), who share common viewpoints regarding, among others, the importance of privacy in the development of the civil RPAS market in Europe. Tables 9 and 10 present the highest and lowest scoring statements for the first factor. The full list of the agreement statements can be found in Appendix III.

[18] P < .05 ; Asterisk (*) Indicates Significance at P < .01

Table 11 presents the distinguishing statements of factor 1. These are the statements on which the participants that load on factor 1 show different attitude than the participants of other factors. For example, factor 1 strongly agrees that RPAS are useful only for emergencies (58, with factor array: +5), while factor 2 shows a quite positive attitude (factor array:+2) and factor 3 has a neutral opinion about that statement (factor array:0). Moreover, in this table the z-scores of the statements can be found and compared for all the factors.

The participants that load in this factor have generally a positive attitude towards the development of a civil RPAS market in Europe, while expressing severe concerns mainly about privacy issues. Generally they believe that ''an RPAS operation is cheaper than the same manned operation'' (71) and that ''RPAS are a perfect alternative for places where manned aircraft cannot go'' (70). Nonetheless, they hesitate on the effect of the utilization of RPAS against possible terrorist acts (26), expressing a neutral opinion. It is worth mentioning that although they are convinced that the civil RPAS market will boom (49), they do not perceive RPAS as an innovative technology but more as an existing one with a lot of applications to be developed and exploited (68).

The statement that ranked first in this factor (''RPAS are useful only for emergencies.'' (58)) supports the need for an increasing use of RPAS for emergency cases, while it implies that there are secondary issues to be taken care of. These issues are revealed by observing the disagreement statements. A close look at them shows that the participants that load on the first factor doubt about the motives of the developers of the civil RPAS market (''The driver behind the development of the civil RPAS market is mainly economic'' (62): -5) and as a participant commented: 'I believe that RPAS market will be mainly developed for surveillance and data collection'. They strongly agree that the citizens are concerned more about the **privacy** issues than the safety ones (32, 43). This perception is also confirmed by the distinction they make between RPAS and commercial plane (35); ''even if RPAS meet the same requirements as manned aircraft, these small aircraft will always be treated as spies in the air by some people''. This comment of a participant explicates the previous statement and the attributed importance on it.

The lack of knowledge of the current regulation regime is expressed in this factor by a general agreement on the need for legislative development regarding privacy and safety issues in civil RPAS market. Moreover, they do not seem to worry a lot about knowing the operators of the civil RPAS (38), emphasizing on the need for **transparency** for the objective of civil RPAS utilization, possible accidents etc.

Regarding the **safety** issues, the respondents that load on the first factor do not share strong safety concerns showing an attitude of risk acceptance. They generally trust automation pointing out that ''most of the accidents are caused due to human factors'' (4) as ''it is a statement supported by historical facts'' according to an expert. Another participant stated that ''automatic systems have proven to be very safe and robust in practice and they are already present everywhere around us in everyday life. A properly designed and tested RPAS will not be an exception.''

Moreover, the participants strongly believe that safety issues should never be overseen and engineers should always work towards the improvement of the safety standards. This is the reason they generally do not agree with the statement: ''technically RPAS are very safe (12)''. An interesting observation on safety has to do with the fact that this factor is the only one that expresses an agreement on the statement 5 (''RPAS are used for a long time, so the safety issues are solved''), while the other factors slightly (2nd factor) or highly (3rd factor) disagree with it.

Regarding the **public opinion** on RPAS, an interesting point is their surprise when people feel unsafe by a RPA that flies over them, when almost no one feels unprotected when commercial

airplanes fly over them (7). Combining this opinion with their belief that ''a lot of people have wrong perception about the level of safety in aviation'' (31), we can conclude that although the first factor expresses a minor concern about technical safety of the system and safety of the people on the ground, there is a strong belief that civil RPAS will be socially accepted at last (34) but not easily due to privacy and mostly wrong safety concerns. In the same direction, they express quite a neutral opinion about the need of a roadmap for civil RPAS in order to be **socially accepted**.

Furthermore, the respondents mostly rejected any psychological complication against the use or the trust in automation and especially unmanned aviation stating that ''most aircraft can fly autonomously but the pilot is used for psychological reasons (67) and that they could ''fly with an RPA or an UA (41)'', because, simply, ''they are not scared'' as a participant commented.

Thus, the core belief in this factor is the privacy concerns bonded with trust to safety. The respondents that hold this perspective generally support the wide utilization of civil RPAS in Europe for emergencies and applications that manned aircraft are unable to perform. They are convinced that civil RPAS market will boom in the near future, but they worry about their privacy rights. Moreover, there is much agreement on the acceptance of the safety standards that already exist and the trust on automation, both in manned and unmanned aviation.

Factor 2

TABLE 12: STATEMENTS WITH MOST AGREEMENT FOR FACTOR 2

Factor Scores -- For Factor 2

No.	Statement	No.	Z-SCORES
10	Safety and regulation issues will be a stalemate in the deve	10	2.191
65	There will be guided information flow regarding RPAS to conv	65	2.143
64	I want transparent information regarding civil RPAS (e.g. li	64	1.688
53	RPAS applications are very useful and people shouldn't have	53	1.658
1	There is no human factor that can act in case of mechanical	1	1.467

TABLE 13: STATEMENTS WITH MOST DISAGREEMENT FOR FACTOR 2

47	RPAS are a promising technology but it is very early to disc	47	-1.431
32	For most of the people, safety is greater issue than privacy	32	-1.931
59	I don't like the fact that RPAs are not noisy because I may	59	-1.971
20	I disagree with allowing everybody to buy an RPAS.	20	-2.066
35	Everybody will accept RPAS if they meet the same requirement	35	-2.551

TABLE 14: DISTINGUISHING STATEMENTS FOR FACTOR 2[19]

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
10	Safety and regulation issues will be a stalemate in the deve	10	1	0.65	5	2.19*	2	0.72
65	There will be guided information flow regarding RPAS to conv	65	-3	-0.47	5	2.14*	2	0.34
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-4	-1.19	4	1.28*	0	0.02
68	RPAS is an innovative technology with a lot of breakthroughs	68	-5	-1.99	3	1.21*	-3	-0.66
62	The driver behind the development of the civil RPAS market i	62	-5	-2.43	3	1.16*	-4	-1.73
58	RPAS are useful only for emergencies.	58	5	1.80	2	0.75	0	-0.01
25	Security operations of RPAS are useful only in small scale i	25	0	-0.05	2	0.66*	-1	-0.24
29	If people know who is responsible for an RPA accident, they	29	-3	-0.50	1	0.52	4	1.30
37	RPAS should be monitored in case of flying outside of the au	37	3	1.15	1	0.39*	5	1.89
44	I am concerned about who is able to have access to data from	44	-4	-1.38	1	0.24*	-4	-1.01
11	Applications related to security and emergency issues will b	11	-4	-1.28	1	0.03*	-4	-1.37
46	Privacy is the only issue for SA; people don't want a spy ab	46	3	1.08	1	-0.03	2	0.58
70	RPAS are a perfect alternative for places where manned aircr	70	2	0.85	0	-0.25*	5	1.90
16	Hardly anybody knows the current regulation for civil RPAS.	16	1	0.34	0	-0.32	5	1.65
41	I would fly with an RPA or an UA.	41	2	0.89	0	-0.41*	4	1.56
5	RPAS are used for a long time, so the safety issues are solv	5	2	0.88	-3	-0.63*	-5	-3.00
71	An RPAS operation is cheaper than the same manned operation.	71	4	1.34	-3	-0.81*	1	0.12
8	My only concern about civil RPAS is regulation.	8	-4	-1.67	-4	-0.95*	-5	-2.12
50	The civil RPAS market growth depends on the level of regulat	50	0	0.00	-4	-1.20*	-1	-0.22
47	RPAS are a promising technology but it is very early to disc	47	1	0.24	-4	-1.43*	1	0.30
59	I don't like the fact that RPAs are not noisy because I may	59	0	0.06	-5	-1.97*	1	0.14
20	I disagree with allowing everybody to buy an RPAS.	20	0	0.02	-5	-2.07*	-3	-0.65

The second factor explains the 17% of the total variance and consists of 5 people, as indicated in the factor matrix (Table 7). It is made up of only laypeople (**LP3, LP5, LP9, LP10, LP13**). Tables 12 and 13 present the highest and lowest scoring statements for the first factor.

The attitude of this factor's respondents towards the civil RPAS market is positive as they strongly agree on the usefulness of RPAS applications (53). However, besides engineering aspects like the level of safety of the system, this factor emphasizes on the possible low SA of RPAS due to regulation and privacy issues that may arise as well as the trust of the authorities.

[19] P < .05 ; Asterisk (*) Indicates Significance at P < .01

The core perception of this factor is that ''safety and regulation issues will be a stalemate in the development of the civil RPAS market in Europe'' (10). As derived from the respondents' comments, this viewpoint has to do with this factor's opinion about the level of SA of civil RPAS, which they believe it will be low. They strongly agree that society will oppose the development of civil RPAS market, at least until the regulatory regime become clear and details in a satisfying level. However, the participants have a positive attitude towards the development of the civil RPAS market if the safety and regulatory requirements are met.

This core belief can be supported by the statement ''I wouldn't mind a RPA flying over me if I knew that they fulfil the safety and regulatory requirements'' (56). It is clear that the participants who hold this perspective support RPAS applications but at the same time they show a reluctant attitude for civil RPAS regarding **privacy** and **regulatory** issues. They seem not to trust the authorities that ''will provide guided information to convince people that RPAS are useful'' (65). Transparency plays an important role for this factor (64) and it is seen as means to protect their privacy from the cameras RPAS are equipped with (43).

Moreover, the emerging character of the civil RPAS market is not attributed ultimately to their applications, as this factor shows neutral scores towards this opinion (49). Privacy issues and trust of the authorities' ''hidden agenda'' (62) are related to this factor's viewpoint as well as to their opinion about SA of civil RPAS. They strongly agree that ''Safety and regulation issues will be a stalemate in the development of the civil RPAS market in Europe '' (10), although they more or less expect that ''RPAS will be socially accepted like manned aircraft'' (34) at last. In this context, they strongly express their certainty that RPAS will not be socially accepted if they meet the same requirements as manned aircraft (35). As a participant stated: ''privacy will still be an issue to be taken care of''. This is closely related to their opinion that there is a negative general opinion of society about civil RPAS due to their military applications (52).

Safety issues are not in the first line of this factor's interest, as they focus more in SA and regulation. However, they are more concerned about safety issues than the first factor and they believe that the absence of the human factor on board influences negatively the level of safety of an RPAS (1). The comparison between manned and unmanned vehicles shows that the respondents that load on this factor believe that people should technologically trust RPAS as they trust commercial aircraft (7). Moreover the fact that this factor comprises of laypeople can give a logical explanation to this factor's neutral attitude towards the level of safety of RPAS (''UAS are safer than RPAS'' (17)).

We can also observe that RPAS is seen as an innovative (68) and promising technology about which it is time to discuss (47). In addition to this, an RPA operation seems to be more expensive than the same manned operation (71). This is closely related to the fact that this factor comprises of people with no deep technical knowledge on RPAS, who are not familiar with the mechanical and operational components of the system.

Regarding the psychological issues, this factor shows a quite negative attitude towards a possible flight with an RPA or an autonomous ground vehicle (39, 41). However, this depends on the level of trust of RPAS technology and not on permanent phobias, as they explained in the interviews. Thus we can say that they express an attitude of risk denial, which will increase if they get more familiar with technical safety of RPAS or safety standards become higher.

It is also remarkable that even the fact that this factor consists only of laypeople, they attributes great importance (through extreme factor scores) to statements like ''Most of the accidents are caused due to human factor and not due to a failure of the system'' (4), which have been expressed by experts during the focus groups. The expected neutral attitude towards statements that require technical knowledge has been replaced by a very strong one. This may be explained

by the fact that the respondents have a general overview of the causes of accidents in aviation and they explicitly express it here.

Thus we observe that the strongest characteristic of this factor is its reluctance and mistrust towards the authorities regarding their hidden objective for the wide utilization of civil RPAS that may affect social privacy rights. They attribute central role to the knowledge of the regulation in order to judge if they are willing to give away part of their privacy, as they believe that RPAS market will be mainly developed for surveillance and data collection.

To conclude with, the respondents that load on the second factor share common viewpoints regarding, among others, the low level of SA that civil RPAS market may enjoy, the suspicion against the authorities, worries about transparency during the development of the market as well as an acceptance of civil RPAS if the regulatory and safety issues are overpassed.

Factor 3

TABLE 15: STATEMENTS WITH MOST AGREEMENT FOR FACTOR 3

Factor Scores -- For Factor 3

No.	Statement	No.	Z-SCORES
70	RPAS are a perfect alternative for places where manned aircr	70	1.896
37	RPAS should be monitored in case of flying outside of the au	37	1.891
7	When the planes are flying above us, we don't have any safet	7	1.833
16	Hardly anybody knows the current regulation for civil RPAS.	16	1.654
41	I would fly with an RPA or an UA.	41	1.562

TABLE 16: STATEMENTS WITH MOST DISAGREEMENT FOR FACTOR 3

62	The driver behind the development of the civil RPAS market i	62	-1.731
8	My only concern about civil RPAS is regulation.	8	-2.123
17	UAS are safer than RPAS.	17	-2.152
35	Everybody will accept RPAS if they meet the same requirement	35	-2.244
5	RPAS are used for a long time, so the safety issues are solv	5	-2.997

TABLE 17: DISTINGUISHING STATEMENTS FOR FACTOR 3[20]

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
70	RPAS are a perfect alternative for places where manned aircr	70	2	0.85	0	-0.25	5	1.90*
37	RPAS should be monitored in case of flying outside of the au	37	3	1.15	1	0.39	5	1.89*
16	Hardly anybody knows the current regulation for civil RPAS.	16	1	0.34	0	-0.32	5	1.65*
41	I would fly with an RPA or an UA.	41	2	0.89	0	-0.41	4	1.56
29	If people know who is responsible for an RPA accident, they	29	-3	-0.50	1	0.52	4	1.30
14	In order to be able to accept them, people need a roadmap as	14	-3	-0.77	-3	-0.85	3	0.83*
65	There will be guided information flow regarding RPAS to conv	65	-3	-0.47	5	2.14	2	0.34*
2	A pilot on board is more useful and effective than a pilot o	2	-4	-1.38	-4	-1.40	1	0.32*
21	Technical safety issues (like safety factors etc) should be	21	-3	-0.46	-3	-0.45	1	0.16
71	An RPAS operation is cheaper than the same manned operation.	71	4	1.34	-3	-0.81	1	0.12*
1	There is no human factor that can act in case of mechanical	1	4	1.28	4	1.47	0	0.12*
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-4	-1.19	4	1.28	0	0.02*
58	RPAS are useful only for emergencies.	58	5	1.80	2	0.75	0	-0.01
43	I don't like the idea of RPAS flying over me because of the	43	1	0.59	3	1.07	0	-0.04
52	I don't like RPAS; they bombard people.	52	3	1.06	4	1.39	-3	-0.64*
20	I disagree with allowing everybody to buy an RPAS.	20	0	0.02	-5	-2.07	-3	-0.65
68	RPAS is an innovative technology with a lot of breakthroughs	68	-5	-1.99	3	1.21	-3	-0.66*
32	For most of the people, safety is greater issue than privacy	32	-5	-2.27	-5	-1.93	-4	-1.15
62	The driver behind the development of the civil RPAS market i	62	-5	-2.43	3	1.16	-4	-1.73*
17	UAS are safer than RPAS.	17	0	-0.13	0	-0.16	-5	-2.15*
5	RPAS are used for a long time, so the safety issues are solv	5	2	0.88	-3	-0.63	-5	-3.00*

The third factor explains the 10% of the total variance and consists of 5 people, as indicated in the factor matrix (Table 7). It is made up of two laypeople (LP1, LP11) and three experts (EX2, EX7, EX8), who seem to share a clear supportive opinion about the usefulness of a wide utilization of civil RPAS with a strong interest in the safety and regulatory regime of this market in a European level. Tables 15 and 16 present the highest and lowest scoring statements for the first factor.

The support of this factor's respondents on civil RPAS is expressed by describing them as ''a perfect alternative for places where manned aircraft cannot go'' (70), which is a something that

[20] P < .05 ; Asterisk (*) Indicates Significance at P < .01

is not so highly supported by the other factors, as well as by their comments regarding their neutral attitude towards the statement: ''RPAS are useful only for emergencies'' (58). The interviews of the respondents that hold this opinion confirmed their support and their positive attitude towards numerous applications of RPAS that they consider useful. As a participant stated: ''There is a need for this type of use and currently no device can meet this demand except RPAS.'' Another participant commented about this statement that '' deployment of surveillance RPAS in war zones (Syria), areas with nuclear activity (Japan) and other places are good examples where RPAS will have their benefit. They can really have an added value in this type of operations.''

At the same time, they claim that they could fly with an RPA or an UA (41), which shows high risk acceptance without having any **psychological** issue towards flying without a pilot onboard. On the other hand, they attribute a possible low level of SA to a public concern about safety of RPAS in case of emergency. They believe that ''at this moment people don't like the fact that there is no real person in control or could act in case of an emergency.''

Their expert's knowledge on RPAS may explain their strong agreement on the level of **safety** of RPAS comparing it with UAS; they believe that RPAS are safer (17). They strongly agree that RPAS are generally safe for the people on the ground and people should realize it as they do for manned aircraft (7). However, this factor focus on the continuous work on improving the safety characteristics of RPAS, as the long history of remotely-piloted flights does not mean that safety of RPAS is an issue that has been solved (5), because '' safety will always be an issue'' according to a participant.

As we saw in Chapter 2, risk acceptance relies on the subjective assessment between society's perception of the level of exposure to the hazard and society's perception of the benefits due to the hazardous activity. Due to this, some participants that load on this factor commented that they are willing to increase the level of their individual risk acceptance, because the societal benefits of civil RPAS applications will be substantial.

Remarkable in this factor is the importance they attribute to issues related to **SA** of civil RPAS. We can see that there is a strong agreement on the very low level of social awareness regarding the current regulatory regime in civil RPAS market (16). According to an expert that shares this opinion: ''regulation is still under development/discussion. Furthermore there is not much information available to the public and therefore I think hardly anybody knows anything about the current regulation.'' At the same time, participants that load in this factor believe that ''If people know who is responsible for an RPA accident, they would accept it easier'' (29). Moreover, they agree on the need of a roadmap in order to increase benefit awareness among the population, which is essential for citizens to accept RPAS (14). On the other hand, they strongly disagree with the statement ''everybody will accept RPAS if they meet the same requirements with manned aircraft'' (35), expressing the perception of a different attitude of society against RPAS compared to commercial aviation.

Furthermore, the development of regulation that will safeguard the citizens from illegal data collection by the cameras of RPAS seems essential for this factor. They strongly agree on monitoring of RPAS as means to prevent flights outside of the authorized airspace (37).

Thus, the core characteristic of this factor is its high support of civil RPAS applications, while expressing the need for further development of the regulatory regime in order to safeguard privacy and achieve higher SA. The level of safety is also significant among the respondents that load on this factor and they believe in the continuous improvement of technical safety.

7.2.2 CONSENSUS AND DISAGREEMENT AMONG FACTORS

In this subchapter the common viewpoints among the factors will be presented and interpreted followed by the statements upon which the factors disagree. The consensus and disagreement statements can be used to provide a comparison between the factors through the identification of their agreement and disagreement and an ex-post verification of the interpretation.

Although there are a lot of distinguishing statements among the factors on which statements are significant and important, we can find a relatively large number of consensus statements that show common frames among all the factors. This is also caused by the large number of confounders, the participants that load significantly in two factors (as mentioned in page 57).

Agreement among factors

Table 18 presents the statements on which there is the highest consensus among three factors that are identified in our research. These are the statements that do not distinguish between any pair of the factors. A full list of the consensus statements can be found in Appendix III.

TABLE 18: STATEMENTS WITH THE STONGEST AGREEMENT[21]

			Factor Arrays		
No.	Statement	No.	1	2	3
12	Technically RPAS are very safe.	12	-3	-3	-2
39	I would never go inside any air or ground vehicle with no pi	39	-3	-3	-2
63	I want the policy maker to ask the citizens whether they agr	63	-3	-3	-2
15	The only way to deal with the privacy concern is strict regu	15	-3	-3	-2
6	RPAS meet the technical requirements, so safety issues are t	6	-3	-3	-2
3	I don't trust automation; systems fail.	3	-3	-3	-2
45	Everything that we do or say can be recorded by satellites,	45	-3	-3	-2
30	People will always be afraid of the autonomous vehicles.	30	-3	-3	-1
57	I don't mind RPA flying over me if they are on emergency or	57	-3	-3	-1
54	I totally approve a wide utilization of civil RPAS.	54	-3	-3	-1
13	There is a long way to prove which one is safer; autonomous	13	3	3	3
60	It will be annoying if an RPA passes above me all the time.	60	-3	-3	-1
27	Privacy is an issue as long as there is no crush; then safet	27	-3	-3	-1
35	Everybody will accept RPAS if they meet the same requirement	35	-5	-5	-5
42	My only concern about civil RPAS is privacy.	42	-3	-3	-3
48	RPAS is the future.	48	-3	-3	0
69	Refueling of civil aircraft in the air using RPAS will becom	69	-3	-3	0
24	Terrorists will not use such high technology as a weapon its	24	-3	-3	-3
51	In the future there will be autonomous flights of commercial	51	-3	-3	0

The statements that are listed in Table 18 are the ones on which the participants showed a significant agreement. We observe that all of the highly consensus statements are generally ranked in the middle of neutral opinion to extreme opinion, getting a score of 3 or -3 in the ideal Q-sort of each factor. The absence of the important statements (ranked in the poles of the distributions) is an expected phenomenon that leads to the distinction between the factors, as every participant attributes a different level of importance into certain statements. In general, the consensus list shows a common agreement on statements that has to do with safety and privacy issues. For example, all the factors agree that RPAS cannot be considered very safe, even if they meet the current technical requirements.

Consensus has been met regarding automation. All of the factors tend to reject the psychological issues related to automated systems. They state that they could get in an air or ground vehicle without a pilot onboard as they generally trust automation. This means that in our research the participants' risk perception is not influenced by subjective probabilities or heuristics and biases (see Chapter 3).

[21] The statement are compared based on their normalized z-scores and not on their factor arrays (variance across Factor Z-Scores)

Privacy infringement is again mentioned as an important issue, but there are a number of ways to approach it and solve it and not only strict regulation according to the participants of this research. Moreover, it is worth mentioning that there is an agreement on a policy of very loose collaboration between the authorities and citizens for the development of the market. They do not want the policy maker to ask the citizens if they agree with the wide utilization of RPAS for civil purposes. This may derive from a feeling that there is a wrong public perception about safety and technical issues related to RPAS, or that subjectivity of the public is highly influenced by psychological issues.

Finally, the participants seem to agree that risk perception can be changed and people will not always be afraid of autonomous vehicles. This can be achieved by communicating the safety characteristics of RPAS and UAS in general, as they are not very familiar with the level of technical safety.

Disagreement among factors

The differences among factors determine their specific characteristics and distinguish them from the other perceptions. The disagreement among the factors has been already explained by the distinguishing statements during the interpretation of each of the factors. Nonetheless a direct comparison between the factors is easier by presenting the statement on which there is a strong disagreement in Table 19.

TABLE 19: STATEMENTS WITH THE STRONGEST DISAGREEMENT

70	RPAS are a perfect alternative for places where manned aircr	70	2	0	5
71	An RPAS operation is cheaper than the same manned operation.	71	4	-3	1
52	I don't like RPAS; they bombard people.	52	3	4	-3
17	UAS are safer than RPAS.	17	0	0	-5
59	I don't like the fact that RPAs are not noisy because I may	59	0	-5	1
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-4	4	0
65	There will be guided information flow regarding RPAS to conv	65	-3	5	2
68	RPAS is an innovative technology with a lot of breakthroughs	68	-5	3	-3
62	The driver behind the development of the civil RPAS market i	62	-5	3	-4
5	RPAS are used for a long time, so the safety issues are solv	5	2	-3	-5

As we can observe in Table 19, there is a strong disagreement on whether safety issues are solved or not. The third factor seems to attribute more importance on improving safety standards as the second just accepts this opinion and the first generally disagree with the other two factors, saying that generally safety issues are generally solved.

Remarkable is the disagreement on the on the objectives of the developers of the market, which is highly related to privacy issues. Do the developers of the market aim at using RPAS in order to benefit the public or there are hidden objectives that cause a direct infringement of privacy rights? The first and third factor share the opinion that the driver behind the development of the civil RPAS market is not economic.

Moreover, an expected differentiation among the perspectives is described by statements that mainly derive from experts during the focus groups, such us:'' UAS are safer than RPAS (17), ''RPAS is an innovative technology with a lot of breakthroughs'' (68) and ''an RPAS operation is cheaper than the same manned operation'' (71). The first and the third factor that consists of experts as well generally reject the innovative character of RPAS as ''people are fascinated by flying robots, but the truth is that this technology already exists for decades''. Notable is that

factor 1 and 3 express a neutral opinion about the comparison of safety levels between UAS and RPAS, while this statement is of high important for the third factor, which strongly believes that RPAS are safer.

Correlation between factors

The symmetric matrix of the correlations between the factor scores can be seen in Table 20 as calculated by the PQmethod software.

TABLE 20: CORRELATIONS BETWEEN FACTOR SCORES

	1	2	3
1	1.0000	0.4488	0.5910
2	0.4488	1.0000	0.4240
3	0.5910	0.4240	1.0000

We can see that factor 1 and factor 3 are quite comparable, when the other correlations show higher variation. This may be explained by the fact that the 2nd factor consists only of laypeople while half of the other two factors' participants are experts.

7.2.3 DISAGREEMENT BETWEEN EXPERTS AND LAYPEOPLE INSIDE FACTORS

The analysis and interpretation of the opinions and beliefs of the participant showed quite remarkable differences between laypeople and experts. These may be of interest of the RPAS community in order to find the areas on which they have to focus more on the development of the civil RPAS market.

Some interesting and sometimes expected differentiations will be presented, using the participants own words, in order to get a better understanding on the way the participants ranked the given statements and thus, get insights on the level of social acceptance of civil RPAS as it is perceived by the two groups of participants. The differences between factors was presented in the previous subchapter 7.2.2 and it can also be derived by a careful look at the interpretation of the results as well as the overview of the factors (subchapter 7.2) that will be followed. Therefore, in this subchapter we will focus on highlighting differences in the opinions of experts and laypeople that load in the same factor. Factor 2, which consists only of laypeople, has thus been decided to be excluded by the analysis of this section and only the first and the third factor that consist of both groups will be presented here.

Factor 1:

As this factor consists of both laypeople and experts, it was expected that some significant differences will occur in their viewpoints., although they share some common beliefs, which led them to load in the same factor.

- **Civil applications of RPAS (e.g. infrastructure inspection or agriculture) will cause unemployment (61)**

The first significant disagreement has to do with the extent to which the development of civil RPAS market will cause unemployment Some of the laypeople that participated in our research expressed their worries for a reduced number of employees for example in the agriculture

sector when the RPAS will be employed. On the other hand, the experts do not share the same opinion. More specifically, according to an expert that loads on the first factor: ''always, a group of people will be necessary to perform missions. The pilots will become ground pilots, but for the rest, the full team will always be necessary to perform inspections and other activities. In current large RPAS application, more personnel than when flying manned aircraft is necessary, including safety officers and communication people, however, this will change in the coming years.''

- **I don't like RPAS; they bombard people (52)**

This statement has been introduced and supported from two laypeople, while the experts strongly rejected it. According to a layperson: '' RPAS are still drones with a bad reputation. I am afraid that they will not stop be utilized as killing machines''. On the contrary, an expert stated that: '' this is only one of the numerous applications which can benefit society''.

- **RPAS are used for a long time, so the safety issues are solved (5)**

Again, some of the laypeople of this factor seem to agree that the fact that RPAS are used for a long time proves that there are no safety issues. However, experts believe that: '' Even though RPAS are used for a long time this is no guarantee at all that the safety issues have been solved. You need to have legislation to be sure that the RPAS reaches a certain safety level. This is independent of the time used in the past.''

- **An RPAS operation is cheaper than the same manned operation (71)**

This statements was supported by a number of laypeople. For example, one of the participants in the laypeople group stated: ''I don't know in the future but for now I think that an RPAS operation is more expensive.'' On the other hand, experts seem to reject this opinion and as an expert claimed: ''This statement has been proven to be wrong''.

- **It is very difficult for the police to enforce the rules on flying RPA (18)**

Laypeople showed an indifferent or quite negative attitude towards this statement, but some experts ranked it in the positive pole of the distribution in their Q-sorts, commenting that: ''it is hard or impossible for the police to track all UAV activities. Furthermore it might not be the highest priority for them.''

- **I don't like the idea of RPAS flying over me because of the cameras they carry(43)**

Although the experts of this factor generally point out the importance of privacy in the development of the civil RPAS market, this statement got a relatively neutral score. This can be explained by the contrast in the scoring of the participants. Most of them agree with it, but some others from the laypeople group do not perceive it as very important. A participant's comment can verify this indifferent opinion saying that ''there are many other ways that government or any other organization can spy on us''.

- **RPAS is a promising technology but it is very early to discuss about it (47)**

Laypeople and experts showed a contradicting attitude on whether now it is the time to discuss about the civil RPAS market. Most of the laypeople ranked this statement in the middle or in the positive area of the distribution, while some experts strongly disagree with this. According to one of the experts: ''Now is the time to discuss. RPAS are becoming widely used in most countries. Small aircraft are already used by the police for surveillance operations in The Netherlands (and other countries) and many requests for photographic and inspection missions are made at this time. We need to act and discuss now.''

Factor 3:

Similarly to the first factor, a lot of differences can be identified between the laypeople and the experts in this category. The remarkable disagreements occur in the following statements:

- **I don't like RPAS; they bombard people (52)**

The same contrast of opinions as in the first factor can be found regarding this statement. The subjective opinion is very well explained by an expert's comment: ''RPAS constitute a typical dual use technology, like the GPS system, a kitchen knife, etc.''

- **RPAS is a promising technology but it is very early to discuss about it (47)**

This opinion seems to be shared by the laypeople, while according to some experts: '' RPAS are already operated around the world at large numbers, thus the discussions on regulations, etc. is urgently needed.''

- **An RPAS operation is cheaper than the same manned operation (71)**

Again, the participants that are not experts in the field of RPAS believe that a manned operation is cheaper than the same unmanned. However, an expert expressed the opposing opinion, because '' All unmanned aircraft tend to be way cheaper to operate than the comparable (with respect to the mission) manned aircraft.''

- **Civil applications of RPAS (e.g. infrastructure inspection or agriculture) will cause unemployment (61)**

In accordance to the first factor's same disagreement, a layperson that loads to this factor commented that: ''society is becoming technology intensive. People are replaced by machines''. This perspective is clearly rejected by the experts of this factor, who have ranked it in the negative part of the distribution.

7.3 OVERVIEW OF FACTOR INTERPRETATION

After the interpretation of the subjective viewpoints of the factors and an analysis on their consensus and disagreement statements, we got insights on different categories of people that are differentiated according to their perspective on civil RPAS. Their characteristics have been presented and analyzed and essential information concerning their subjective beliefs can be derived after addressing the underlying values.

The general conclusion to be drawn is the conditional acceptance of this new technology, as all of the factors recognized the benefits of the civil RPAS applications for society, other in emergencies (1st factor), and other in different fields (2nd and 3rd factor) who share an enthusiasm on the usefulness of their applications. However, the conditions that should be met are highly important for them and thus for SA of civil RPAS, as all factors commented based on their individual risk perception and the characteristics they consider significant.

In all perspectives, protection of the privacy rights seems to be critical and it is an issue that should be taken care of with the introduction of a regulatory umbrella under which the market can perform for the social benefit. The trust to the authorities seems to be highly related to the level of transparency during this process and people need clear information in order to accept the development of this emerging market.

Moreover, all factors identify safety as a substantial issue that should be never overseen. Technical estimations of safety highly influence risk perception and thus are crucial for the level of SA of civil RPAS. The theory that risk acceptance relies on the subjective assessment between society's perception of the level of exposure to the hazard and society's perception of the benefits due to the hazardous activity is accepted by a number of participants in our research. They showed a tendency to increase the level of their individual risk acceptance, because of the substantial societal benefits from civil RPAS applications. Regarding the experts' viewpoint on risk and safety, they strongly express an attitude of improvement on safety characteristics. This adds to the theoretical viewpoint of experts that often tend to perceive risks within their competence area lower than the public, as mentioned in Chapter 2.

Consensus has also been drawn regarding phobias and psychological issues. All of the factors identified in this research did not show any psychological issue or phobia that would affect the level of the acceptance of civil RPAS. So we can conclude that subjective probabilities and

heuristics regarding phobias of automation and flying showed negligible influence in the risk acceptance of the factors in this research. Moreover, the factors addressed a different attitude towards other autonomous vehicles, for example autonomous cars, which enhance the belief that risk acceptance is highly influenced by the nature of risk exposure. People tend to perceive risk differently if they are on the ground than in the air.

Moreover, the first and the second factor hold a quite reluctant position towards the real objectives of the operators of civil RPAS, worrying about a possible violation of their privacy rights. This is why people seem to perceive RPAS in a very different way than they do for manned aircraft, which are not seen as spies in the air.

We also observe that two of the three factors consist of both experts and laypeople, thus the level of technical expertise and deep knowledge of the current situation is not the binding characteristic of these perspectives. Of course, the differentiation in the opinions of these two groups of respondents is significant. The analysis revealed some expected areas of conflict (e.g. level of technical safety, cost of the operation) and interesting areas of consensus among them (e.g. no phobia, safety still an issue).

Furthermore, a distinction should be made on the personal viewpoint of the participants on civil RPAS and their opinion on how the society will perceive the development of this market in Europe. In addition to values that are shared among all of the perspectives, the extent to which civil RPAS will be socially accepted is an issue that concerns all the factors. Nonetheless, the second factor holds a pessimistic attitude towards the level of SA of civil RPAS believing that safety and regulation will be a stalemate in the development of the market. On the other hand, the other two factors express the opinion that civil RPAS will be socially accepted at last, when the regulatory issues will be solved.

In a nutshell, we observe that the overall perspective tends to show a positive attitude towards the development of a civil RPAS market in Europe with the combination of privacy and safety issues as the crucial aspect to be focus on. This can be interpreted as an expected public attitude towards a new technological project, with which the majority of people are not familiar. Therefore, the actual knowledge of technical safety and the benefit awareness play a central role in the determination of the level of risk acceptance, which is critical in new technological projects such as the civil RPAS market.

CHAPTER 8: EVALUATION OF Q METHODOLOGY: CRITICISM, LIMITATIONS AND REFLECTION

After the identification and analysis of the perspectives regarding SA of civil RPAS, the second part of our research question will be answered. In this chapter, we will evaluate Q methodology addressing this method's limitations and the extent to which they influence the results and conclusions of our research. Finally, a personal reflection on the methodology will be presented.

Generally, most of the influential limitations of our study may derive from the methodology that has been used. In our research, Q methodology was applied in order to study SA of civil RPAS in Europe. After elaborating in chapter 3 on the usefulness of this method and presenting a justification on the choice of the method, the evaluation of Q will be followed and some limitations will be presented.

Q methodology has been criticized for its reliability in a sense of how replicable are the results. A Q-sorting of the same P-set will not necessarily give the same outcome. However, this is common in social psychology as an individual can express different views on a topic in different occasions (W. Stainton Rogers, 1991). However, Brown (1980) claims that a Q-sorting is possible to be replicated with a consistency of 85% within a year.

The effectiveness of Q- methodology, and thus our research, highly depends on the cooperation and frankness of the participants, which may have unfortunate consequences. It is possible that a participant gives a fake Q-sort (Oppenheim, 1992). For example, some participants may not want to reveal their true perspective and they answer strategically for a number of reasons. However, we believe that in our research the participants did not have any motivation to answer strategically and not frankly as there is no right or wrong answer regarding SA of civil RPAS. In addition to this, experts did not seem to follow a ''right'' pattern; they all expressed their own subjective opinions and beliefs.

Another critic aims at the interpretation of the statements by the researcher. The analysis by Q methodology is quantitative in basis, but its interpretation is qualitative. Thus, there is room for discussion regarding the interpretation process and variation could occur among the researchers. This is an inevitable limitation that I tried to minimize in order to draw the picture of the analysis as objective and clear as possible. The fact that the participants can comment on the extreme statements is also an advantage that gave me the opportunity to verify the sorting using quotes from the participants. If I had to do the interpretation again, I would follow the same steps that led me to the current results.

The analysis of Q-sorting showed a number of participants with double loads (confounders) which means that they do not have a clear distinctive opinion towards one factor or another. They could load in both, showing some similarities with both factors' beliefs. Another analysis and interpretation can be made taking into account only the participants that significantly load on one factor. The confounders may influence the final conclusions, because we did not consider their double loads as part of the analysis.

The small sample size is another point of criticism. According to Valenta et al. (1997) "The results of Q methodology are less influenced by low response rates compared with the results of other surveys". The core of Q methodology is the representation of different perceptions (Akhtar-Danesh et al., 2008) and not the number of participant, thus theoretical sampling, that is, theoretically selecting participants, is allowed. Therefore, in our case we consider the size of 21 participants large enough as it gave 3 different factors with information-rich viewpoints. The main criterion for the selection of the participants is to be laypeople. Even if the P-set of LP group was formed only by highly educated people, they were laypeople towards RPAS

technology. Of course more diversity could occur if the sample consisted of laypeople with completely different educational backgrounds and ages and in this way the homogeneity of this sample would be larger. For example, elder people would be possible to have shown a more conservative view towards this new technology. However this has nothing to do with the quantity of the Q-sorts, but with the homogeneity of the P-set. Even a heterogeneous sample could give the same statements, so we cannot claim that this would add to the diversity of the statements. Thus, we consider the sample representative enough for a valid study with the characteristic of high homogeneity.

The extent to which the P-set consists of a representative sample of the population could be under question for other researchers. Therefore, another study could be performed with larger heterogeneity and a comparison between the statements could be done in order to investigate the effect of homogeneity in the research of SA of civil RPAS.

Other could say that another limitation can be derived by the fixed distribution that influences the ranking of the statements. However, Watts et al (2005) showed in his research the noticeable contribution of the distribution to the factors that are produced. Surprisingly for some people, a forced distribution is actually no more restrictive than a 'free' distribution. It is used to encourage the participants to give careful consideration to the ranking they wish to achieve, bringing out true feelings in response (=subjectivity) (Barry & Proops, 1999). If Q-methodologists generally prefer the forced distribution, therefore, it is because it delimits unnecessary work and it is convenient for their participants (Watts & Stenner, 2005).

Regarding the limitations of factor analysis, it was based on the centroid method for its longest use in Q methodology and its computational ease. There were some critics on this relatively easy method, but research shows that this method does not underperform compared to others methods such as principal component (PCA). Actually they produce virtually the same results (Brown, 1980).

A final limitation has to do with the selection of the participants in the focus groups that directly affects the set of statements that form the Q-set. As we mention in Chapter 4, the fact that they are all friends of the researcher made the process of selection easier and quick, but on the other hand, it has the disadvantage of a possible informal attitude during the discussion. In our case, the statements seem to derive from rational thoughts of the participants that are supported by argumentation, thus we can claim that this limitation did not affect the quality[22] of the statements. Of course, a different set of participants in the focus groups of laypeople may have given different statements, but this is inevitable and the quality of the statements cannot be known in advance.

Therefore, from all the above we can claim that, besides the limitations that were presented above, the application of Q methodology for the identification and analysis of the opinion of the participants in our study regarding civil RPAS produced information-rich results, justifying the choice of this method as our research methodology.

Generally reflecting on Q methodology, I would like to mention that I was not familiar with this method before this research and that added a period of getting familiar with it both in theoretical level and practical (running the PQmethod). The method was time-consuming for the participants, thus the process of selecting P-set became a challenge. However, I was surprised by the freedom it gives to the participants to express their opinion and the interesting results. Through the use of this method, I increased my knowledge on quantitative analysis.

[22] With ''quality'' of statements, we mean the extent to which the statements cover the whole range of the possible viewpoints expressed by the participants.

As a personal reflection to the methodology I could say that the combination of qualitative and quantitative analysis is always a challenge for me and adds another exciting point; a way to analyze human mind and human subjectivity. I would definitely suggest this method to a researcher with a relevant objective. I finally want to mention that if I had to do this research from the beginning, I would choose this methodology again.

CHAPTER 9: CONCLUSIONS, RECOMMENDATIONS AND REFLECTION

This report is an exploratory study regarding SA of civil RPAS, providing insights about the issues under discussion regarding this emerging market, as well as a theoretical background regarding SA of a new technological project. Through this, we identified subjective, socially organized semantic patterns that will enhance the existing knowledge about the public opinion for the civil RPAS market.

9.1 CONCLUSIONS

The main research question of this research is:

What can we learn about social acceptance of RPAS while applying Q methodology, and what is it worth?

A number of sub-questions were defined, which were clustered in two categories:

- General research sub-questions
- Method- and outcome- related research sub-question

GENERAL RESEARCH SUB-QUESTIONS

1. WHAT IS SOCIAL ACCEPTANCE OF NEW TECHNOLOGIES?

In order to successfully analyze the issue of SA of civil RPAS, an introduction to the theoretical concept of SA of new technological projects is needed. The first research sub-question was answered in the first chapter of this report based on literature review as well as critical reflection by the researcher.

A conceptual model for SA of new technologies was drawn in Chapter 1 based on literature, presenting four not interdependent issues, on which we critically reflected in order to give the theoretical definition of SA of new technologies. Firstly, we consider SA as a broader range of opinions and views not only of experts and the policy community, but also laypeople that can be influenced by this technology. The application of this in our research provided a comparison between the opinions of experts and laypeople and revealed points of consensus and disagreement.

The second point has to do with the dynamic nature of the public, whose opinion may change and co-evolve along with the technology. Indeed, in our research, the conclusion showed three factors that adopt the viewpoints regarding civil RPAS. Nonetheless, these opinions rely on specific conditions and they may change after an alignment of expectations or, in our case, regulatory changes, larger awareness and/or safety improvements on the system.

Thirdly, the technocratic way of perceiving SA is rejected in order to broaden the theoretical horizons of the research and contribute towards a widely accepted conclusion. Our research was based on the assumption that the participants in the focus groups as well as the participants in

the Q-sorting could express their subjective opinion, on which no one can comment if they are right or wrong.

Finally, 'process successfulness' seems to be highly important in our research. The participants did not focus only on the usefulness of the civil RPAS applications, but more on the problematic issues like data protection, safety standards etc.

Moreover, the theory of frames was adopted to theoretically present SA and support the internal logic of the interpretation of the results. The concept of SA was used to form the frame of people's opinions and beliefs about civil RPAS. In simple words, framing is the way each of us understand all the information given from the environment and helps us form a certain opinion about an issue. The way of interpretation of the individual is closely related to SA and it helps people build their own mental filters according to their perception and culture.

To conclude, the usefulness of this chapter is dual; first, it provides theoretical insights on the issue of SA, which is significantly important during the development of every new technology and gives a better understanding of the theoretical issue under investigation. Secondly, it shows the theoretical and conceptual context of the way this report approaches the issue of SA that is analyzed after the application of the methodology. The main point that influences the rest of this report and is the issue that makes this approach interesting is the subjectivity of the beliefs and opinions of people. Beliefs and opinions can be based on facts and knowledge, so they can have an objective sense, but also on psychological issues, feelings, culture, social environment, religion etc.

2. WHAT IS SOCIAL ACCEPTANCE OF CIVILIAN RPAS?

After the conceptualization of SA and the presentation of the way we approach it in our research, a bridge between SA and civil RPAS is necessary. This bridge, which is based on literature review, is drawn in the second chapter, which answers the second research sub-question.

The overview of the research that has already been done in the field of civil applications of RPAS, which is presented in chapter 2, shows the area of conflict between the supporters of the development of the civil RPAS market and the opponents. A number of initiatives by a lot of stakeholders have been taken the last decade in Europe in order to reinforce cooperation among the industrial and the RPAS community representatives as well as the policy-makers of the EC.

The supporters of the wide utilization of civil RPAS mainly focus on the benefits that European citizens will enjoy, which are related to the variety of applications of RPAS presented in subchapter 2.3.1. On the other hand, SA of civil RPAS is also formed and influenced by the opinion of the opponents regarding sensitive issues that form a barrier in the development of the market of civil RPAS. Issues like infringement of privacy, liability and automation as well as technical safety of RPAS enhance a negative attitude towards civil RPAS. The opponents either totally reject the wide utilization of civil RPAS or highlight the importance of regulation in order to accept RPAS flying in the segregated airspace. It is also worth mentioning that SA of civil RPAS shows a significant influence by risk perception, which is in turn based on a number of criteria like voluntariness, familiarity, benefit awareness, level of automation, phobias etc.

3. USING Q METHODOLOGY, WHAT ARE THE CATEGORIES OF PEOPLE WITH THE SAME WAY OF THINKING REGARDING CIVIL RPAS?

In order to answer this question, Q methodology was applied and all the steps presented in Chapter 3 had been followed. This question can be approached giving answers to the following questions:

How can I get a set of people in order to form representative focus groups of experts and laypeople?

In order to have a first view on the public opinion on civil RPAS and to apply the first step of Q methodology, the verbal concourse is obtained by focus groups aiming at producing the statements (Q set) that will be sorted by the set of participants (P set). Given the facts that Q method needs a variety of points of view for the issue under study and not necessarily a huge number of participants, focus groups seem a suitable way to retrieve the list of the statements that will be used as the input to Q methodology. The only criterion for representativeness is the focus groups to be formed by laypeople, that is, people that are not familiar with the RPAS technology.

Through this method, we aim at eliciting people's understandings, opinions and views, and the exploration of how these are advanced, elaborated and negotiated in social context. The unstructured methodological strategy that the method of focus groups adds produces greater ranges of responses from the participants.

In order to increase this variety of the perspectives and ensure the validity of the concourse, focus groups with laypeople and focus groups with experts were conducted. Thirteen laypeople and eight experts expressed their opinion on civil RPAS and their applications. The laypeople were selected according to their availability and willingness to participate in the research. Moreover, we tried to form a group with four nationalities in order to increase reliability and diversity of perspectives. The only requirement for the participants of LP groups was this one; being laypeople and not knowing the subject. Regarding the experts, they are all working in the Aerospace vehicles division of NLR.

What are the statements that represent the different perceptions of the focus groups?
The final statements derived from the focus groups have been presented in Table 5 and they are the first overview of the public opinion on civil RPAS. The process of getting to these statements has been presented in Chapter 5.

How does a sorting of statements regarding civil RPAS look like?
In order to conduct the Q-sorting, the participants used an online tool, the FlashQ application. Chapter 6 presents the different steps that the participants should follow, with most important on the ranking of the statements of the Q-set in the given distribution. Through this, they are forced to compare the statements in order to rank them according to their preferences and subjective opinions. A Q-sorting of a participant is the following[23]:

[23] The numbers in the boxes represent the number of each statement.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
24	52	10	60	14	59	47	37	48	64	70
15	71	22	67	63	6	57	61	12	51	21
42	8	40	7	18	65	30	31	32	36	66
56	5	13	43	16	41	34	68	23	44	69
	3	58	17	38	54	50	33	20	19	
		11	26	28	29	55	62	9		
			4	53	2	49	45			
				1	27	25				
					46					
					35					
					39					

FIGURE 23: A Q-SORT

Can we find categories of people with the same way of thinking regarding civil RPAS?
As described in chapter 7, the analysis of the Q-sorts of the participants revealed three factors, that is, thee different perspectives that are shared by the participants that load on the same factor.

The general conclusion to be drawn is the conditional acceptance of this new technology, as all of the factors recognized the benefits of the civil RPAS applications for society, other in emergencies (1st factor), and other in different fields (2nd and 3rd factor). However, the conditions that should be met are highly important for them and influence the level of SA of civil RPAS, as all factors commented.

More specifically:

Factor 1

The first factor explains the 24% of the total variance and consists of 10 people, both laypeople and experts. The core belief in this factor is the privacy concerns bonded with a general trust to safety. The respondents that hold this perspective generally support the wide utilization of civil RPAS in Europe for emergencies and applications that manned aircraft are unable to perform. They are convinced that civil RPAS market will boom in the near future, but they worry about their privacy rights. Moreover, there is much agreement on the acceptance of the safety standards that already exist and the trust on automation, both in manned and unmanned aviation.

The statement that ranked first in this factor (''RPAS are useful only for emergencies.'' (58)) supports the need for an increasing use of RPAS for emergency cases, while it implies that there are secondary issues to be taken care of. A close look at them shows that the participants that load on the first factor doubt about the motives of the developers of the civil RPAS market. They strongly agree that the citizens are concerned more about the privacy issues than the safety ones.

Moreover, they do not seem to worry a lot about knowing the operators of the civil RPAS (38), emphasizing on the need for transparency for the objective of civil RPAS utilization, possible accidents etc. The respondents that load on the first factor do not share strong safety concerns showing an attitude of risk acceptance. They generally trust automation pointing out that ''most of the accidents are caused due to human factors'' (4).

Regarding the public opinion on RPAS, although the first factor expresses a minor concern about technical safety of the system and safety of the people on the ground, there is a strong belief that

civil RPAS will be socially accepted at last (34) but not easily due to privacy and mostly wrong safety concerns.

Factor 2

The second factor explains the 17% of the total variance and consists of 5 people, only laypeople. The attitude of this factor's respondents towards the civil RPAS market is positive as they strongly agree on the usefulness of RPAS applications (53). However, besides engineering aspects like the level of safety of the system, this factor emphasizes on the possible low SA of RPAS due to regulation and privacy issues that may arise as well as the trust of the authorities. They attribute central role to the knowledge of the regulation in order to judge if they are willing to give away part of their privacy, as they believe that RPAS market will be mainly developed for surveillance and data collection.

The core perception of this factor is that ''safety and regulation issues will be a stalemate in the development of the civil RPAS market in Europe'' (10). However, the participants themselves have a positive attitude towards the development of the civil RPAS market if the safety and regulatory requirements are met. It is clear that the participants who hold this perspective support RPAS applications but at the same time they show a reluctant attitude for civil RPAS regarding privacy and regulatory issues. They seem not to trust the authorities. They are more concerned about safety issues than the first factor. The comparison between manned and unmanned vehicles shows that the respondents that load on this factor believe that people should technologically trust RPAS as they trust commercial aircraft (7). The participants that adopt this factor's perspectives believe that RPAS is an innovative (68) and promising technology about which it is time to discuss (47).

Factor 3

The third factor explains the 10% of the total variance and consists of 5 people, both laypeople experts. The core characteristic of this factor is its high support of civil RPAS applications, while expressing the need for further development of the regulatory regime in order to safeguard privacy. The level of safety is also significant among the respondents that load on this factor, who believe in the continuous improvement of technical safety.

The support of this factor's respondents on civil RPAS is expressed by describing them as ''a perfect alternative for places where manned aircraft cannot go'' (70). They claim that they could fly with an RPA or an UA (41), which shows high risk acceptance without having any psychological issue towards flying without a pilot onboard. Regarding the safety issues, they strongly agree that RPAS are generally safe for the people on the ground. Nonetheless, this factor focuses on the continuous work on improving the safety characteristics of RPAS, as the long history of remotely-piloted flights does not mean that safety of RPAS is an issue that has been solved (5).

They attribute great importance to issues related to **SA** of civil RPAS. There is a strong agreement on the very low level of social awareness regarding the current regulatory regime in civil RPAS market (16). Furthermore there is not much information available to the public and therefore I think hardly anybody knows anything about the current regulation.''

Moreover, an analysis of the consensus statements and areas of conflict among the factors was presented as well as statements that showed a disagreement between experts and laypeople. All factors identify safety as a substantial issue that should be never overseen. Technical estimates of safety highly influence risk perception and thus are crucial for the level of SA of civil RPAS. the theory that risk acceptance relies on the subjective assessment between society's perception of the level of exposure to the hazard and society's perception of the benefits due to the hazardous

activity is accepted by a number of participants in our research. They showed a tendency to increase the level of their individual risk acceptance, because of the substantial societal benefits from civil RPAS applications.

Regarding the experts' viewpoint on risk and safety, they strongly express an attitude of improvement on safety characteristics. This comes in contrary to the theoretical viewpoint of experts that tend to perceive risks within their competence area lower than the public, as mentioned in Chapter 2.

Finally, the added value of the Q methodology in the investigation of social acceptance has been presented in chapter 3, in which the requirements that had to be met by the methodological tool that we would use in our research and an elaboration on the choice of Q methodology are presented, as well as in chapter 8, in which a number of limitations of the method are identified and the extent to which these limitations affected the results is presented.

More specifically, regarding the selection of the method, the main requirement of our methodological tool is the extent to which it can ''map the public''. Q methodology can be used to explore and understand the public opinion about civil RPAS as it is a quantitative tool that identifies shared frames and perceptions among the citizens while trying to understand their characteristics. It can answer questions of ''how'' and ''why'' people have a certain perception towards a particular discourse, which makes it a proper method for our research.

Q methodology proved to be an interesting tool from the researcher's point of view in order to reveal and analyze the different viewpoints of the subset of the public that participated in our research regarding the civil RPAS market. Recommendations on how to use the knowledge gained are presented in the subchapter 9.2.

MAIN RESEARCH QUESTION

What can we learn about social acceptance of RPAS while applying Q methodology, and what is it worth?

SA of civil RPAS is a very interesting topic that has not been studied yet in the academic world. It produced a wide range of results in terms of issues under discussion about civil RPAS. A lot of different opinions were revealed and different levels of importance were paid to different issues. Some of the participants for example attributed great importance to technical safety and its improvement, while others valued the potential infringement of privacy more. Human subjectivity appeared in a number of statements, in which the participants expressed their own opinion.

After the interpretation of the subjective viewpoints of the factors and an analysis on their consensus and disagreement statements, we got insights on different categories of people that are differentiated according to their perspective on civil RPAS.

The general conclusion to be drawn is the conditional acceptance of this new technology, as all of the factors recognized the benefits of the civil RPAS applications for society. However, the conditions that should be met are highly important for them and thus for SA of civil RPAS.

In all perspectives, protection of the privacy rights seems to be critical, as well as the trust to the authorities. This characteristic seems to be highly related to the level of transparency during this

process. Moreover, all factors identify safety as a substantial issue that should be never overseen. There is tendency to increase the level of their individual risk acceptance, because of the substantial societal benefits from civil RPAS applications. An attitude of improvement on safety characteristics was strongly expressed.

Consensus has also been drawn regarding phobias and psychological issues. All of the factors identified in this research did not show any psychological issue or phobia that would affect the level of the acceptance of civil RPAS. However, we observed that people tend to perceive risk differently if they are on the ground than in the air, attributing a different level of risk acceptance on autonomous vehicles on the ground and in the air.

Although that there is a general positive attitude towards civil RPAS if the conditions that discussed before are met, some participants holds a pessimistic attitude towards the level of SA of civil RPAS believing that safety and regulation will be a stalemate in the development of the market.

All the above general conclusions have been drawn in a specific context; by applying Q methodology. The methodology seems to be a new approach to solving problems in the intersection of social sciences and engineering. There are not only tools like surveys that can measure the public opinion. A qualitative approach like Q method can give another viewpoint to the interested parties (in our case RPAS community) in order to get insights and better understanding of the issue under investigation.

9.2 HOW TO USE THE KNOWLEDGE GAINED AND RECOMMENDATIONS

In this chapter, the scientific and practical usefulness of the results will be explained in order to identify the potential usability of the results and Q methodology for the RPAS community. Some recommendations will also be provided.

First of all, we can support that this study contributes to the literature review in a topic that is highly new and hardly any publication has been made. It can give insights with the experience and the results in a field with a knowledge gap in information which is mainly presented in conferences of the international RPAS community. This report provides information on the issues under discussion among citizens regarding civil RPAS.

This research also provides a theoretical representation of SA in Chapter 1, a definition of which can be used to conceptualize the problem of the civil RPAS market development in Europe. As the theoretical topic is SA, a recommendation to the RPAS sector could be a clear definition of SA for RPAS, with specific goals and tools that can be used to achieve the objective of a successful civil RPAS market in Europe. This definition should be communicated within the RPAS community and start a dialogue on improving it into a widely accepted one.

As derived from the definition provided in Chapter 1, the stakeholders from the RPAS community in our case should take into account SA in order to take into account the opinion of the public and adjust their concepts of operation and maybe technology used and not spend their time trying to convince the public that they have the ultimate solution.

Furthermore, before the application of Q methodology takes place and the analysis reveals the viewpoints of the participants, it is considered important to provide a general overview of the issues under discussion in the civil RPAS market. Therefore, the opposing viewpoints were

presented, the privacy and regulatory issues were identified and risk perception was theoretically approached. Finally, the technical estimates of risk of RPAS as well as a safety regulatory framework that is currently under discussion was presented. In this way, a smooth transition to the analysis of the values under consideration can be achieved after presenting the theoretical background.

Moreover, concerning Figure 5 (and 6) that represents a cognitive map of the current situation in the civil RPAS world at a European level, the issues under investigation in this study (*Societal dimensions of UAS*, *Industry and market issues* and *Safety of UAS*) are all interrelated. This interrelation can be made more explicit adding more issues to the arrow from *Societal dimensions of UAS* to *Industry and market issues.* The current *Acceptability issues that can limit the UAS benefits* can be rewritten as *Limitations to be overcome: privacy and transparency*. Moreover, the improvement of the technical safety level can be added to the arrow from *Societal dimensions of UAS* to *Safety of UAS.* The contribution of this report to the existing knowledge in the field of the topics under discussion regarding civil RPAS have been presented, in a nutshell, in subchapter 5.2 and more in depth in Chapter 7.

Regarding the method that was used, the evaluation of Q methodology and the results showed a significant amount of information that can be used to get insights on what is discussed regarding civil RPAS as well as a first comparison between the experts' and laypeople viewpoints. Moreover, in general Q methodology is a tool that can be used in the process of a policy discourse in which collaboration of interested parties is needed as well as deep knowledge and understanding of the issue. A critical reflection on the rationality behind the viewpoints expressed can be supported (Raadgever et al, 2008) and the stimulation of a constructive conflict can emerge (Cuppen, 2012), which is necessary for achieving a mutual understanding between the parties (Pahl-Wostl and Hare, 2004; Ridder et al., 2005).

Following to that, a recommendation to the RPAS community could be the method itself; the method provides a new approach to solving issues of social sciences and engineering. Additionally to surveys and questionnaires, public opinion can be measured by Q methodology. A qualitative approach like Q method can give another viewpoint to the RPAS community in order to get insights and better understanding of the issue under investigation.

Moreover, it is recommended that a dialogue among the policy makers, RPAS manufacturers and operators and the public is structured, which can have certain reference/starting points. With the involvement of different stakeholders (in our case the public), the decision making process can be facilitated in issues that have polarized stakeholders' groups. Especially in a new field like the civil RPAS market, all the above can be applied for the RPAS community while developing the regulation regime for the civil RPAS market in Europe, during which opposing public opinions may appear.

The RPAS community can use the factors that are identified and that represent different perspectives regarding civil RPAS as well as areas of consensus and disagreement. After identifying these areas, the underlying values can be found as well as the extent to which people consider them important or not. In our research, technical safety, privacy, trust of the operator and regulation are some of the values that the factors included in the discourse and attribute significant importance to one of them or a combination of them. These values can be included in the research agenda of the next policy discourse in a conference or a meeting among the interested parties and the stakeholders of the civil RPAS market in Europe. As we have seen, most of these issues are already taken into consideration, thus the results can be used to confirm their emergent character, but the importance that people attribute to each of the issues under discussion is an area that this research contributes.

The shared perspectives and the resulted values can be used in order to raise awareness among the factors and the RPAS community or citizens in general. By providing the participants a set of statements, they may encounter some of them for the first time as they may have not considered them in the first place. It is highly possible that the participants were surprised by some statements and opinions, which made them more aware about the issues related to SA of civil RPAS. In addition to this, awareness can be enhanced between the two groups of participants, laypeople and experts. The experts may be interested in analyzing the viewpoints of the laypeople and the conflicting opinions they have as the majority of the citizens consists of people with no technical knowledge of aviation and RPAS specifically. However, they influence the level of SA therefore their opinions should be understood and taken into consideration.

As discussed in Chapter 1 in which the theoretical definition of SA has been presented, SA is a mutual alignment of RPAS industry and stakeholders' opinions that result to a socially constructed process. This process can be facilitated by the knowledge of the areas of consensus and disagreement regarding civil RPAS. Then a participatory policy can be introduced by the interested parties in order to identify controversies and come to a mutually accepted solution. In our case, we can see that factor 1 and factor 3 do not agree on the current level of technical safety of civil RPAS or the extent to which a roadmap is needed, thus it is clear that the public has a divergent opinion on the sensitive issue of technical safety.

The way people anticipate the future of the civil RPAS market (some believe that RPAS market will boom, others that it will not be developed at all due to the opposition of the citizens) can be used in order to identify the public viewpoint and form scenarios. For example, factor 1 believes that the market will boom and people will finally accept civil RPAS, while factor 2 strongly supports the idea that the low SA of this new technological project will be a stalemate in the development of the market. Knowing the way people anticipate the future of the civil RPAS market can add to the experience of interested parties in the RPAS community and is highly connected to the raised awareness on what people think of the future regarding civil RPAS. The RPAS community, should be ready for all the possible 'futures'; based on the scenarios, specific actions could be prepared in case of, for example, an accident with a number of death casualties that may cause public rage towards RPAS.

More specifically, the results of the analysis showed some remarkable characteristics. For example, it is widely acceptable that some people have phobias for aircraft and especially automated technology. In our research, only few laypeople rejected the idea of travelling with UA due to psychological issues regarding aviation. The ones that refused attributed their opinion to low awareness of the level and reliability of technical safety, which they significantly connected to risk acceptance. In addition to this, the participants seem to accept civil RPAS under the condition of safeguarding privacy rights.

The extent to which the participants trust the authorities is also a significant issue that can be considered while discussing possible solutions to problems that may arise. The reluctant attitude of most of the participants (factor 1 and 2) towards the operators and the authorities in the development of the civil RPAS market should initiate a transparent and clear information flow towards the public for the objectives of the development of this market in order to clarify sensitive issues like privacy. The RPAS community should inform the public when accomplishing different steps in the process of the development of the market.

The most important conclusion that entails a recommendation to the RPAS community has to do with the high concern of the citizens with privacy issues, thus a regulatory framework should be developed before the wide utilization of civil RPAS. People should be aware of their benefits as well as the technical characteristics of RPAS and a roadmap presented in the public through a campaign could be a way to achieve it. They could also present the public the measures that have been taken to prevent situation of flying spies with, for example, developing a centralized data

storage system which will be under the umbrella of governmental authorities and only specific people will have access to.

Thus, we can claim that this research is an interesting stepping stone to a better understanding of the current situation regarding SA of civil RPAS. It also shows to all the relevant parties how perspectives can be measured and analyzed in order to deal with complex issues that need a socially accepted solution. This report aimed at answering the question: ''what is currently being said about civil RPAS?'' in a stimulating way that will initiate further research on this topic with a deeper analysis or different methodological approach.

9.2.1 FURTHER RESEARCH

The results that this research has provided can be used as a basis for further studies in the field of SA of civil RPAS in order to further identify the market characteristics and their interrelations, as they are shown in the cognitive map of Figure 5. As the topic of public opinion is very broad, a different P-set that will be formed by citizens of other European countries as well as older people could be used in the Q methodology to enhance the knowledge on this topic and identify the public viewpoints within countries with a different cultural context.

During the Q-sorting, as it is mentioned in subchapter 6.2, information such as demographics (age, gender and nationality) can be used in a further research to compare the level of SA of civil RPAS according to these characteristics. The participants also indicated the level of understanding on how civil RPAS are used today, which can be used with a combination of relevant statements to support that they have high level of technical knowledge on civil RPAS or prove that they have a wrong perception about it.

A future study could also focus on the subjectivity regarding civil RPAS based on cultural issues. Opinions are formed not only due to facts and knowledge on the specific issue, but also due to cultural influence, thus a study using a sample from different cultures in Europe, for example South vs North, could show potential similarities and opposing opinions in the way of perceiving civil RPAS benefits and risks.

Furthermore, the number of statements in each pile of the first step of Q-sorting could be used to check for agreement-disagreement balance in the Q set in a deeper analysis of the opinions of the participants.

Finally, society's attitude towards the use of RPAS can also be explored by a comparison and deep research on other unmanned vehicles (like metros, trains, and cars) and the way the public perceive them, using the same or a different methodology. The difference in risk perception among the different levels of automation is also an interesting field of study.

9.3 REFLECTION: WHAT SHOULD I DO DIFFERENTLY IN THE PROJECT?

Taking into consideration that the reflection on the methodology that has been used was already provided in chapter 8, in this final chapter, we give the reflection on the process that was followed during our research.

The research question and sub-questions are an important part that I would like to address on the reflection of the process. At the beginning, there was a difficulty in formulating the research question, having to balance between an academic and a more practical report. My decision was an academic report taking into account the need for a practical approach to a study with a very theoretical concept. At last, although it is quite wage and open and taking into account my engineering background, if I had to formulate the research question again, I would not change it. I believe that it is as broad as it should, as this report focuses on a topic which is very broad itself and in the intersection of social and engineering studies.

The idea behind the structure of this report comes from the creation of a logical storyline that aims at providing the reader with useful and interesting information. The reasoning starts from the theoretical concept of SA and the second chapter bridges it with the specific topic, which is in our case the civil RPAS.

The literature review on SA of new technologies showed quite poor results, but we tried to draw the definition of SA of our study after a reflection on literature. Before bridging SA and civil RPAS though, we had to provide a background on the civil RPAS market, the current situation and the problem description, that revealed two polarized viewpoints. Moreover, risk perception was the theoretical bridge between safety and SA of civil RPAS. After the application of Q methodology, the conclusions address the interesting points of this research and a connection to the theoretical first chapters merges the different parts of the report, from theory to practice. The logic of the process is focusing, then applying and then defocusing. It makes the understanding of the results easier and it helps the readers to think in a broader way about the issue of the civil RPAS market.

Regarding the literature review of Chapter 2, the most relevant issues under consideration were articles on theoretical level, websites and papers that have not been published yet and they are part of the roadmap for the civil RPAS market. Through these, a deeper understanding of the problem and the current situation regarding the civil RPAS market occurs, as I believe I provided the reader with interesting and significant information in order to understand the problem in a more theoretical sense. Moreover, through this process I enhanced my knowledge on data collection and summarizing the most important points from a substantial amount of information.

Reflecting on the first steps of the methodology, my friends helped me to conduct the focus groups, which was not easy as people were not available and they were reluctant mainly because of the lack of knowledge on civil RPAS. If I had to do the research again, I would have tried to approach laypeople that were not my friends in order to enhance the heterogeneity of the results. It would have been interesting to go to a social science faculty, for example a faculty in Leiden or University of Amsterdam, aiming at approaching students or professors from a different backgrounds.

The focus groups of experts were a very time consuming process with waiting for more than two months for their meeting. However, I cannot claim that I could do something different if I had to do the research again, as it was dependent on external factors and their availability.

It is worth mentioning that one of the lessons I learned, on which I would focus if I had to do the research again, was the lack of theoretical representation in most of the statements. The statements were opinions of the participants in the focus groups, sometimes expressed with the same words. I believe that a reference to the underline value, for example regarding perceived risk or heuristics, would have made the statements clearer for the P-set and the interpretation of the results more accurate. This could also derive from the focus groups. I could structure the discussion with specific answers in a more theoretical level, so the respondents' statements would have a theoretical sense. This could also help in the focus and defocus of the conversation in the focus groups.

Regarding the Q-sorting procedure, I chose to use an online tool instead of the traditional and maybe old-fashioned card procedure and I think this choice was very successful. Although it took me some time to adapt the application to my topic, I believe it made the Q-sorting more interesting for the participants, who have never seen this application before.

Furthermore, after the analysis of the results, I had to choose on whether I should provide the factors with a name. I decided not to give them a name for two reasons: first to avoid researcher's bias (the reader should be left free to proceed to the detailed characteristics of the factors and not be preoccupied with a specific name) and second, due to the fact that in order to distinguish each factor from the others, a very long name should be given to each factor, using phrases that would add the importance each factor attributes to a specific characteristic. This is caused by the fact that the factors may address the same issues, like technical safety, privacy etc, but they attribute different importance to them and this is the main distinguishable point that the name should have addressed.

The overall reflection on the research is definitely positive and I hope that I have contributed to an emerging issue that will be high in the European agenda the coming years. I was really enthusiastic by the topic of my research and its relevance my engineering background as well as to TPM. This research shows the applicability of the knowledge gained in MSc Engineering and Policy Analysis in real world problems.

Mostly, I would say that my enthusiasm derives from the engagement with a new field; the analysis of human subjectivity through Q methodology. This has clearly contributed to my multi-disciplinary character and a broader way of thinking, giving me new theoretical lenses for understanding and looking at the world.

REFERENCES

AIA (2013). New poll data for Civil RPAS. URL: http://www.uasvision.com/2013/06/24/aia-poll-demonstrates-popular-support-for-civil-unmanned-aircraft-systems/?utm_source=Newsletter&utm_medium=email&utm_campaign=0588824233-RSS_EMAIL_CAMPAIGN&utm_term=0_799756aeb7-0588824233-297544953

Akhtar-Danesh, N., Baumann, A., & Cordingley, L. (2008). Q methodology in Nursing Research A Promising Method for the Study of Subjectivity. *Western Journal of Nursing Research*, *30*(6), 759-773.

Alongi, F. (2011). Remotely Piloted Aircraft. *European Commission Working Panel on UAS.* Brussels: European Commission.

Assefa, G., & Frostell, B. (2007). Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technology in Society*, *29*(1), 63-78.

Barry, J., & Proops, J. (1999). Seeking sustainability discourses with Q methodology. *Ecological Economics*, *28*(3), 337-345.

Blyenburgh, P. v. (2011). *European Commission UAS Panel, UAS INDUSTRY & MARKET ISSUES .* UVS International, The Netherlands .

Blyenburgh, P. v. (2012). *The European Commission's RPAS Initiative.* The European Commission's RPAS Initiative.

Böhm, A. (2011). Demarcation between national. *EU UAS Panel – 3rd Workshop.* Brussels: European Commission.

Brohmann, B., Feenstra, Y., Heiskanen, E., Hodson, M., Mourik, R., & Prasad, G. (2007). Factors influencing the societal acceptance of new, renewable and energy efficiency technologies: Meta-analysis of recent European projects.*European Roundtable for Sustainable Consumption and Production*.

Brouwer, M. (1999). Q is accounting for tastes. Journal of Advertising Research; 39(2): 35-39

Brown, S. R. (1980). *Political subjectivity: Applications of Q methodologyin political science* (pp. 239-247). New Haven, CT: Yale University Press.

Brown, SR. (1986). Q technique and method: Principles and procedures. In: Berry WD, Lewis-Beck MS (eds). New tools for social scientists. Beverly Hills: Sage Publications.

Brown, SR. (1993). A primer on Q methodology. Operant Subjectivity;16(3/4): 91-138

Brown, SR. (2002[a]). Q technique and questionnaires. Operant Subjectivity 26(2): 117-126

Calvo, J. A. (2011). Safe UAS operations. *2011 ASD Annual Convention.* Brussels: European Commission.

Cavoukian A. (2012). Privacy and Drones: Unmanned Aerial Vehicles. URL: http://www.ipc.on.ca/images/Resources/pbd-drones.pdf

Child, D. (1990). *The essentials of factor analysis* . Cassell Educational.

Creswell, J. (2003). Quantitative and Mixed Methods Approaches. SAGE

Cuppen, E. (2012). Diversity and constructive conflict in stakeholder dialogue: considerations for design and methods. *Policy Sciences*, *45*(1), 23-46.

Curt, B. C. (1994). *Textuality and tectonics: Troubling social and psychological science*. Open University Press.

EC (2012). *Towards a European strategy.* Brussels: EUROPEAN COMMISSION.

Denzin, N. K. and Lincoln, Y. S. (2000). Handbook of qualitative research, 2nd Ed., Sage, Thousand Oaks,.

DG MOVE, 2012. The European Commission initiatives. URL: http://ec.europa.eu/transport/modes/air/uas_en.htm)

Duquerroy, R. R. (2011). ESA (D-TIA) activities on Unmanned Aircraft Systems (UAS). *UAS workshop.* Brussels : European Commission.

EASA (2010). Airworthiness aspects of UAS – Preliminary Regulatory Impact Assessment, MDM.030, TE.RMP.00037-002, Version 0.1

EASA (2012). Unmanned Aircraft Systems (UAS) and Remotely Piloted Aircraft Systems (RPAS). URL: https://www.easa.europa.eu/rulemaking/Unmanned-Aircraft-Systems-(UAS)-and-Remotely-Piloted-Aircraft-Systems-(RPAS).php

EASA (2013). Unmanned Aircraft Systems (UAS) and Remotely Piloted Aircraft Systems (RPAS). URL: http://www.easa.europa.eu/rulemaking/Unmanned-Aircraft-Systems-(UAS)-and-Remotely-Piloted-Aircraft-Systems-(RPAS).php

EC. (2009). *HEARING ON LIGHT UNMANNED AIRCRAFT SYSTEMS (UAS).* Brussels: EUROPEAN COMMISSION.

EC Enterprise and Industry 2012). European RPAS Roadmap. URL: http://ec.europa.eu/enterprise/sectors/aerospace/uas/index_en.htm

Eden, C. (1988). Cognitive mapping: A review, Eur. J. Oper. Res., 36, 1–13

ERSG (2013). Roadmap for Complementary Measures on RPAS. 3 January 2013 – Version 05. Doc name: WG3 roadmap Version 05 - 3 JAN 2013 doc

EUROCONTROL(2008).UAS ATM Integration Activity.

European Commission, D. M. (2010). Conclusions of the first European High Level Conference . *European High Level Conference* (p. 3). Brussels: DG Mobility and Transport, the European Defense Agency.

Eeten, M. v. (1998). Dialogues of the Deaf: Defining New Agendas for Environmental Deadlocks. Delft: Eburon.

Evans, J. S. T. (1988). The knowledge elicitation problem - a psychological perspective, Behav. Inform. Technol., 7, 111–130,

Exel, N. v., & Graaf, G. d. (2005). *Q methodology: A sneak preview.* [available from www.jobvanexel.nl].

Fischer, G. (2001). External and shareable artifacts as opportunities for social creativity in communities of interest. In *UNIVERSITY OF SYDNEY*.

Finmeccanica (2011). EC UAS Panel, Finmeccanica White Paper contribution to Workshop 3: UAS Safety and Certification.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.

González, P. (2011). UAS technology and applications for the . *UAS Panel 4 Workshop .* Brussels: European Commission.

Green, D. (1999). Cross-Cultural Transfer of Sustainable Energy Systems: A Critical Analysis. Renewable Energy 16: 1133-1137.

Hodson, M., Marvin, S., and Simpson, V., (2006), 'A Five Step Framework for Researching and Analysing the "Success" of Renewable Energy Initiatives', Working Paper 9, SURF, December.

Horlick-Jones, T., Walls, J., Rowe, G., Pidgeon, N., Poortinga, W., Murdock, G., & O'Riordan, T. (2007). *The GM debate: Risk, politics and public engagement*. Routledge.

ICAO. (1944). *Convention on international civil aviation.* international civil aviation organization .

ICAO (2011); Unmanned Aircraft Systems (UAS), Circular 328-AN/190, ISBN 978-92-9231-751-5.

Kalinowski, N. (2010), FAA Vice President for System Operations Services; Statement on the Role of Unmanned Aerial Systems on Border Security.

Kershaw, D. P. (2011). Responsibility and Liability For UAS. *UAS Panel 4th Workshop.* Brussels: European Commission.

Kline, P. (1993). An easy guide to factor analysis.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., & Combs, B. (1978). Judged frequency of lethal events. Journal of experimental psychology: Human learning and memory, 4(6), 551.

Fishbein M. and Ajzen I. (1975), Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research.

Fischhoff , B., Slovic P., and Lichtenstein S., (1982). Lay Foibles and Expert Fables in Judgments about Risk, American Statistician 36, 240–255.

Malloy, D. (2011). Modeling the Life Cycle Cost Impact of Product Development Decisions. *Systems Dynamics Society .*

McNaught, A., & Howard, C. (2001). Q methodology: Pragmatic considerations and epistemological concerns. *Health Psychology Update*, *10*, 24-28.

McKeown, B. & Thomas, D. (1988). *Q methodology(Quantitative Applications in the Social Sciences series, Vol. 66).* Newbury Park, CA: Sage Publications.

Mas, C. (2011). Rulemaking of very. *Direction de la sécurité de l'aviation .* Brussels: European Commission.

NATO (2007). UAV Systems Airworthiness Requirements (USAR), STANAG 4671.

NATO(2008). Sense and Avoid Requirements for Unmanned Aerial Vehicle Systems operating in non-segregated Airspace.

Netherlands Information Service, (2012) Dutch Drones Fall Out of the Sky. URL: http://www.defense-aerospace.com/article-view/release/147865/dutch-army-grounds-raven-drones-after-crashes.html?goback=%2Egde_941207_member_273196521#%21

Oppenheim, A.N. (1992). Questionnaire Design, Interviewing and Attitude Measurement. Continuum, London.

Ozuncer, A. A.D. Ozuncer, L.J.P. Speijker, J.A.A.M. Stoop, R. Curran (2011). Development of a safety assessment methodology for the risk of collision of a Unmanned Aircraft System with the ground, NLR-TP-2011-325.

Pagallo, U. (2011). Societal Impacts of UAS. *4th EC UAS Panel Workshop.* European Commission.

Pahl-Wostl, C. and Hare, M. (2004). Processes of social learning in integrated resources management, J. Community Appl. Soc., 14, 193–206,

Persie, M. v., & Oostdijk, A. (2012). *Real-Time UAV based geospatial video integrated into the Fire Brigades crisis management GIS system.* Amsterdam: National Aerospace Laboratory NLR.

Raadgever, G. T., Mostert, E., & Giesen, N. C. (2008). Identification of stakeholder perspectives on future flood management in the Rhine basin using Q methodology. *Hydrology and earth system sciences*, *12*(4), 1097-1109.

Reichert, O. (2011). UAS Airworthiness . *UAS Panel 3rd Workshop on Safety aspects.* Brussels: European Commission.

Ricci, M., Bellaby, P., & Flynn, R. (2008). What do we know about public perceptions and acceptance of hydrogen? A critical review and new case study evidence. *International Journal of Hydrogen Energy*, *33*(21), 5868-5880.

Ridder, D., Mostert, E., Wolters, H. A., Cernesson, F., Echavarren, J. M., Enserink, B., Kranz, N., Maestu, J., Maurel, P., Otter, H., Patel, M., Schlussmeier, B., Tabar´a, D., and Taillieu, T. (2005). Learning together to manage together – Improving participation in water management, Druckhaus Bergmann, Osnabruck,.

Roma, A. (2012). REMOTELY PILOTED AIRCRAFT PRIVACY AND DATA PROTECTION PROVISIONS, A EUROPEAN PESPECTIVE, not published yet.

Rogers, W. S. (1991). *Explaining health and illness: An exploration of diversity*. Hemel Hempstead: Harvester Wheatsheaf..

Roma, A. (2011). How to protect society from very small UAS. *EU UAS Panel .* Brussels: European Commission.

Roma, A. (2011). The societal impact of UAS. *4th EC UAS Panel Workshop.* Brussels: European Commission.

RPAS CivOps (2012). Current European Context and Conference Objectives. ULTRA doc 0_RPAS-Aerial-Work_Current-Euro-Context_120820_B

Raadgever, G. T., and Becker, G. (2008). Exploring future flood management: A comparison of scenarios from literature and stakeholder perspectives, in: Managing Flood Risk, Reliability and Vulnerability (Proceedings of the 4th International Symposium on Flood Defence), edited by: Simonovic, S. P., Bourget, P. G., and Blanchard, S. F., ICLR, Toronto, 95, 1–9.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J. & Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of environmental management*, *90*(5), 1933-1949.

Robbins, P., & Krueger, R. (2000). Beyond bias? The promise and limits of Q method in human geography. *The Professional Geographer*, *52*(4), 636-648.

Rosenberg, A. S. (2009). An evaluation of a UAV guidance system with consumer grade GPS receivers. Ph.D. dissertation, University of Arizona. Online: http://www.casa.arizona.edu/data/abigail/Abigail_Rosenberg_

Rugg, G. and McGeorge, P. (1997). The sorting techniques: A tutorial paper on card sorts, picture sorts and item sorts, Expert Syst., 14, 80–93,.

SESAR Roadmap (2012). R&D Roadmap *for RPAS integration into non-segregated airspace and ATM environments.*

Schmolck, P., & Atkinson, J. (2002). PQMethod (version 2.11). *Computer Software]. Available from: http://www. qmethod. org/Tutorials/pqmethod. htm*.

Schön, D. A., & Rein, M. (1995). *Frame reflection: Toward the resolution of intractable policy controversies*. Basic Books.

Sjöberg L. and Biel A. (1983). Mood and Belief–Value correlation, Acta Psychologica 53, 253–270.

Sjöberg L. and Montgomery H. (1999), "Double Denial in Attitude Formation," Journal of Applied Social Psychology 29, 606–621.

Smith, NW. (2001). Current systems in psychology: history, theory, research, and applications. Wadsworth.

Speijker, L. (2011). FRAMEWORK FOR UNMANNED AIRCRAFT SYSTEMS SAFETY RISK MANAGEMENT. NLR.

Stainton Rogers, R. (1995). Q methodology. *Rethinking methods in psychology*, 178-192.

Starr C. (1969). Social Benefit versus Technological Risk, *Science* **165**, 1232–1238

Stenner, P. H., Cooper, D., & Skevington, S. M. (2003). Putting the Q into quality of life; the identification of subjective constructions of health-related quality of life using Q methodology. *Social science & medicine*, *57*(11), 2161-2172.

Stricklin, M., & Almeida, R. (1999). PCQSoftware Manual.

Sturgis, P., & Allum, N. (2004). Science in society: re-evaluating the deficit model of public attitudes. *Public understanding of science*, *13*(1), 55-74.

Thompson C. P. and Mingay D. (1991). Estimating the Frequency of Everyday Events, Applied Cognitive Psychology 5, 497–510

Tomasello, F. (2011). Which rules for UAS OPS? *UAS Workshop.* Brussels: European Commission.

UAS-Vision (2013). Boston Police Chief Considers UAS for Next Marathon – URL: http://www.uasvision.com/2013/04/29/boston-police-chief-considers-uas-for-next-marathon/#sthash.8Ca3tgwk.dpuf

UAVS (2013). UAV or UAS? URL: http://www.uavs.org/index.php?page=what_is

UVS-info (2012). Survey CivOps (2012 and ongoing). URL: http://www.uvs-info.com/index.php?option=com_phocadownload&view=category&id=139:survey-luas-civops-2012-ongoing&Itemid=426)

ULTRA (2013). Safety aspects of civil UAS operations. Document ID: ULTRA-WP3-NLR-D3.1-CO

Valenta, A. L., & Wigger, U. (1997). Q methodology: definition and application in health care informatics. *Journal of the American Medical Informatics Association*, *4*(6), 501-510.

Venables, D., Pidgeon, N., Simmons, P., Henwood, K., & Parkhill, K. (2009). Living with Nuclear Power: AQ-Method Study of Local Community Perceptions.*Risk Analysis*, *29*(8), 1089-1104.

Venema, Jan Cees (2013). Multi-UAS testbed proves usefulness. URL: http://wp.nlr.nl/en/2013/07/29/multi-uas-testbed-bewijst-nut/

Verhaegen, B. (2011). Societal Impacts on UAS, ICAO perspectives on SAFETY of UAS. European Commission.

Watts, S., & Stenner, P. (2005). Doing Q methodology: theory, method and interpretation. *Qualitative Research in Psychology*, *2*(1), 67-91.

Webler, T., Danielson, S., & Tuler, S. (2009). Using Q method to reveal social perspectives in environmental research. *Greenfield, MA: Social and Environmental Research Institute*.

Weibel, R. E., & Hansman, J. J. (2005). *An Integrated Approach to Evaluating Risk Mitigation Measures for UAV Operational Concepts in the NAS.* Arlington, VA.: AIAA.

Weinstein N. D. (1987). Unrealistic Optimism about Illness Susceptibility: Conclusions from a Community Wide Sample, Journal of Behavioral Medicine 10, 481–500.

Wilkinson, S. (1998). Focus groups in feminist research:: Power, interaction, and the co-construction of meaning. In *Women's Studies International Forum* (Vol. 21, No. 1, pp. 111-125). Pergamon.

Williams, K. (2004). *A summary of unmanned aircraft accidents/ incident data: human factors implications.* CAMI.

APPENDIX

APPENDIX I: GLOSSARY

TABLE I 1: GLOSSARY

Centroid	The centroids are the initial factors (usually seven in total) that are extracted from the correlation matrix by means of the centroid method.
Centroid method	Method of extracting factors from the raw data of the Q-sorts. It is the method used most frequently in Q methodology and the one used in this research.
Concourse	The total set of statements about a given subject, the researcher draws a sample from this concourse to investigate.
Confounder	A person whose Q-sort is loaded on more than one factor.
Correlation matrix	N x N matrix, where N are the number of Q-sorts (perspectives) used in the research. In this matrix the correlation of each individual Q-sort with each of the other Q-sorts is calculated. It represents the degree of similarity or dissimilarity between each of the Q-sorts.
Factor	Cluster of correlations between Q-sorts: mathematical representation of common viewpoints, shared by all those Q-sorts that load significantly on that factor.
Factor array	Composite Q-sort: from the scores of each statement for a factor the Q-sort belonging to that factor is constructed; the scores of the statements are reconverted to scores of -3 to +3.
Factor loading	The correlation of a specific Q-sort with a certain factor.
Factor score	The score given to a statement within that factor; it is a weighted average of all scores given to that statement in the individual Q-sorts that make up the factor.
Non-loader	A person whose Q-sort is not significantly loaded on any factor.
P-set	The sample of persons used for the research: the group of respondents.
PQMethod	Software program developed for the statistical analysis of Q-studies. In this research version 2.32 (September 2012) was used. The program can be downloaded through: http:/schmolck.org/qmethod/
Q-sample (or Q-set)	A subset taken from the concourse, this sample of statements that is used in the sorting procedure.
Q-sort	The basic tool of Q methodology: the ranking of the statements in the ranking sheet. Through this process the respondent gives his subjective viewpoint on the statements that make up the Q-sample.
Rotated factor	The factor that is achieved after the rotation process has completed: the final factor; in which the relationships between the Q-sorts have been clarified.
Rotation	The factors that are extracted by means of the centroid factor analysis are rotated as to come to the final set of factors. In the process of rotation, the raw data itself is not altered; the coordinate system represented by the factors is rotated and new factors are formed, in order to increase the loading of each of the Q-sorts on the factor. The rotation process does not alter the raw data, but changes the perspective by which the researcher looks at it.
Statement	Since Q methodology is usually used to rank subjective statements on a subject, the items to be ranked are referred to as 'statements', though in this case it are not statements, but success criteria that are to be ranked.
Unrotated factor	The factors that are first extracted from the correlation matrix by means of the centroid method (centroids); they have not yet been rotated to improve the loadings.

APPENDIX II: INSTRUCTIONS IN FLASHQ

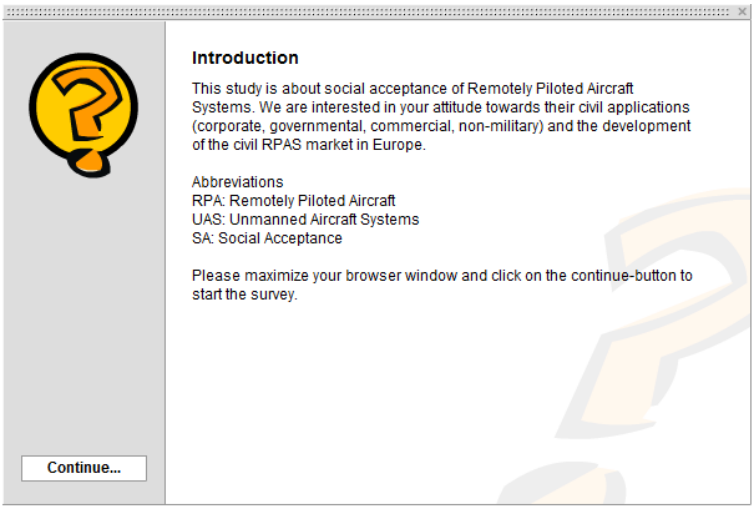

FIGURE I 1: INTRODUCTION IN FLASHQ

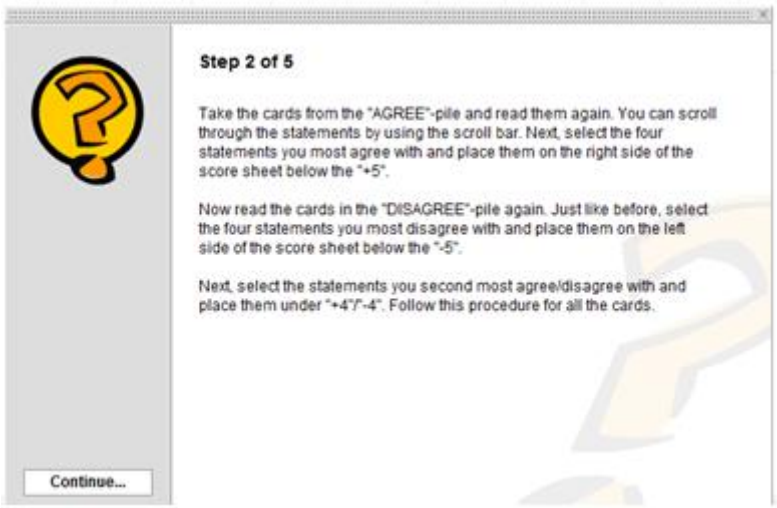

FIGURE I 2: INSTRUCTIONS IN THE 2ND STEP OF FLASHQ

Age*

Please enter your year of birth (YYYY, eg. 1980).

Gender*

Please select your gender.

- female
- male

Nationality*

- Dutch
- Greek
- Other

Please answer the following questions.

	Yes	*No*
Do you work at NLR?		

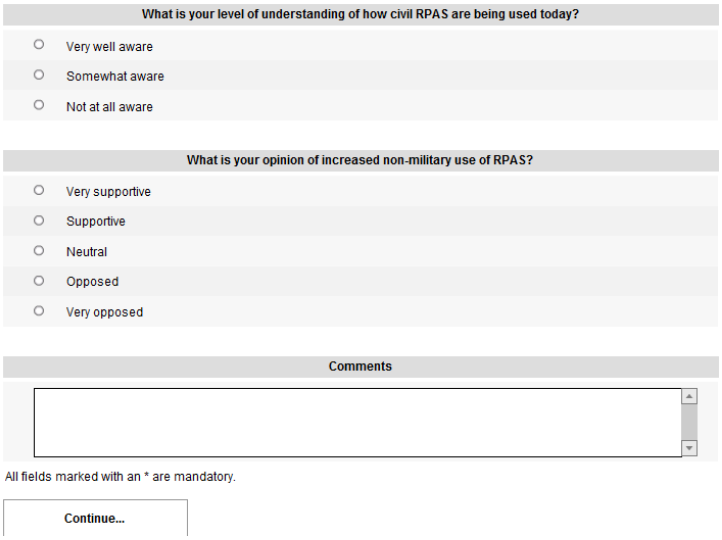

FIGURE I 3: DIMOGRAPHICS AND RELEVANT QUESTIONNAIRE

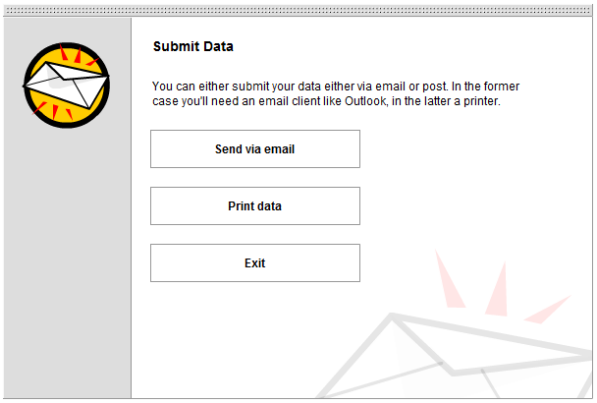

FIGURE I 4: LAST SCREEN OF COMPLETED FLASHQ

TABLE III 1: UNROTATED FACTOR MATRIX

Unrotated Factor Matrix

	Factors 1	2	3	4	5	6	7
SORTS							
1 LP1	0.5970	-0.1058	0.3555	0.1662	0.0723	-0.1462	-0.0887
2 LP2	0.7824	-0.1069	-0.1726	0.1431	0.0051	-0.1990	-0.1694
3 LP3	0.5388	-0.2117	0.2880	0.0305	0.0611	-0.1200	0.1183
4 LP4	0.6531	0.0335	0.0521	-0.2930	0.0868	0.0066	-0.2207
5 LP5	0.6206	-0.5034	0.1581	-0.2394	0.1981	0.1226	0.2229
6 LP6	0.6794	0.1570	-0.2211	-0.1583	0.0738	0.2000	-0.0477
7 LP7	0.5838	0.4140	-0.2118	0.0234	0.1332	0.0075	0.2259
8 LP8	0.6111	0.1479	-0.1320	0.0247	0.0219	0.0708	-0.1830
9 LP9	0.4759	-0.4111	-0.2180	0.2697	0.0946	0.1458	0.0393
10 LP10	0.4333	-0.5434	-0.2861	0.2259	0.1729	0.1935	0.0347
11 LP11	-0.1148	0.1036	0.3088	0.2224	-0.0965	0.2056	0.2202
12 LP12	0.7939	0.1257	0.3149	0.2085	0.0753	0.0137	-0.1751
13 LP13	0.6292	-0.5528	0.1476	-0.2803	0.2471	0.0577	0.1891
14 EX1	0.5101	0.1324	-0.2897	0.0834	0.0460	0.0974	0.0332
15 EX2	0.7823	0.0914	0.3384	0.2087	0.0784	0.0126	-0.2518
16 EX3	0.7175	0.2105	-0.1583	-0.0063	0.0440	-0.1563	0.1010
17 EX4	0.7547	0.2189	-0.0619	0.0170	0.0351	-0.2010	0.2461
18 EX5	0.4815	0.3828	-0.2341	-0.2835	0.2140	0.0216	-0.0750
19 EX6	0.7308	0.1319	0.0319	-0.1006	0.0346	-0.0408	0.0259
20 EX7	0.6041	0.2411	0.2830	0.1682	0.0902	-0.1451	0.0058
21 EX8	0.1303	0.1508	0.2723	0.2399	0.0690	0.2625	0.2302
Eigenvalues	7.8044	1.6992	1.1609	0.7408	0.2657	0.4066	0.5480
% expl.Var.	37	8	6	4	1	2	3

TABLE III 2: CUMULATIVE COMMUNALITIES MATRIX

Cumulative Communalities Matrix

	Factors 1 Thru 1	2	3	4	5	6	7
SORTS							
1 LP1	0.3564	0.3676	0.4940	0.5216	0.5269	0.5482	0.5561
2 LP2	0.6122	0.6236	0.6534	0.6739	0.6739	0.7135	0.7422
3 LP3	0.2903	0.3351	0.4180	0.4190	0.4227	0.4371	0.4511
4 LP4	0.4265	0.4276	0.4303	0.5162	0.5237	0.5238	0.5725
5 LP5	0.3851	0.6386	0.6636	0.7209	0.7602	0.7752	0.8249
6 LP6	0.4616	0.4863	0.5352	0.5602	0.5657	0.6057	0.6079
7 LP7	0.3408	0.5122	0.5571	0.5576	0.5754	0.5754	0.6265
8 LP8	0.3734	0.3953	0.4127	0.4133	0.4138	0.4188	0.4523
9 LP9	0.2265	0.3955	0.4430	0.5157	0.5247	0.5460	0.5475
10 LP10	0.1877	0.4830	0.5648	0.6158	0.6457	0.6832	0.6844
11 LP11	0.0132	0.0239	0.1192	0.1687	0.1780	0.2203	0.2688
12 LP12	0.6303	0.6461	0.7453	0.7887	0.7944	0.7946	0.8252
13 LP13	0.3959	0.7014	0.7232	0.8018	0.8628	0.8662	0.9019
14 EX1	0.2602	0.2777	0.3616	0.3686	0.3707	0.3802	0.3813
15 EX2	0.6120	0.6203	0.7348	0.7784	0.7845	0.7847	0.8481
16 EX3	0.5149	0.5592	0.5842	0.5843	0.5862	0.6106	0.6208
17 EX4	0.5696	0.6175	0.6214	0.6217	0.6229	0.6633	0.7239
18 EX5	0.2318	0.3783	0.4331	0.5135	0.5593	0.5598	0.5654
19 EX6	0.5340	0.5514	0.5524	0.5626	0.5638	0.5654	0.5661
20 EX7	0.3649	0.4231	0.5032	0.5315	0.5396	0.5607	0.5607
21 EX8	0.0170	0.0397	0.1138	0.1714	0.1762	0.2451	0.2981
cum% expl.Var.	37	45	51	54	56	58	60

TABLE III 3: FREE DISTRIBUTION DATA RESULTS

Free Distribution Data Results

QSORT		MEAN	ST. DEV.
1	LP1	0.577	2.284
2	LP2	0.859	2.079
3	LP3	0.662	2.323
4	LP4	0.690	1.997
5	LP5	0.620	2.093
6	LP6	0.648	2.050
7	LP7	0.690	1.976
8	LP8	0.972	1.912
9	LP9	1.028	1.920
10	LP10	1.085	2.068
11	LP11	0.000	2.777
12	LP12	0.690	2.175
13	LP13	0.620	2.093
14	EX1	0.704	2.161
15	EX2	0.690	2.175
16	EX3	0.620	2.180
17	EX4	0.732	2.236
18	EX5	0.648	2.098
19	EX6	0.549	2.083
20	EX7	0.592	2.221
21	EX8	0.000	2.777

TABLE III 4: FACTOR SCORES WITH CORRESPONDING RANKS

Factor Scores with Corresponding Ranks

No.	Statement	Factors					
		No.	1		2		3	
1	There is no human factor that can act in case of mecha	1	1.28	7	1.47	5	0.12	32
2	A pilot on board is more useful and effective than a p	2	-1.38	66	-1.40	66	0.32	25
3	I don't trust automation; systems fail.	3	-0.46	59	-0.45	58	-0.55	56
4	Most of the accidents are caused due to human factor a	4	1.74	2	1.35	7	1.27	10
5	RPAS are used for a long time, so the safety issues ar	5	0.88	18	-0.63	60	-3.00	71
6	RPAS meet the technical requirements, so safety issues	6	-0.46	59	-0.45	58	-0.55	55
7	When the planes are flying above us, we don't have any	7	1.51	3	1.32	8	1.83	3
8	My only concern about civil RPAS is regulation.	8	-1.67	67	-0.95	64	-2.12	68
9	A mid-air collision with other aircraft is possible du	9	-0.46	59	-0.45	58	0.13	29
10	Safety and regulation issues will be a stalemate in th	10	0.65	24	2.19	1	0.72	16
11	Applications related to security and emergency issues	11	-1.28	64	0.03	29	-1.37	66
12	Technically RPAS are very safe.	12	-0.46	59	-0.45	58	-0.47	52
13	There is a long way to prove which one is safer; auton	13	1.21	11	1.15	12	0.96	14
14	In order to be able to accept them, people need a road	14	-0.77	62	-0.85	62	0.83	15
15	The only way to deal with the privacy concern is stric	15	-0.46	59	-0.45	58	-0.54	54
16	Hardly anybody knows the current regulation for civil	16	0.34	27	-0.32	34	1.65	4
17	UAS are safer than RPAS.	17	-0.13	35	-0.16	31	-2.15	69
18	It is very difficult for the police to enforce the rul	18	-0.46	59	-0.45	58	-0.05	38
19	Legislation has to be developed regarding privacy and	19	0.11	30	0.33	26	0.61	17
20	I disagree with allowing everybody to buy an RPAS.	20	0.02	32	-2.07	70	-0.65	58
21	Technical safety issues (like safety factors etc) shou	21	-0.46	59	-0.45	58	0.16	27
22	The operator may not care if an RPA crushes as there a	22	1.24	10	0.59	22	0.35	21
23	RPA can be a potential terrorist tool, like a bomb.	23	0.85	20	-0.24	32	-0.30	47
24	Terrorists will not use such high technology as a weap	24	-0.46	59	-0.45	58	-0.78	61
25	Security operations of RPAS are useful only in small s	25	-0.05	34	0.66	20	-0.24	45
26	RPAS surveillance will not have a deterrent effect on	26	0.12	29	-0.57	59	-0.93	62
27	Privacy is an issue as long as there is no crush; then	27	-0.46	59	-0.45	58	-0.19	42
28	The safety standards should increase, so eventually on	28	1.40	4	1.01	16	1.41	7
29	If people know who is responsible for an RPA accident,	29	-0.50	61	0.52	23	1.30	9
30	People will always be afraid of the autonomous vehicle	30	-0.46	59	-0.45	58	-0.32	49
31	A lot of people have wrong perception about the level	31	1.26	8	0.89	18	1.48	6
32	For most of the people, safety is greater issue than p	32	-2.27	69	-1.93	68	-1.15	64
33	Social acceptance will degrade if a crush takes place.	33	-0.46	59	-0.45	58	-0.04	36
34	RPAS will be socially accepted like manned aircraft.	34	0.68	22	1.10	14	1.39	8
35	Everybody will accept RPAS if they meet the same requi	35	-2.41	70	-2.55	71	-2.24	70
36	Civil RPAS may be illegally used for non-authorised pu	36	-0.46	59	-0.45	58	0.12	31
37	RPAS should be monitored in case of flying outside of	37	1.15	12	0.39	25	1.89	2
38	I want to know who the operator of the RPA that is fly	38	-0.44	36	-0.92	63	-1.24	65
39	I would never go inside any air or ground vehicle with	39	-0.46	59	-0.45	58	-0.43	51
40	I would go inside autonomous trains/trams because I fe	40	0.82	21	0.41	24	0.34	23
41	I would fly with an RPA or an UA.	41	0.89	17	-0.41	35	1.56	5
42	My only concern about civil RPAS is privacy.	42	-0.46	59	-0.45	58	-0.72	60
43	I don't like the idea of RPAS flying over me because o	43	0.59	25	1.07	15	-0.04	37

44	I am concerned about who is able to have access to dat	44	-1.38	65	0.24	28	-1.01	63
45	Everything that we do or say can be recorded by satell	45	-0.46	59	-0.45	58	-0.34	50
46	Privacy is the only issue for SA; people don't want a	46	1.08	14	-0.03	30	0.58	18
47	RPAS are a promising technology but it is very early t	47	0.24	28	-1.43	67	0.30	26
48	RPAS is the future.	48	-0.46	59	-0.45	58	-0.17	41
49	Civil RPAS market will boom due to the high interest o	49	1.24	9	0.26	27	0.33	24
50	The civil RPAS market growth depends on the level of r	50	0.00	33	-1.20	65	-0.22	43
51	In the future there will be autonomous flights of comm	51	-0.46	59	-0.45	58	-0.06	39
52	I don't like RPAS; they bombard people.	52	1.06	15	1.39	6	-0.64	57
53	RPAS applications are very useful and people shouldn't	53	0.47	26	1.66	4	1.09	11
54	I totally approve a wide utilization of civil RPAS.	54	-0.46	59	-0.45	58	-0.25	46
55	I will not have a specific personal benefit from a wid	55	1.09	13	0.65	21	1.09	12
56	I wouldn't care a RPA to fly over me if I knew that th	56	-1.19	63	1.28	9	0.02	34
57	I don't mind RPA flying over me if they are on emergen	57	-0.46	59	-0.45	58	-0.32	49
58	RPAS are useful only for emergencies.	58	1.80	1	0.75	19	-0.01	35
59	I don't like the fact that RPAs are not noisy because	59	0.06	31	-1.97	69	0.14	28
60	It will be annoying if an RPA passes above me all the	60	-0.46	59	-0.45	58	-0.22	44
61	Civil applications of RPAS (e.g. infrastructure inspec	61	0.66	23	1.10	13	0.50	19
62	The driver behind the development of the civil RPAS ma	62	-2.43	71	1.16	11	-1.73	67
63	I want the policy maker to ask the citizens whether th	63	-0.46	59	-0.45	58	-0.48	53
64	I want transparent information regarding civil RPAS (e	64	1.38	5	1.69	3	1.03	13
65	There will be guided information flow regarding RPAS t	65	-0.47	60	2.14	2	0.34	22
66	For technology development and ethical reasons, I want	66	-0.46	59	-0.45	58	0.10	33
67	Most aircraft can fly autonomously but the pilot is us	67	0.94	16	0.96	17	0.39	20
68	RPAS is an innovative technology with a lot of breakth	68	-1.99	68	1.21	10	-0.66	59
69	Refueling of civil aircraft in the air using RPAS will	69	-0.46	59	-0.45	58	-0.14	40
70	RPAS are a perfect alternative for places where manned	70	0.85	19	-0.25	33	1.90	1
71	An RPAS operation is cheaper than the same manned oper	71	1.34	6	-0.81	61	0.12	30

TABLE III 5: FACTORS SCORES FOR FACTOR 1

Factor Scores -- For Factor 1

No.	Statement	No.	Z-SCORES
58	RPAS are useful only for emergencies.	58	1.803
4	Most of the accidents are caused due to human factor and not	4	1.738
7	When the planes are flying above us, we don't have any safet	7	1.513
28	The safety standards should increase, so eventually only the	28	1.404
64	I want transparent information regarding civil RPAS (e.g. li	64	1.379
71	An RPAS operation is cheaper than the same manned operation.	71	1.339
1	There is no human factor that can act in case of mechanical	1	1.276
31	A lot of people have wrong perception about the level of saf	31	1.260
49	Civil RPAS market will boom due to the high interest of the	49	1.240
22	The operator may not care if an RPA crushes as there are no	22	1.239
13	There is a long way to prove which one is safer; autonomous	13	1.213
37	RPAS should be monitored in case of flying outside of the au	37	1.148
55	I will not have a specific personal benefit from a wide civi	55	1.092
46	Privacy is the only issue for SA; people don't want a spy ab	46	1.077
52	I don't like RPAS; they bombard people.	52	1.061
67	Most aircraft can fly autonomously but the pilot is used for	67	0.937
41	I would fly with an RPA or an UA.	41	0.889
5	RPAS are used for a long time, so the safety issues are solv	5	0.881
70	RPAS are a perfect alternative for places where manned aircr	70	0.850
23	RPA can be a potential terrorist tool, like a bomb.	23	0.845
40	I would go inside autonomous trains/trams because I feel saf	40	0.817
34	RPAS will be socially accepted like manned aircraft.	34	0.684
61	Civil applications of RPAS (e.g. infrastructure inspection o	61	0.656
10	Safety and regulation issues will be a stalemate in the deve	10	0.650
43	I don't like the idea of RPAS flying over me because of the	43	0.585
53	RPAS applications are very useful and people shouldn't have	53	0.468
16	Hardly anybody knows the current regulation for civil RPAS.	16	0.340
47	RPAS are a promising technology but it is very early to disc	47	0.238
26	RPAS surveillance will not have a deterrent effect on terror	26	0.121
19	Legislation has to be developed regarding privacy and safety	19	0.110
59	I don't like the fact that RPAs are not noisy because I may	59	0.065
20	I disagree with allowing everybody to buy an RPAS.	20	0.018
50	The civil RPAS market growth depends on the level of regulat	50	-0.003
25	Security operations of RPAS are useful only in small scale i	25	-0.048
17	UAS are safer than RPAS.	17	-0.134
38	I want to know who the operator of the RPA that is flying ov	38	-0.444
12	Technically RPAS are very safe.	12	-0.460
36	Civil RPAS may be illegally used for non-authorised purposes	36	-0.460
39	I would never go inside any air or ground vehicle with no pi	39	-0.460
21	Technical safety issues (like safety factors etc) should be	21	-0.460
42	My only concern about civil RPAS is privacy.	42	-0.460
24	Terrorists will not use such high technology as a weapon its	24	-0.460
45	Everything that we do or say can be recorded by satellites,	45	-0.460

48	RPAS is the future.	48	-0.460
9	A mid-air collision with other aircraft is possible due to a	9	-0.460
33	Social acceptance will degrade if a crush takes place.	33	-0.460
51	In the future there will be autonomous flights of commercial	51	-0.460
15	The only way to deal with the privacy concern is strict regu	15	-0.460
54	I totally approve a wide utilization of civil RPAS.	54	-0.460
57	I don't mind RPA flying over me if they are on emergency or	57	-0.460
3	I don't trust automation; systems fail.	3	-0.460
60	It will be annoying if an RPA passes above me all the time.	60	-0.460
63	I want the policy maker to ask the citizens whether they agr	63	-0.460
18	It is very difficult for the police to enforce the rules on	18	-0.460
66	For technology development and ethical reasons, I want a bla	66	-0.460
27	Privacy is an issue as long as there is no crush; then safet	27	-0.460
69	Refueling of civil aircraft in the air using RPAS will becom	69	-0.460
30	People will always be afraid of the autonomous vehicles.	30	-0.460
6	RPAS meet the technical requirements, so safety issues are t	6	-0.460
65	There will be guided information flow regarding RPAS to conv	65	-0.466
29	If people know who is responsible for an RPA accident, they	29	-0.505
14	In order to be able to accept them, people need a roadmap as	14	-0.772
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-1.185
11	Applications related to security and emergency issues will b	11	-1.277
44	I am concerned about who is able to have access to data from	44	-1.382
2	A pilot on board is more useful and effective than a pilot o	2	-1.385
8	My only concern about civil RPAS is regulation.	8	-1.666
68	RPAS is an innovative technology with a lot of breakthroughs	68	-1.989
32	For most of the people, safety is greater issue than privacy	32	-2.272
35	Everybody will accept RPAS if they meet the same requirement	35	-2.409
62	The driver behind the development of the civil RPAS market i	62	-2.425

TABLE III 6: FACTORS SCORES FOR FACTOR 2

Factor Scores -- For Factor 2

No.	Statement	No.	Z-SCORES
10	Safety and regulation issues will be a stalemate in the deve	10	2.191
65	There will be guided information flow regarding RPAS to conv	65	2.143
64	I want transparent information regarding civil RPAS (e.g. li	64	1.688
53	RPAS applications are very useful and people shouldn't have	53	1.658
1	There is no human factor that can act in case of mechanical	1	1.467
52	I don't like RPAS; they bombard people.	52	1.388
4	Most of the accidents are caused due to human factor and not	4	1.353
7	When the planes are flying above us, we don't have any safet	7	1.316
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	1.282
68	RPAS is an innovative technology with a lot of breakthroughs	68	1.210
62	The driver behind the development of the civil RPAS market i	62	1.155
13	There is a long way to prove which one is safer; autonomous	13	1.146
61	Civil applications of RPAS (e.g. infrastructure inspection o	61	1.103
34	RPAS will be socially accepted like manned aircraft.	34	1.103
43	I don't like the idea of RPAS flying over me because of the	43	1.074
28	The safety standards should increase, so eventually only the	28	1.013
67	Most aircraft can fly autonomously but the pilot is used for	67	0.955
31	A lot of people have wrong perception about the level of saf	31	0.888
58	RPAS are useful only for emergencies.	58	0.750
25	Security operations of RPAS are useful only in small scale i	25	0.664
55	I will not have a specific personal benefit from a wide civi	55	0.647
22	The operator may not care if an RPA crushes as there are no	22	0.586
29	If people know who is responsible for an RPA accident, they	29	0.518
40	I would go inside autonomous trains/trams because I feel saf	40	0.412
37	RPAS should be monitored in case of flying outside of the au	37	0.392
19	Legislation has to be developed regarding privacy and safety	19	0.332
49	Civil RPAS market will boom due to the high interest of the	49	0.263
44	I am concerned about who is able to have access to data from	44	0.242
11	Applications related to security and emergency issues will b	11	0.030
46	Privacy is the only issue for SA; people don't want a spy ab	46	-0.034
17	UAS are safer than RPAS.	17	-0.156
23	RPA can be a potential terrorist tool, like a bomb.	23	-0.240
70	RPAS are a perfect alternative for places where manned aircr	70	-0.252
16	Hardly anybody knows the current regulation for civil RPAS.	16	-0.316
41	I would fly with an RPA or an UA.	41	-0.413
36	Civil RPAS may be illegally used for non-authorised purposes	36	-0.447

39	I would never go inside any air or ground vehicle with no pi	39	-0.447
24	Terrorists will not use such high technology as a weapon its	24	-0.447
42	My only concern about civil RPAS is privacy.	42	-0.447
15	The only way to deal with the privacy concern is strict regu	15	-0.447
45	Everything that we do or say can be recorded by satellites,	45	-0.447
30	People will always be afraid of the autonomous vehicles.	30	-0.447
48	RPAS is the future.	48	-0.447
27	Privacy is an issue as long as there is no crush; then safet	27	-0.447
51	In the future there will be autonomous flights of commercial	51	-0.447
6	RPAS meet the technical requirements, so safety issues are t	6	-0.447
54	I totally approve a wide utilization of civil RPAS.	54	-0.447
21	Technical safety issues (like safety factors etc) should be	21	-0.447
9	A mid-air collision with other aircraft is possible due to a	9	-0.447
57	I don't mind RPA flying over me if they are on emergency or	57	-0.447
60	It will be annoying if an RPA passes above me all the time.	60	-0.447
12	Technically RPAS are very safe.	12	-0.447
63	I want the policy maker to ask the citizens whether they agr	63	-0.447
3	I don't trust automation; systems fail.	3	-0.447
66	For technology development and ethical reasons, I want a bla	66	-0.447
18	It is very difficult for the police to enforce the rules on	18	-0.447
69	Refueling of civil aircraft in the air using RPAS will becom	69	-0.447
33	Social acceptance will degrade if a crush takes place.	33	-0.447
26	RPAS surveillance will not have a deterrent effect on terror	26	-0.570
5	RPAS are used for a long time, so the safety issues are solv	5	-0.627
71	An RPAS operation is cheaper than the same manned operation.	71	-0.813
14	In order to be able to accept them, people need a roadmap as	14	-0.851
38	I want to know who the operator of the RPA that is flying ov	38	-0.920
8	My only concern about civil RPAS is regulation.	8	-0.955
50	The civil RPAS market growth depends on the level of regulat	50	-1.198
2	A pilot on board is more useful and effective than a pilot o	2	-1.402
47	RPAS are a promising technology but it is very early to disc	47	-1.431
32	For most of the people, safety is greater issue than privacy	32	-1.931
59	I don't like the fact that RPAs are not noisy because I may	59	-1.971
20	I disagree with allowing everybody to buy an RPAS.	20	-2.066
35	Everybody will accept RPAS if they meet the same requirement	35	-2.551

TABLE III 7: FACTORS SCORES FOR FACTOR 3

Factor Scores -- For Factor 3

No.	Statement	No.	Z-SCORES
70	RPAS are a perfect alternative for places where manned aircr	70	1.896
37	RPAS should be monitored in case of flying outside of the au	37	1.891
7	When the planes are flying above us, we don't have any safet	7	1.833
16	Hardly anybody knows the current regulation for civil RPAS.	16	1.654
41	I would fly with an RPA or an UA.	41	1.562
31	A lot of people have wrong perception about the level of saf	31	1.479
28	The safety standards should increase, so eventually only the	28	1.410
34	RPAS will be socially accepted like manned aircraft.	34	1.387
29	If people know who is responsible for an RPA accident, they	29	1.301
4	Most of the accidents are caused due to human factor and not	4	1.268
53	RPAS applications are very useful and people shouldn't have	53	1.093
55	I will not have a specific personal benefit from a wide civi	55	1.085
64	I want transparent information regarding civil RPAS (e.g. li	64	1.026
13	There is a long way to prove which one is safer; autonomous	13	0.958
14	In order to be able to accept them, people need a roadmap as	14	0.833
10	Safety and regulation issues will be a stalemate in the deve	10	0.724
19	Legislation has to be developed regarding privacy and safety	19	0.605
46	Privacy is the only issue for SA; people don't want a spy ab	46	0.585
61	Civil applications of RPAS (e.g. infrastructure inspection o	61	0.497
67	Most aircraft can fly autonomously but the pilot is used for	67	0.385
22	The operator may not care if an RPA crushes as there are no	22	0.349
65	There will be guided information flow regarding RPAS to conv	65	0.342
40	I would go inside autonomous trains/trams because I feel saf	40	0.341
49	Civil RPAS market will boom due to the high interest of the	49	0.331
2	A pilot on board is more useful and effective than a pilot o	2	0.316
47	RPAS are a promising technology but it is very early to disc	47	0.305
21	Technical safety issues (like safety factors etc) should be	21	0.164
59	I don't like the fact that RPAs are not noisy because I may	59	0.137
9	A mid-air collision with other aircraft is possible due to a	9	0.132
71	An RPAS operation is cheaper than the same manned operation.	71	0.121
36	Civil RPAS may be illegally used for non-authorised purposes	36	0.117
1	There is no human factor that can act in case of mechanical	1	0.117
66	For technology development and ethical reasons, I want a bla	66	0.103
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	0.016
58	RPAS are useful only for emergencies.	58	-0.014
33	Social acceptance will degrade if a crush takes place.	33	-0.036
43	I don't like the idea of RPAS flying over me because of the	43	-0.037
18	It is very difficult for the police to enforce the rules on	18	-0.053
51	In the future there will be autonomous flights of commercial	51	-0.064
69	Refueling of civil aircraft in the air using RPAS will becom	69	-0.139
48	RPAS is the future.	48	-0.171
27	Privacy is an issue as long as there is no crush; then safet	27	-0.188
50	The civil RPAS market growth depends on the level of regulat	50	-0.219

60	It will be annoying if an RPA passes above me all the time.	60	-0.220
25	Security operations of RPAS are useful only in small scale i	25	-0.242
54	I totally approve a wide utilization of civil RPAS.	54	-0.249
23	RPA can be a potential terrorist tool, like a bomb.	23	-0.301
57	I don't mind RPA flying over me if they are on emergency or	57	-0.324
30	People will always be afraid of the autonomous vehicles.	30	-0.324
45	Everything that we do or say can be recorded by satellites,	45	-0.338
39	I would never go inside any air or ground vehicle with no pi	39	-0.431
12	Technically RPAS are very safe.	12	-0.474
63	I want the policy maker to ask the citizens whether they agr	63	-0.477
15	The only way to deal with the privacy concern is strict regu	15	-0.540
6	RPAS meet the technical requirements, so safety issues are t	6	-0.552
3	I don't trust automation; systems fail.	3	-0.555
52	I don't like RPAS; they bombard people.	52	-0.645
20	I disagree with allowing everybody to buy an RPAS.	20	-0.654
68	RPAS is an innovative technology with a lot of breakthroughs	68	-0.662
42	My only concern about civil RPAS is privacy.	42	-0.722
24	Terrorists will not use such high technology as a weapon its	24	-0.783
26	RPAS surveillance will not have a deterrent effect on terror	26	-0.926
44	I am concerned about who is able to have access to data from	44	-1.012
32	For most of the people, safety is greater issue than privacy	32	-1.152
38	I want to know who the operator of the RPA that is flying ov	38	-1.237
11	Applications related to security and emergency issues will b	11	-1.375
62	The driver behind the development of the civil RPAS market i	62	-1.731
8	My only concern about civil RPAS is regulation.	8	-2.123
17	UAS are safer than RPAS.	17	-2.152
35	Everybody will accept RPAS if they meet the same requirement	35	-2.244
5	RPAS are used for a long time, so the safety issues are solv	5	-2.997

TABLE III 8: FACTOR CHARACTERISTICS

Factor Characteristics

	Factors		
	1	2	3
No. of Defining Variables	10	5	5
Average Rel. Coef.	0.800	0.800	0.800
Composite Reliability	0.976	0.952	0.952
S.E. of Factor Z-Scores	0.156	0.218	0.218

TABLE III 9: STANDARD ERRORS

Standard Errors for Differences in Factor Z-Scores

(Diagonal Entries Are S.E. Within Factors)

Factors	1	2	3
1	0.221	0.268	0.268
2	0.268	0.309	0.309
3	0.268	0.309	0.309

TABLE III 10: FACTOR Q-SORT VALUES FOR STATEMENTS SORTED BY CONSENSUS VS DISAGREEMENTS (VARIANCE ACROSS FACTOR Z-SCORES)

			Factor Arrays		
No.	Statement	No.	1	2	3
12	Technically RPAS are very safe.	12	-3	-3	-2
39	I would never go inside any air or ground vehicle with no pi	39	-3	-3	-2
63	I want the policy maker to ask the citizens whether they agr	63	-3	-3	-2
15	The only way to deal with the privacy concern is strict regu	15	-3	-3	-2
6	RPAS meet the technical requirements, so safety issues are t	6	-3	-3	-2
3	I don't trust automation; systems fail.	3	-3	-3	-2
45	Everything that we do or say can be recorded by satellites,	45	-3	-3	-2
30	People will always be afraid of the autonomous vehicles.	30	-3	-3	-1
57	I don't mind RPA flying over me if they are on emergency or	57	-3	-3	-1
54	I totally approve a wide utilization of civil RPAS.	54	-3	-3	-1
13	There is a long way to prove which one is safer; autonomous	13	3	3	3
60	It will be annoying if an RPA passes above me all the time.	60	-3	-3	-1
27	Privacy is an issue as long as there is no crush; then safet	27	-3	-3	-1
35	Everybody will accept RPAS if they meet the same requirement	35	-5	-5	-5
42	My only concern about civil RPAS is privacy.	42	-3	-3	-3
48	RPAS is the future.	48	-3	-3	0
69	Refueling of civil aircraft in the air using RPAS will becom	69	-3	-3	0
24	Terrorists will not use such high technology as a weapon its	24	-3	-3	-3
51	In the future there will be autonomous flights of commercial	51	-3	-3	0
28	The safety standards should increase, so eventually only the	28	5	2	4
18	It is very difficult for the police to enforce the rules on	18	-3	-3	0
33	Social acceptance will degrade if a crush takes place.	33	-3	-3	0
19	Legislation has to be developed regarding privacy and safety	19	1	1	2
4	Most of the accidents are caused due to human factor and not	4	5	4	3
55	I will not have a specific personal benefit from a wide civi	55	3	2	3
40	I would go inside autonomous trains/trams because I feel saf	40	2	1	1
7	When the planes are flying above us, we don't have any safet	7	5	4	5
31	A lot of people have wrong perception about the level of saf	31	4	2	4
61	Civil applications of RPAS (e.g. infrastructure inspection o	61	1	3	2
66	For technology development and ethical reasons, I want a bla	66	-3	-3	0
67	Most aircraft can fly autonomously but the pilot is used for	67	2	2	2
36	Civil RPAS may be illegally used for non-authorised purposes	36	-3	-3	0
64	I want transparent information regarding civil RPAS (e.g. li	64	4	5	3
9	A mid-air collision with other aircraft is possible due to a	9	-3	-3	1
34	RPAS will be socially accepted like manned aircraft.	34	2	3	4
21	Technical safety issues (like safety factors etc) should be	21	-3	-3	1
38	I want to know who the operator of the RPA that is flying ov	38	0	-4	-4
22	The operator may not care if an RPA crushes as there are no	22	3	2	2
25	Security operations of RPAS are useful only in small scale i	25	0	2	-1
26	RPAS surveillance will not have a deterrent effect on terror	26	1	-3	-3
49	Civil RPAS market will boom due to the high interest of the	49	4	1	1
46	Privacy is the only issue for SA; people don't want a spy ab	46	3	1	2
43	I don't like the idea of RPAS flying over me because of the	43	1	3	0
32	For most of the people, safety is greater issue than privacy	32	-5	-5	-4
8	My only concern about civil RPAS is regulation.	8	-4	-4	-5
53	RPAS applications are very useful and people shouldn't have	53	1	5	3
50	The civil RPAS market growth depends on the level of regulat	50	0	-4	-1
23	RPA can be a potential terrorist tool, like a bomb.	23	2	0	-1
1	There is no human factor that can act in case of mechanical	1	4	4	0
37	RPAS should be monitored in case of flying outside of the au	37	3	1	5
11	Applications related to security and emergency issues will b	11	-4	1	-4
44	I am concerned about who is able to have access to data from	44	-4	1	-4
10	Safety and regulation issues will be a stalemate in the deve	10	1	5	2
29	If people know who is responsible for an RPA accident, they	29	-3	1	4
58	RPAS are useful only for emergencies.	58	5	2	0
14	In order to be able to accept them, people need a roadmap as	14	-3	-3	3
47	RPAS are a promising technology but it is very early to disc	47	1	-4	1
2	A pilot on board is more useful and effective than a pilot o	2	-4	-4	1
16	Hardly anybody knows the current regulation for civil RPAS.	16	1	0	5
41	I would fly with an RPA or an UA.	41	2	0	4
20	I disagree with allowing everybody to buy an RPAS.	20	0	-5	-3
70	RPAS are a perfect alternative for places where manned aircr	70	2	0	5
71	An RPAS operation is cheaper than the same manned operation.	71	4	-3	1
52	I don't like RPAS; they bombard people.	52	3	4	-3
17	UAS are safer than RPAS.	17	0	0	-5
59	I don't like the fact that RPAS are not noisy because I may	59	0	-5	1
56	I wouldn't care a RPA to fly over me if I knew that they ful	56	-4	4	0
65	There will be guided information flow regarding RPAS to conv	65	-3	5	2
68	RPAS is an innovative technology with a lot of breakthroughs	68	-5	3	-3
62	The driver behind the development of the civil RPAS market i	62	-5	3	-4
5	RPAS are used for a long time, so the safety issues are solv	5	2	-3	-5