FH | JOANNEUM
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Master's Thesis

Social Acceptance of Civil Drones: Similarities, Distinctions and Specifics of about 100 International Drone Acceptance Studies and Their Significance for Austria

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Declaration of Academic Honesty

I hereby declare that the present Master's thesis was composed by myself and that the work contained herein is my own. I also confirm that I have only used the specified resources. All formulations and concepts taken verbatim or in substance from printed or unprinted material or from the Internet have been cited according to the rules of good scientific practice and indicated by footnotes or other exact references to the original source.

The present thesis has not been submitted to another university for the award of an academic degree in this form. This thesis has been submitted in printed and electronic form. I hereby confirm that the content of the digital version is the same as in the printed version.

I understand that the provision of incorrect information may have legal consequences.

Vienna, 11th September 2020

Felix Podgorschek, BSc

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The creation of this Master´s thesis could not have been possible without the participation of so many entities. Therefore, I would like to express my deep appreciation and indebtedness particularly to the following:

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Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)

TAKE OFF

Aeronautics Research and Technology Program (TAKE OFF)

Preface

This Master´s thesis has been prepared during my internship at AAI (Austrian Aeronautics Industries Group), with the target to examine, compare and analyse societal dimensions, issues and especially public acceptance of civil drones. The prevalent script aims to accomplish my studies and to achieve the academic title *Master of Science* (MSc).

In the versatile operational areas of AAI, I experienced topic-oriented expertise and know-how in the field of emerging aeronautical technologies, especially civil drones. In this way, I took advantage to specialize my knowledge on civil drones, attended industry-specific events or meetings (e.g. AAI-UAS-WG, EASA High Level Conference) and finally, I was able to develop sufficient field-relevant knowledge, which facilitated the creation of this Master´s thesis under memorable Covid-19 circumstances.

At the beginning of this thesis, I would like to take opportunity and give thanks to all people, who supported me in writing this thesis or promoted me on my educational and professional way so far. Firstly, I explicitly want to thank the Deputy Secretary General of AAI, Raoul Fortner, MSc for all his commitment, effort and proactive input. I also want to thank the Secretary General of AAI, KR Ing. Franz Hrachowitz, for all provided resources as well as opportunities and memories, which were given to me. Furthermore, I want to express gratitude to my predecessor, Alexander Lappi, MSc, who initiated research on international drone acceptance studies at AAI and to Michaela Schmöllerl, who massively facilitated work-intensive office days with her sunny character. Over and above, I would like to express my appreciation to the academic supervisor of this script and head of the institute at the FH JOANNEUM, Dr.-Ing. Holger Friehmelt for his commitment, support and all valuable contributions.

Finally, I explicitly want to thank my family and friends, who supported me during my studies. In virtue of this gratefulness, especially to my closest family (Max, Manuela, Philipp, Sandra), I would like to dedicate this thesis to all these people.

Felix Podgorschek, BSc

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Table of Contents

Abstract

Public acceptance is crucial and one of the decisive key drivers for the future development and integration of civil drones in the emerging UAS-market in our society, especially into the daily routine of urban and rural areas. This fact is highlighted in many statements and surveys on international and European level, but not yet fully covered for Austria. Therefore this Master's thesis - side by side with project GARDA at AAI - examines the public acceptance of civil drone applications worldwide, based on more than 100 international drone acceptance studies or surveys, and derives subsequent implications as well as recommendations for drone acceptance in Austria.

Key research questions of this thesis are therefore the global situation, especially similarities as well as distinctions and influential factors described in so many international studies on drone acceptance, and their implications for Austria, derived from typical Austrian characteristics in the application of drones (e.g. demography, mountainous topography, societal system or regulatory regime).

Noteworthy findings are striking worldwide similarities (e.g. regarding age or gender) as well as conclusions about worldwide very well accepted applications (emergency or governmental) and less accepted ones (commercial and recreational applications). Also an in-depth analysis of country-specific distinctions is provided (e.g. France is the European leader in drone acceptance). Final comparisons with Germany, Switzerland and USA complete the thesis together with final recommendations for drone acceptance in Austria (e.g. target currently less informed groups, provide convincing regulatory measures as well as ‘no drone zones’ and drone protection systems). In a nutshell, this thesis merges the wisdom of more than 100 international acceptance studies for civil drones with Austrian characteristics to derive manifold relevant conclusions for the Austrian UAS community.

Kurzfassung

Die gesellschaftliche Akzeptanz ist entscheidend und einer der wesentlichen Treiber für die zukünftige Entwicklung und Integration von zivilen Drohnen im aufstrebenden UAS-Marktumfeld, speziell für alltägliche Aufgaben in urbanen aber auch ruralen Gebieten. Diese Tatsache wird durch zahlreiche internationale wie besonders auch europäische Stellungnahmen und Untersuchungen unterstrichen, ist aber bisher in Österreich noch nicht vollumfänglich bearbeitet worden. Daher untersucht die vorliegende Arbeit - im Einklang mit Projekt GARDA bei der AAI - die öffentliche bzw. gesellschaftliche Akzeptanz von zivilen Drohnenanwendungen auf der ganzen Welt, basierend auf über 100 internationalen Drohnenakzeptanz-Studien bzw. Untersuchungen, und leitet die sich daraus ergebenden Auswirkungen wie auch Empfehlungen für die Drohnenakzeptanz in Österreich ab.

Zentrale Forschungsfragen der Arbeit sind daher die weltweite Situation, speziell Gemeinsamkeiten wie auch Unterschiedlichkeiten und wesentlichen Einflussfaktoren aus zahlreichen internationalen Drohnenakzeptanz-Studien, sowie deren Auswirkungen für Österreich, insbesondere abgeleitet von typischen Eigenschaften österreichischer Drohnenanwendungen (z.B. Demographie, bergige Topographie, Gesellschaftssystem und Rechtsregime).

Bemerkenswerte Erkenntnisse sind die erstaunlichen weltweiten Gemeinsamkeiten (z.B. betreffend Alter und Geschlecht) wie auch Schlussfolgerungen über weltweit besonders akzeptierte Anwendungen (Blaulicht- und staatliche Einsätze) oder weniger akzeptierte (kommerzielle und Freizeit-Aktivitäten). Auch eine tiefgehende Analyse landesspezifischer Unterschiede ist enthalten (z.B. führt Frankreich in Europa klar in Sachen Drohnenakzeptanz). Die abschließenden Ländervergleiche mit Deutschland, Schweiz und den USA komplettieren die Arbeit samt finaler Empfehlungen für die Drohnenakzeptanz in Österreich (z.B. gezieltes Ansprechen derzeit unzureichend informierter Gruppen, starke regulatorische Maßnahmen zusammen mit "no drone zones" und Drohnenabwehrsystemen). Die Arbeit führt daher im Wesentlichen das Wissen aus über 100 internationalen Drohnenakzeptanz-Studien zusammen mit österreichischen Besonderheiten, um daraus vielfältige Schlussfolgerungen für die UAS-Community in Österreich abzuleiten.

List of Figures

List of Tables

List of Abbreviations

A	
AAI	Austrian Aeronautics Industries Group
ACG	Austro Control GmbH
AGL	Above ground level
AIA	Aerospace Industries Association
AIT	Austrian Institute of Technology
ANSP	Air navigation service provider
ARC	Air risk class
ASD	AeroSpace and Defence Industries Association
ATM	Air traffic management
B	
BMK	Austrian Federal Ministry for climate, environment, energy, mobility, innovation and technology
BVLOS	Beyond visual line of sight
C	
CAAC	Civil Aviation Administration of China
CAR	Canada Aviation Regulation
CASP	Critical appraisal skill program
CCTV	Closed circuit television
CE	Name of a standardisation institute: CENELEC
CEO	Chief executive officer
CO_2	Carbon dioxide
CONOPS	Concept of operations
CS	Certification specifications
CTR	Controlled traffic region
D	
DG ENTR	Directorate - General enterprise and industry
DG MOVE	Directorate - General for Mobility and Transport
DJI	Da-Jiang Innovations Science and Technology Co.
E	
EASA	European Union Aviation Safety Agency
EC	European Commission

ELOS	Equivalent level of safety
EP	European Parliament
ERSG	European RPAS Steering Group
EU	European Union
F	
FAA	Federal Aviation Administration
FACC	Fischer advanced composite components
FFG	Austrian research promotion agency
FH	University of applied sciences Guidance material
G	
GDPR	General data protection regulation
GM	Guidance material
GARDA	Gesellschaftliche Akzeptanz & Relevanz (ziviler) Drohnen-Anwendungen
GRC	Ground risk class
H	
HCI	Human computer interaction
I	
ICAO	International Civil Aviation Organisation
ILS	Integrated logistic support
ITF	International transport forum
J	
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
L	
LBTH	Certification of airworthiness and serviceability
LFG	General aviation act (Austria)
LTO	Long-term orientation
M	
MOD	Ministry of Defence
MS	Member state
MTOW	Maximum take-off weight
N	
NAA	National aviation authority
NZL	New Zealand

O

OEM	Original equipment manufacturer
OSP	Operational safety objectives
P	
PbD	Privacy enhancing technologies
PET	Privacy by design
PDI	Power distance index
PDRA	Pre-defined risk assessment
PwC	PricewaterhouseCoopers International
Q	
QC	Quality committee
R	
RPAS	Remotely piloted aircraft system
S	
SAIL	Specific Assurance and Integrity Level
SARPs	Standards and recommended practices
SMEs	Small and medium-sized enterprises
SORA	Specific operational risk assessment
STS	Standard scenarios
sUAC ARC	Small Unmanned Aircraft System Aviation Rulemaking Committee
T	
TU	Technical university
U	
UAM	Urban air mobility
UAS	Unmanned aerial vehicle
UASSG	Unmanned aircraft system study group
UAV	Unmanned aerial vehicle
UK	United Kingdom
US	United States
UTM	Unmanned aircraft system transport management
V	
VLOS	Visual line of sight
VTOL	Vertical take-off or landing

1. Introduction

Since the last decade, drones are coming increasingly into question to accomplish civil tasks more efficient, safe or convenient. Accordingly, civil drones are currently moving incrementally into the societal centre, thus public acceptance appears to be a decisive factor for the economic success of this sector.

1.1. Subject, Purpose and Research Questions of This Thesis

In the prevalent Master´s thesis entitled ‘Social Acceptance of Civil Drones: Similarities, Distinctions and Specifics of about 100 International Drone Acceptance Studies and Their Significance for Austria’ a thorough examination of relevant societal dimensions affected by civil drones is conducted, especially focussing on global acceptance trends enabling also statements regarding the public perception in Austria, which is a key prerequisite and requirement to facilitate the development of a sustainable domestic drone sector. Therefore, this script addresses, besides any interested reader, especially stakeholders of the civil drone sector, for example NAAs (National aviation authorities), business executives or potential adopters.

This research examines a to date sparsely researched Austrian topic, that is elementary for the establishment of a domestic drone sector. Therefore, to maximise the scientific quality and to validate several applied scientific methods, pervasive research questions are defined, which are essential to facilitate concluding statements regarding the acceptance of civil drones in Austria as well as for the ultimate combination and interpretation of achieved results in the course of all applied research methods. The research questions of this Master´s thesis are as follows:

Q1: What is the current global situation regarding the public acceptance of civil drones?

Q1.1.: What are noteworthy similarities and distinctions on a global level?

Q1.2.: What are noteworthy trends on a global level?

Q2: What factors are influencing the societal acceptance of civil drones?

Q2.1.: How pronounced are topographic and geographic influences?

Q2.2.: How pronounced are socio-demographic influences?

Q2.3.: Are there any other influencing factors obtainable?

Q3: What are verified implications for civil drones in Austria?

Q3.1.: What are valid estimations regarding the public acceptance in Austria?

Q3.2.: Way forward – Are there ways to improve drone acceptance in Austria?

According to various statements of EU and EASA, like the Riga or Amsterdam declaration, public acceptance of civil drones is of key importance to enable a sustainable market growth. Therefore, impairments to citizen fundamental´s rights, any negative externalities and safety or security threats should be mitigated (EASA, 2015, p.4). Moreover, beyond the importance of public acceptance for the establishment of a domestic drone market, as visible in Figure 1, some further aspects must be considered: infrastructure, regulation, technology and overall economy.

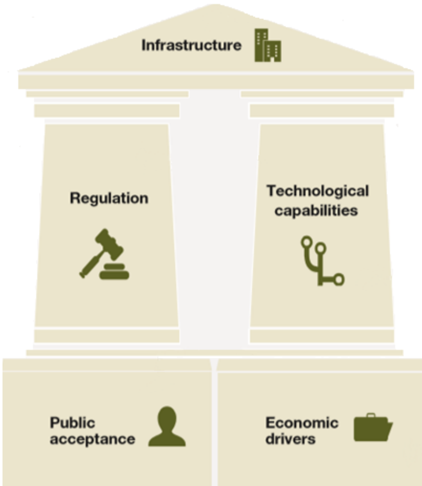


Figure 1: Key drivers of the domestic drone market (Cohn et al., 2017, p.6).

Nevertheless, a couple of European and other international countries already initiated evaluations on the public drone acceptance by distributing respective questionnaires. Primary target of public evaluations is always the generation of valid statements concerning the societal awareness level, influential concerns and the perception of specific drone applications to foster a commercial drone market by revising enacted regulations, enhancing the level of societal involvement or expediting technological research. All in all, targeted societal measures or campaigns can enhance public acceptance and facilitate the establishment of a sustainable, competitive and profitable civil drone market.

Nowadays many European and American regions already conducted studies on the acceptance of civil drones to facilitate proper measures and mitigate potential concerns or abolish societal barriers, which limit further accretion. Besides this international view, the situation in Austria is slightly different. During the last decade, the emerging domestic civil drone sector initiated mainly to grow in kind of innovative start-up businesses and besides that, also remarkable and successful drone research has been conducted and funded by government or other institutions. Nevertheless, one still missing facet in the Austrian research is an evaluation regarding the public acceptance, which is undoubtedly important for scheduling any further steps, strategies and measures to promote a domestic market. Therefore, to counteract the beforementioned situation and to strengthen the position of the Austrian drone market on the long term, this Master´s thesis – also inspired by my internship at AAI and my collaboration in project GARDA – targets primarily to evaluate, analyse and compare a broad pallet of publicly accessible international studies on drone acceptance to enable, in combination with some complementary research, profound statements and implications concerning the perception of drones in Austria.

Recapitulatory, this Master´s thesis intends to close a distinctive gap in the domestic research and to elaborate and provide a thorough insight into major drivers, trends and the current international situation regarding the public acceptance of civil drones. All this enables verified statements or recommendations for Austria, which maybe promote or facilitate in ultimate consequence the development of a sustainable, safe and societally supported market in Austria.

1.2. Background and Motivation

Economic forecasts regarding the future market development are invariably optimistic and indicate a rapid and economically feasible growth of this emerging sector. In general, drones are deployable in miscellaneous contexts so that they can initialize new markets or facilitate prevailing operational procedures in private, industrial or commercial contexts by adjustable payloads, diverse model sizes and moderate purchase prices combined with an expeditiously maturing technology. Especially the wide range of available drone types, in connection with its straightforward accessibility, transforms drones into a useful technology for many civil or business purposes. In this context, special reference is made on applications as part of relief missions, commercial assignments or recreational flights, highlighting the auspicious technological and economical potential as well as the multitude of involved stakeholders.

Aside from the distinctive economic potential, drones are often associated with preceding military deployments and hence, drone applications in civilian contexts are still highly innovative and accordingly often misinterpreted, unknown or unfamiliar to the general public.

Into the bargain of that, drones are often subject of the yellow press, with the target to attract interest by mentioning the term ‘drone’ in article headlines, dealing about military drone deployments or other adverse topics. However, civil drones are easily adjustable, affordable and operable by the general public, but currently in Austria explicitly operable in the uncontrolled domestic airspace (Class G) in VLOS (Visual line of sight) conditions and within a maximum operational radius of 500m (Figure 2).

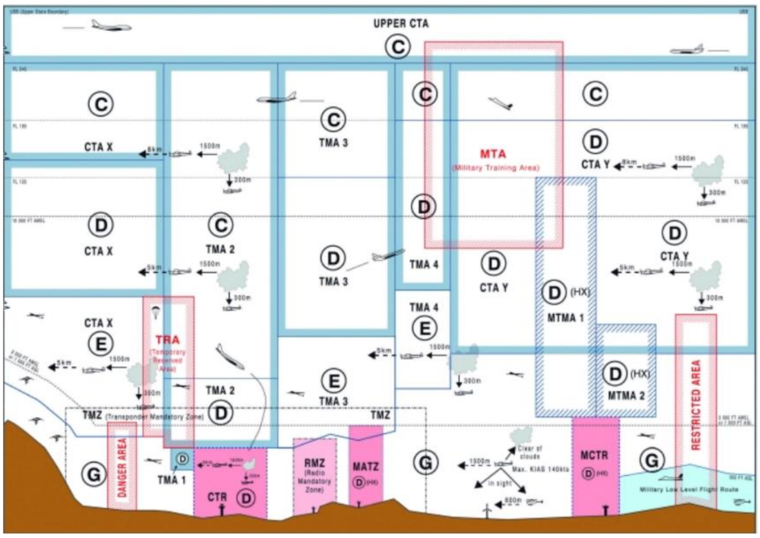


Figure 2: The Austrian airspace structure (ivao.at, 2015).

By reference to the Austrian airspace structure, class G is exclusively uncontrolled and covers, excluding predefined CTRs (Controlled traffic regions) in the proximity of airports, heights up to 300m AGL (Above ground level). In consequence, drone operations always cause a certain risk that third parties get unintentionally involved in respective activities (e.g. accidents, unauthorized property overflights, filming activities). Accordingly, drones are useful technological devices affecting the society in various personal dimensions (e.g. privacy, data-protection, safety, security), whereby the extent depends on factors like application, payload or operator. However, to utilise the economic and technological potential in Austria advantageously and to proactively enhance societal awareness, acceptance and also adoptability of civil drones, still a lot of regulatory, organisational and societal framework must be accomplished on a national as well as European level, but the economic potential of this emerging field is distinctive and incomparable to other aeronautical fields. All this finally motivated me to investigate in this research various international fields of tension caused by societal (e.g. privacy concerns), economical (e.g. new market opportunities) and regulatory aspects of drones, enabling statements regarding the public acceptance in Austria.

On a personal level, due to my affinity towards novel technologies, I early experienced my interest in aeronautics and therein especially drones. Backed on this, after reaching the A-level, I decided to continue my educational way with a Bachelor´s and subsequently also Master´s degree in Aviation at the FH JOANNEUM in Graz. The curriculum of this study is perfectly aligned to actual aeronautical developments and besides a profound education, the institute is also scientifically specialised on many drone aspects. In this way, I utilised already during my studies the chance to conduct research on drones and to expand my knowledge in this field. In summary, my education encouraged me to recognise the enormous economic and technological potential of drones at a quite early stage.

Subsequently, as part of the scheduled internship in the Master´s program, I intended to specialise also professionally on UAS and thus utilised the opportunity to work for AAI, which is nationally appreciated for their expertise in the domestic and international drone market and frequently involved in governmentally funded research projects. Furthermore, AAI hosts the Austrian working group concerning civil drones (AAI-UAS-WG), incorporating all field-relevant Austrian stakeholder groups (Universities, Industries, SMEs, NAA and even MOD). Consequently, during my internship at AAI I utilised the opportunity to participate in respective meetings and thus learned a lot about sectoral developments, innovations and trends.

To recapitulate, especially my enthusiasm towards innovative technologies, my educational background and the gathered expertise during my internship at AAI for project GARDA, engaged me to focus in this Master´s thesis on the public perception of civil drones, which is marginally researched in Austria and vital for business decisions as well as the establishment of civil drones in Austria. In summary, this research represents wistfully required framework for the establishment of civil drones in the Austrian society. Furthermore, the topic enables the conduction of multidisciplinary research, which facilitates the creation of a Master´s thesis containing significant international research results, enabling implications and statements regarding the status and expected development of public drone acceptance in Austria.

1.3. Supervising Company – Austrian Aeronautics Industries Group (AAI)

The prevalent scientific script proceeds from a Master´s internship at the Austrian Aeronautic Industries Group (AAI) for project GARDA and has been composed by utilisation of obtained knowledge and expertise of AAI and all its bodies, but especially the AAI-UAS-WG.

1.3.1. Overview

The Austrian Aeronautics Industries Group was founded as non-profit organisation in the year 1999 by KR Ing. Franz Hrachowitz, who is still leading the association in the position Secretary General. Main objective of the association is the further development and national as well as international interconnection of the entire aviation industry in Austria (Companies, Universities, Research Institutes, Start-Ups) to create or promote synergies and enhance the competitiveness of the Austrian aviation sector in a worldwide, but especially European comparison (Figure 3).

Figure 3: Official emblem of the Austrian Aeronautics Industries Group (aaig.at, 2020).

The association represents on a national and international level common interests of its member companies, which predominantly shape an advantageous development of this sector. AAI currently encompasses 38 Austrian companies and is frequently organising joint information exchange as well as marketing, networking activities, events, working groups and trainings.

Furthermore, AAI and all its members are registered at the ASD (Aerospace & Defence Industries Association of Europe), so that the Austrian aviation industry is also involved in respective European information and decision-making processes. All in all, the operational area of AAI rests upon three pillars:

- Networking & Representation of interests
- Marketing
- Services (incl. WGs & trainings)

The Austrian Aeronautics Industries Group is a non-profit organisation, which is financed by its member companies with the main objective to enhance and strengthen the Austrian aviation industry. All this causes a sophisticated structure of the association that incorporates the following working bodies:

- General Assembly
- Board
- Secretary General & AAI-Office
- Working Groups (QC, ILS, UAS)

1.3.2. AAI – UAS Working Group

The AAI-UAS-WG is nationally appreciated for profound knowledge exchange involving all relevant national and international stakeholders of the UAS-domain. Founded in August 2012, the AAI-UAS-WG facilitates information exchange between Austrian companies, researchers and developers. The working group is accessible also for external companies, meets quarterly at different Austrian locations and targets primarily the interconnection of all field-relevant stakeholders (e.g. industry, researchers, SMEs, developers, key operators) to foster national and international collaborations and the creation of synergies. Additionally, in December 2013 AAI became an official member of UVS-International and in 2019 a member of UAV-DACH.

Regarding regulatory processes, AAI and all its members or stakeholders involved in the AAI-UAS-WG promote the seamless information exchange in the entire Austrian UAS-community, also including entities like BMK (Austrian Federal Ministry for climate, environment, energy, mobility, innovation and technology), ACG (Austro Control GmbH) and also towards European institutions like EASA (European Aviation Safety Agency).

2. Structure, Scientific Methodology and Selection Criteria

In the upcoming chapter, the research structure, applied scientific methodology and quantitative selection criteria of this Master´s thesis is determined, also containing a brief overview of scheduled chapters, scientific targets and intended research scope.

2.1. Structure of This Master´s Thesis

The structure of this Master´s thesis targets primarily the publication and elaboration of a fundamental research dealing about societal aspects, influences and key factors regarding the acceptance of civil drones in Austria. For that reason, the determined structure intends to attract readers by combining results from an extensive qualitative research and elaborated implications from already conducted international quantitative studies to ensure the coverage of relevant aspects.

To safeguard the elaboration of reliable answers to all postulated research questions (Chapter 1.1.), this research applies a parallel mixed-methods approach, wherein qualitative and quantitative methods are simultaneously conducted with the target to enhance overall research flexibility and quality. Moreover, the prevalent combination of qualitative and quantitative methods is mainly responsible for the final chapter arrangement in this thesis (Figure 4).

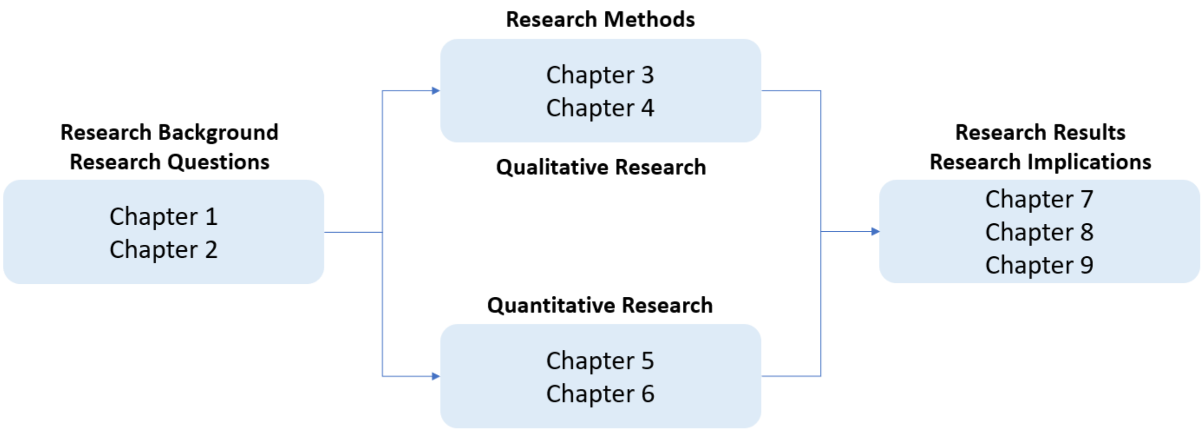


Figure 4: Structure of this Master´s thesis using a parallel mixed-methods approach (own work).

Backed on this, in the first half of this thesis aspects like general paper framework and applied scientific methodology are described and subsequently a comprehensive qualitative study, ranging from a national and international market analysis to a description of relevant influences and key driving factors for public acceptance is conducted. In the run-up to all qualitative chapters, comprehensive research is realised, wherein a multitude of different scientific opinions and viewpoints are considered.

In specific, in the aftermath of the introductory session, in Chapters 3 and 4 qualitative research is conducted. Therein, acquired and non-numerical data of a profound literature research enable in ultimate consequence valuable interpretations in the concluding chapters of this script.

In Chapters 5 and 6, profound quantitative research is conducted, wherein after an accurate research on international drone acceptance studies, several relevant studies are assessed, selected, described and ultimately quantitatively analysed and compared.

In Chapters 7 and 9 of this Master´s thesis, achieved results originating from both qualitative and quantitative research are presented, discussed and analysed, targeting the elaboration of scientifically reliable answers to all research questions (Chapter 8). In specific, especially in Chapter 9, outcomes from both methods are interpretively combined to facilitate the drawing of plausible final conclusions as well as the creation of a prospective outlook, emphasising the establishment of civil drones in Austrian society and potential societal acceptance barriers (e.g. privacy issues).

To recapitulate, the structure of the prevalent Master´s thesis is pursuing the ruleset of a parallel-mixed-methods approach. In line with this, in Chapter 1.1. pervasive scientific research questions are defined, and after the introductory section, profound qualitative research is conducted. In the qualitative research (Chapters 3 and 4) an extensive literature research is carried out, wherein manifold relevant information, facts and insights are collected, analysed and appropriately converted into the context of this thesis.

Subsequently, Chapters 5 and 6 initiate quantitative research in this script, wherein before researched international studies are analysed, compared and evaluated. Finally, in the closing Chapters 7, 8 and 9 several elaborated information, insights and conclusions from both methods are combined to answer in Chapter 8 all postulated research questions sufficiently and to prepare proper concluding statements and recommendations towards the public acceptance in Austria.

2.2. Data Acquisition – Applied Research Methods

This research devotes a mixed-methods-approach that maximises the possibility to achieve plausible and verified results in the prevalent research context.

Besides both conventional approaches (i.e. quantitative and qualitative research), a mixed-methods-approach is comprehensible as a third, independent research approach (Roch, 2017, p.4). This implies, that both conventional approaches are not excluding each other and sometimes it is useful to combine them to a mixed-methods-approach, which expands research opportunities and facilitates the elaboration of answers to respective research questions (Röbken et al., 2016, p.12). Subsequently, due to the prevalent combination of qualitative as well as quantitative research methods in this work, both approaches are briefly explained.

2.2.1. Qualitative Research Methods

Qualitative research methods are the counterpart to quantitative research methods in a mixed-methods-approach and are characterisable by an increased interpretive and subject-oriented manner compared to quantitative research (Röbken et al., 2016, p.14). Backed on this, especially this interpretive, content-oriented manner differentiates this approach from quantitative research and leads to the condition, that predominantly interpretive data are required to postulate new theories or hypotheses (Roch, 2017, p.4).

In general, in advance of qualitative research, it is necessary to check the suitability of prevalent data for this methodology. Exemplary, absolute numerical numbers are useless for qualitative approaches, signifying that exclusively datasets are applicable, which are independently available besides any prevalent quantitative study (Roch, 2017, p.7). Qualitative research targets the subjective projection of the real situation, facilitating the comprehension of specific behaviours and attitudes. Moreover, qualitative data evaluations are increasingly interpretive so that theoretical pre-assumptions are more flexible adaptable as in a quantitative research (Röbken et al., 2016, p.14). In contrast to all advantages, qualitative methods entail also determinative research disadvantages, which influenced the ultimate decision to apply a mixed-methods-approach in this Master´s thesis.

Owing to the prevalent mixed-methods-approach, even the structure of this thesis displays chapters that contain qualitative research. Therefore, after profound research on qualitative secondary literature, which has been conducted on internet, scientific literatures and specialist journals, relevant data are stored, combined and analysed. In the aftermath, all data are evaluated and conveyed to the discussion section at the end of the thesis, in which all collected facts and information are combined with results from the quantitative section. At this stage, especially the descriptive and interpretive manner of these data facilitates the interpretation of quantitative numbers, finally enabling reliable conclusions regarding the acceptance of civil drones in Austria by answering several research questions.

2.2.2. Quantitative Research Methods

Quantitative research is object-oriented, which implies that the respective research targets primarily the identification and explanation of cause-effect relationships. In contrast to a qualitative approach, quantitative methods are exclusively utilising absolute numerical data (Röbken et al., 2016, p.13).

In advance of quantitative research, it must be ensured that the respective research question is solely answerable by collecting and analysing exact numerical data. Therefore, already in the project preparation phase and while defining suitable research methods, respective information must be projectable in absolute numbers and units (Roch, 2017, p.7). Besides overall striking research advantages, quantitative methods include also disadvantages, which are briefly scrutinised in the explanation of the mixed-methods approach and reason why this thesis is not exclusively applying quantitative methods.

In this Master´s thesis, quantitative research is conducted in Chapters 5 and 6, wherein subsequently to an encompassing internet and literature research, focussing on available surveys and studies evaluating the acceptance of civil drones, relevant data is collected and introduced into the discussion section. In this concluding section, combined with several qualitative implications, a statement regarding the acceptance of drones in Austria is provided.

2.2.3. Mixed-methods Approach

The structure of this Master´s thesis incorporates quantitative and qualitative research. In line with this, the decision to deploy a mixed-methods-approach is reasonable, especially by analysing several research questions, which are mainly responsible for the design-choice. In general, a mixed-methods approach enables the combination of quantitative and qualitative research characteristics to a new, multiphasic approach (Kukartz, 2014, p.33).

Primary target of this method is the balancing of disadvantages, incorporated in both conventional methods by combining them into a new approach, leading to scientifically valid and profound answers to many research questions (Roch, 2017, p.13). To argue the deployment of the mixed-methods-approach in this scientific work, it is useful to visualise advantages and disadvantages of both methods (Table 1).

	Qualitative method	Quantitative method
Advantages	Individuality	Data precision
	Data versatility	Data comparability
	Data flexibility	Data attachability
	/	Data clearness
	/	Data efficiency
Disadvantages	General statements hardly possible	Scaling information required
	Many different methods	Possible information loss (visualisation)

Table 1: Pros and cons of qualitative and quantitative research methods (Röbken et al., 2016, p.15).

In correspondence with Table 1, on the upside, qualitative methods impress with an enhanced flexibility, versatility and individuality in the course of any data handling. On the downside, especially the interpretive manner of qualitative methods severely aggravates universal statements.

Quantitative methods captivate predominantly with precision, clearness and offered comparability by handling absolute, numerical data. Besides that, a striking drawback is the threat of losing essential information owing to the scaling of datasets.

All in all, the mitigation of individual methodological drawbacks by combination of both individual methods is the striking advantage of a mixed-methods approach, ultimately enabling proper statements and research implications.

2.2.4. Implications for the Structure of This Thesis

As noticeable from Table 1, quantitative and qualitative research methods provide variant advantages or disadvantages, but particularly due to the wide-ranging scope of all manifested research questions in this thesis, it is beneficial to combine both methods to a mixed-methods approach, ensuring that different methods incorporated in both spectrums are combinable. All this facilitates an increased research flexibility and the establishment of reliable answers or hypotheses to respective research questions.

Regarding all defined research questions and overall structure, the majority of defined research questions is answerable by application of quantitative methods. In line with this, preliminarily research on international acceptance studies is conducted on internet, scientific literatures or professional journals. Afterwards several acquired numerical datasets are appropriately prepared, collected and assorted so that in a final step a statistical evaluation, comparison and analysis is facilitated. This circumstance reasons, due to the processing of absolute numerical numbers, the application of quantitative research in the following parts (e.g. chapters, research questions) of this scientific script:

- 5. International Drone acceptance studies – Overview & Selection
- 6. International Drone Acceptance Studies – Analysis & Evaluation

For the remaining chapters and research questions, qualitative methods are exerted. As stated above, this method facilitates the interpretation of non-absolute data or implications from already completed studies and the subject-oriented examination of facts, which enhances overall research flexibility and quality of attained outcomes. To gather sufficient and scientifically useful data in this elaboration, also qualitative research is predominantly conducted on the internet, scientific literatures, professional magazines and relevant media. Thereafter, collected data are rehashed, stored, interpreted and combined to ensure on one hand proper qualitative research results and on other hand profound interpretative approaches in the discussion, wherein results of both methods are ultimately combined. The prevalent scientific script applies qualitative research in the following sections:

- 3. Civil Drone applications – Technology, markets and regulations
- 4. Public acceptance of civil Drones – Key factors and stakeholders

In accordance with several applied research methods and due to the defined structure, this script deploys a parallel mixed-methods approach (Figure 5), wherein both research methods are conducted separately and afterwards all achieved quantitative and qualitative results are combined to answer all research questions (Roch, 2017, p.9).

Furthermore, most sequences in this thesis display quantitative background. In line with this, the mixed-methods approach in this script exhibits a slight priority to quantitative research.

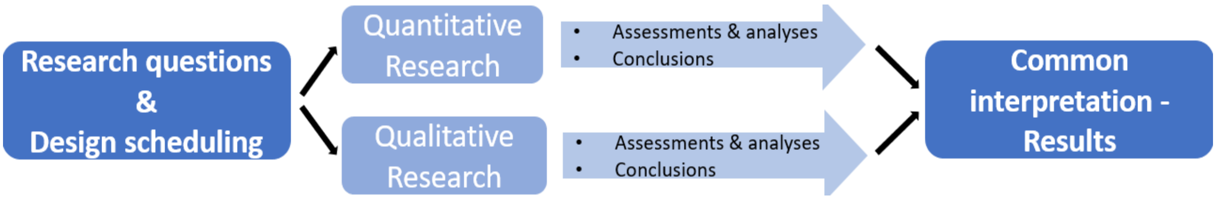


Figure 5: Flowchart illustrating the principle of a parallel mixed-methods approach (Roch, 2017, p.9).

To recapitulate, the prevalent research applies a parallel mixed-methods approach aiming to establish scientifically adequate answers to all research questions. Therein, a thorough parallel and simultaneous data evaluation is conducted by combination, interpretation and conclusion of all available data and results from both individual methods, as part of the discussion at the end of this thesis. Therein, compatibility between both methods is sufficiently guaranteed and potential outcomes, with respect to the significance for the drone acceptance in Austria, are enhanced by combination of both methods. In the incipient sections, predominantly non-numerical, qualitative data regarding the public drone acceptance is researched, summarised and described. Simultaneously, as part of Chapters 5 and 6, quantitative international drone acceptance studies are researched and examined.

Finally, in the concluding sections (Chapters 7, 8 and 9), relevant results and statements from both research methods are combined, merged and discussed with the target to answer all research questions and to elaborate valid statements regarding the public acceptance of drones in Austria.

2.3. *Selection Criteria and Categorisation of Adequate Research Studies*

As recognisable from Figure 6, several quantitative selection criteria are based on five defined parameters and thus, in Chapter 2.3.6. the so-called CASP-tool is introduced, which is a rating method that distinctively facilitates a transparent and reasonable study selection process.

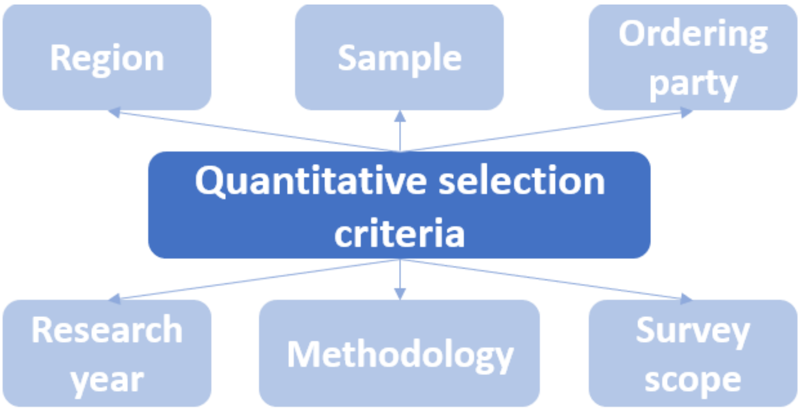


Figure 6: Overview of all determined quantitative selection criteria (own work).

Subsequently, all defined quantitative selection criteria are briefly expounded, highlighting influences on public drone acceptance.

2.3.1. Region

An effective way to differentiate researched international drone acceptance studies is to categorise them according to their geographic origin. Consequently, to ensure a maximum of geographical coverage, including a balanced number of different cultures, living or social standards, topographies and political situations, an evaluation of the survey region is crucial for the final quality of this thesis. All beforementioned parameters are solely associated with the terminology 'Region' and therefore, it is of importance to consider all selection criteria to determine relevant international drone acceptance studies. Therethrough, especially regional or cultural majorities or other disbalances must be prevented in the spectrum of all final selected studies.

As stated above, differences in common risk perception or common technology affinity are strongly depending on influences triggered by regional differences (e.g. culture, ethics, religion). Therefore, to emphasize the importance of a comprehensive and clear geographical consideration in this scientific work, it is worthwhile to analyse these indications at this stage briefly.

Many global regions are primarily differentiable by cultural specifics. According to Kaasa et al. (2014), a region is a geographic concept that denotes a set of places that have something in common (p.7). In principal, regions share the same culture and therefore, it is important to analyse cultural differences to facilitate an understanding towards diverging human behaviours by the introduction of cultural dimensions (Budak et al., 2014, p.5):

- Power distance
- Masculinity vs. Femininity
- Power Distance Index (PDI)
- Long-term orientation (LTO)
- Uncertainty avoidance (UAI)

In this context, the cultural parameter ‘Power distance’ evaluates the level, at which several social classes expect that power is distributed socially unequally. The subsequent factor ‘Masculinity vs. Femininity’ assesses, if a society is living more according to masculine (e.g. aggressiveness, dominance) or feminine values (e.g. empathy, emotional openness). The ‘Power Distance Index’ (PDI) measures the level of societal inequality and evaluates how the society counteract these inequalities. Finally, the dimension ‘Long-term orientation’ (LTO) indicates the societal tendency of developing individual long-term orientations and finally, the parameter ‘Uncertainty avoidance’ (UAI) assesses how societal members deal with uncertainty and ambiguity (Budak et al., 2014, p.7).

Several beforementioned parameters facilitate the detection and determination of cultural or regional differences. According to Kaasa et al. (2014), differences in historical background, geographic characteristics or ethnical identity may cause significant cultural differences between adjacent regions (p.5). In this context, a suitable example for a historically developed region is the to date prevalent cultural difference between former West- and East Germany (Kaasa et al., 2014, p.25). By evaluation of all cultural parameters in Europe, due to the dynamic historical background, 82 diverging cultures are identifiable in 32 countries (Kaasa et al., 2014, p.7). Based on these insights, especially in Europe it is of decisive importance to deploy a wide-ranging geographical scope in the quantitative part of this thesis.

Recapitulatory, regional differences influence the public perception of novel technologies, drones or other inventions. Therefore, in this Master´s thesis it is elementary, that in advance of any quantitative research, all available studies are analysed, clustered and selected to ensure a maximum of geographical coverage, including a balanced number of different cultures, societal or political systems, topographies and historical backgrounds. All this safeguards the attainment of reasonable implications for the public acceptance of civil drones in Austria. To clarify, in virtue of possible regional differences on an in intranational level and to enhance the study scope, this thesis considers ‘Regions’ and not ‘Countries’.

2.3.2. Ordering Party

The emerging civil drone sector involves and affects an imposing number of potential stakeholders on a recreational, industrial and governmental level. As a result, on the back of the prevailing economic potential, also reinforced by various statements of EU and EASA (e.g. Riga declaration), international research concerning the acceptance of civil drones has been conducted, targeting the expedition of the implementation, regulatory and societal adoption process of drones by proper strategies. In close connection to the magnitude of involved stakeholders, civil drone acceptance has already been evaluated by the following international actors:

- European Parliament (EP) & European Commission (EC) (e.g. Eurobarometer survey)
- Governments (e.g. House of Lords – UK)
- National aviation authorities (NAA) (e.g. AIRWAYS – NZL)
- Universities and research institutes (e.g. ETH Zürich – SUI)
- Official aviation associations (e.g. Aerospace Industries Association (AIA) – USA)
- Industrial organisations (e.g. insurances, delivery services, retailers)
- Private persons (e.g. enthusiasts, students)

Especially the variety of ordering parties signifies the relevance of societal drone acceptance for the entire international stakeholder community. Besides that, it is worth mentioning that also the consideration of the ordering party type is important for the plausibility of this thesis. On one hand, especially studies conducted in commercially driven backgrounds are often endangered of being too suggestive, unrepresentative or non-exhaustive, assessing only specific drone aspects without publishing any survey details (e.g. demography, methodology). On other hand, especially many studies from the US, have been conducted in an academic context, with non-representative scopes, vague questioning or exclusively students as interviewees.

Resting upon all prior statements, in the final quantitative selection process, also the type of ordering party is evaluated and categorised in advance of each examination. Especially the thorough implementation and realisation of this procedure safeguards that solely studies of reliable ordering parties are considered. Moreover, a heightened focus on study results, which have been achieved by governmental incentives or by trustworthy field-relevant organisations, significantly enhance the quality and impartiality of results, statements and implications. Nevertheless, in advance of applying the CASP-Tool, all researched studies are displayed in the study pre-selection in Chapter 5. At this stage, the CASP-Tool is distinctively facilitating a plausible and objective study selection process, showing the reader the multitude of internationally available drone acceptance studies, emphasising the significance of societal acceptance for this emerging market.

2.3.3. Research Year

Drones were firstly deployed during World War I to accomplish exclusively military tasks. From then on, the technology developed and matured rapidly, so that drones were frequently used in armed conflict of the past (e.g. Pakistan, Afghanistan, Iraq) to transport weaponry, drop bombs or to conduct reconnaissance flights (Braun et al., 2015, p.3).

Besides the still ongoing military usage of high-tech drones, mainly military enabled technological developments in the field of miniature electronics and mass production during the last decades have increasingly facilitated the public access to affordable civil drones, applicable by general public, companies or authorities for civil purposes (European Parliament, 2015, p.2). In consequence to this development and all its accompanied risks and chances, the European Union (EU) initiated in 2009 an early consultation process, wherein until 2012 in three stages, containing a hearing (2009), a high level conference (2010) and five workshops, hosted by DG ENTR and DG MOVE, required framework for a harmonised pan-European drone regulation has been elaborated by addressing several barriers, concerns and benefits entailed by civil drones to the European market (Boucher, 2014, p.10). According to these consultations, a first EC working document has been issued in 2012 and the ERSG (European RPAS steering group) was founded in 2013 to accompany the integration of civil drones into European airspace by 2016, as stated in 2014 by the European Commission (Boucher, 2014, p.10). Subsequently, in March 2015 EU and EASA issued the pathbreaking Riga declaration, wherein all EU-MS (Member States) and relevant European industrial stakeholders mutually strengthened the intention to open the European airspace in 2016 for civil drones (Nader et al., 2016, p.3). At present, in the European Union fragmented rules concerning civil drones below 150 kg are prevalent. A harmonised regulation for the whole European Union is already enacted and will enter into force on 1st January 2021.

This overview of the regulatory history in Europe demonstrates, how rapid the application field of drones expanded from entirely military (single use) up to military-civilian (dual use) deployments. Nevertheless, it took until 2021 to establish a harmonised ruleset for civil drones below 150kg in the EU, but regarding the regulatory processes of other continents, estimated temporal horizons and regulative procedures are comparative. Concerning the usage of civil drones, in the interim between the early EC consultation process in 2009 and the upcoming regulatory harmonisation in 2021, civil drones were increasingly used for miscellaneous routine tasks and thus stepped more and more into the centre of our daily life. Complementary, this timeframe is also relevant for the public perception and acceptance of civil drones, because potential incentives by NAA or EC, obtained personal experiences or changed media reporting styles can influence the public acceptance over years, so that to date civil drones are perhaps not that innovative or frightening for common society as they have been in 2009.

Based on the timely compressed introduction of civil drones in Europe, the research year is undoubtedly one of the key decision factors in evaluating and comparing different acceptance studies. In general, a quantitative survey is a suitable instrument to evaluate the current social perception, but potential prospective favourable or adverse events (e.g. information campaigns, technological or regulatory improvements, accidents, incidents) can affect public acceptance afterwards, so that respective effects remain unconsidered in an out-dated survey. Furthermore, most European research on drone acceptance has been initiated in the aftermath of the Riga declaration (2015) and therefore, the density of European studies before this year is rare.

The quantitative section of this Master´s thesis targets the analysis of a balanced amount of research years to provide this research with a maximal research volume, identify potential influences on public acceptance in consequence to governmental incentives or to detect societal trends in the period from the early phase (2009) to today. Therein, the most important target is the postulation of implications and recommendations for the Austrian civil drone sector.

2.3.4. Sample and Demography

An adequate sample size and survey quality, which ensures that several national demographics are represented correctly are essential prerequisites for plausible final implications and results in this scientific script.

Regarding survey quality, a crucial parameter is the total survey error, which measures the influence of potential error sources, originating from data collection or final data evaluation.

Besides that, especially the sample error, incorporating an estimation and selection error, are determinative for survey quality and representativity (Faulbaum, 2019, p.23). Moreover, Faulbaum (2019) states, that a sample is representative if therein all demographic characteristics like gender, age, education or occupation are correctly represented, containing frequencies that are proportional to those in the entire population (p.364).

Backed on this, predefined requirements on overall sample quality are of key importance to ensure that in this thesis national populations are accurately displayed, especially in the context of drone acceptance. In accordance with that, predominantly socio-demographic parameters like age, gender, education, occupation or national social-welfare influence the individual risk-perception, risk sensitivity and thus, also risk acceptance.

Exemplary, prevalent differences concerning social welfare systems between member states of the EU and the USA also influenced the individual risk perception, because European social systems are undoubtedly more generous and reach a larger scale of people as in the US (Alesina et al., 2014, p.2). All this affects the risk perception of specific social classes, and triggers perhaps also acceptance differences between both continents.

Another demographic parameter involves the correct projection of the national age pyramid and gender distribution by the sample of a survey. For instance, women are expressing often more concerns and higher perceived risk levels than men, whereby even proper knowledge about prevalent risks are not completely diminishing gender differences (Hitchcock, 2001, pp.1-2). In general, primary causes for this behaviour are differences in the ‘perceived vulnerability’ and the fact, that males are often more motivated to take risks (Arch, 1993, p.4).

Behavioural research argues that risk perception is significantly changing by age. Therefore, besides the fact, that detailed changes are dependant to the specific risk domain, the disposition to take recreational risks is steeply reducing from young to middle ages and slightly from middle ages to older ages, which probably causes also age differences in the acceptance of civil drones (Rolison et al., 2013, p.3).

To sum up, several established selection criteria safeguard that only representative international acceptance studies are considered in this Master´s thesis, so that also demographical effects of gender, age or occupation are replicable.

2.3.5. Survey Methodology

The applied survey methodology constitutes especially in the context of civil drones and innovative technologies a crucial selection criterion. In principal, opinion research differentiates four different interview methods (Kuß et al., 2017, pp. 49-60):

- In-person interview
- Written interview
- Telephone interview
- Online interview

In this context, every method is entailing different advantages or disadvantages with respect to efficiency, representativeness, survey quality or equivalent. Furthermore, it is assumable that participants of an internet survey are on average more supportive towards innovative technologies as people, who are approached with paper questionnaires.

2.3.6. Critical Appraisal Skill Program (CASP)

To ascertain an appropriate scientific quality of all researched and considered studies, a pre-selection of all gathered international studies is conducted in Chapter 5, based on the 'Critical Appraisal Skill Program' (CASP).

In total, more than 100 international drone acceptance studies have been collected. Therefore, to ensure that several considered studies are complying with the predefined quality requirements of this Master´s thesis, all previously specified selection criteria are implemented in the CASP-template (Figure 7). Consequently, several studies are evaluated by the following parameters: survey method, scope, region, research year, sample size and ordering party.

In specific, after all parameters are incorporated in the adjusted CASP-Tool, each drone acceptance study is evaluated and graded according to a predefined rating scheme (Figure 7), enabling ratings up to five points per category, depending on the individual category,.

Nat.	Year	Survey method	Survey scope	Region	Research year	Sample size	Ordering party	Total Score
		Which survey method is applied?	*Are all aspects of drones covered in the survey?*	*Is many research available for this region?*	*Is many research available for this year?*	*Does the sample ensure representiveness?*	*What´s the context of the ordering party?*	
			0 (none) - 5 (all)	0 (many) - 2 (less)	0 (many) - 2 (less)	0 (undersized) - 3 (adequate)	0 (private) -4 (government)	

Figure 7: Adapted and weighted CASP categorisation or study rating scheme (own work).

As recognisable from the applicated point distribution in Figure 7, and as already stated above, this research attaches great importance to the context of the ordering party (4 points) and the research scope (5 points), which both represent 9 of 16 in total achievable points.

After completion of the CASP-assessment, several categorically achieved 'points' are added and ultimately, only international acceptance studies that reach at least 50% of all available points (≥8 points) are considered for the quantitative part. Apart from this, addressing nationally or methodologically unique studies that are CASP-rated below 8 points, the research reserves itself the option of granting case-by-case exemptions (e.g. to enlarge geographical scope).

3. Civil Drone Applications – Technology, Markets and Regulations

This chapter provides in-depth knowledge regarding the current or prospective civil drone market, the prevalent and prospective regulatory regime as well as a thorough description of potential drone applications.

3.1. What are Civil Drones? – Common Definitions

Drones are powered unpiloted aerial vehicles, either steered by a remote pilot or by a pre-programmed autonomous system, which can accomplish a broad pallet of potential applications in recreational, industrial or military contexts by easily adjustable payloads or various model types (Boucher, 2014, p.1). The technological principle dates from 1849, in which Austrian forces besieged Venice by dropping incendiary balloons (historytoday.com, 2016). Basically, due to the long history and the enormous potential of drones, over the years many different terms emerged internationally (Landrock et al., 2018, pp.2-3):

- **Drone** – Derived from robotic planes, used for target practices in World War II. Ten years ago, the term was mainly addressing military drones (and state-building insects).
- **UAV** (unmanned aerial vehicle) – Addresses unpiloted airspace models without its sub-systems and ranges from weather balloons to military transport planes.
- **UAS** (unmanned aircraft system) – Generic term addressing more autonomous systems, also including platform, ground control station, data transmission, sensors and payload.
- **RPAS** (remotely piloted aerial systems) – Aerial systems that have no pilot on board, but this terminology highlights the remote, non-autonomous control by humans.

Beyond several nowadays utilised terminologies, since the first military use of drones in 1914, the technology and applicational range has increasingly shifted from entirely military to a military-civil use. In addition, the establishment of civil drones has already been anticipated by ICAO (International Civil Aviation Organisation) in the Chicago Convention of 1944 (ITF, 2018, p.9):

> *No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization.* – Chicago Convention, ICAO, 1944

To secure a safe and sustainable civil drone integration process, many international aviation authorities started to develop a regulatory framework for civil drones around the turn of the millennium. For example, EASA initiated the EU policy discussion in 2002 with the target to integrate civil drones into the European airspace by 2028 (Volovelsky, 2014, p.3). In the United States, civil drones were already used by disaster relief organisations in 2005 (Greenwood et al., 2019, p.2). Whilst any regulatory initiatives of EASA or FAA, the versatility of available drone definitions were an obstacle and triggered several iterations in the consultation process until a final definition for civil drones, excluding any misconceptions, has been elaborated. Nevertheless, definitions vary distinctively between EASA and FAA (Table 2).

Authority	Definiton
EASA	An Unmanned Aircraft System (UAS) comprises individual system elements consisting of an “unmanned aircraft”, the “control station” and any other system elements necessary to enable flight, i.e. “command and control link” and “launch and recovery elements”. There may be multiple control stations, command & control links and launch and recovery elements within a UAS.
FAA	A device used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot. Unmanned aircraft are understood to include only those aircraft controllable in three axes and therefore, exclude traditional balloons.

Table 2: Applied civil drone definitions of EASA and FAA.

Extensive military drone deployments and pathbreaking research on military drones enabled since World War I a rapid technological development in the field of lightweight constructions, microelectronics and signal processing, which ultimately facilitated also applications in civil contexts (Finn et al., 2012, p.2). Nowadays, the operational versatility of drones is one of the key drivers for the emerging civil drone sector. According to Sandbrook (2015), drones are a flexible, accurate and affordable solution for many recreational, industrial or governmental tasks (p.9). This enormous design variety creates an enormous market potential and a wide range of potential civil applications, ranging from aerial photography to fire monitoring up to agricultural tasks (Straub, 2013, p.2). On the back of this variety, drones can be classified in many ways, but the most common is to differentiate them according to technological capabilities and design-specific parameters (Boucher, 2015, p.1):

- Model size
- Quality
- Capability
- Complexity

Apart from the military history and dual-use aspect of drones, this Master´s thesis focusses explicitly on civil drones and all its associated non-lethal, recreational, industrial or governmental applications, including also potential UAM (Urban Air Mobility) aspects. However, to deploy the most comprehensive terminology, avoiding the word ‘unmanned’, this research applies consistently the term ‘civil drone’. Thereby, to counteract any kind of military associations regarding the term ‘drone’, the preposition ‘civil’ highlights and reinforces, that this work considers exclusively non-military drones. Referencing to EASA (2020), model aircraft flights are organised by authorized organisations for the purpose of conducting leisure flights, air displays, sporting activities or competition activities (p.17). In consequence, this Master´s thesis is not considering any model flights conducted at respective cites.

3.2. Civil Drones – Categorisations, Capabilities and Applications

The operational versatility, flexibility and common accessibility entailed by civil drones to people of the private, industrial or governmental sector is mainly responsible for the coherently optimistic market forecasts of this sector. Civil drones are easily available, adjustable and deployable in various ways, which is in the upcoming chapter described from a common, technological and practical perspective.

3.2.1. Various Categorisations of Civil Drones

Technological developments in terms of miniaturisation, signal processing and power supply have incrementally increased technological and operational capabilities of drones on a military but especially civilian matter. Nowadays, many different concepts and configurations are obtainable, whereby it is hardly possible to keep track of all sectoral developments (Kückelhaus, 2014, p.6).

Beyond that, diverging ways to differentiate and categorise drones are in common use, because the versatility of this sector leads to the circumstance that specific attributes or criteria are identical or overlapping each other, aggravating a strict and universally valid classification (Skrzypietz, 2012, p.6). Contrary to this, to enhance reader comprehensiveness and to enable profound insights into various application fields, a categorisation of drones is required in this Master´s thesis. In general, the operational performance of drones is strongly varying in terms of size, weight and technological capabilities and thus, drones can be as large as conventional, manned aircraft or as small as matchboxs (Altawy et al., 2016, p.3). To maintain the structure in this thesis, according to Custers (2016), drones can be reasonably categorised by differentiation according to the following parameters (p.42):

- Configuration (Fixed-wing, rotorcraft, hybrid)
- Degree of autonomy
- Size & weight
- Power source
- Maximum payload

In the following sequences, each category is briefly explained, focussing explicitly on relevant technologies and categories concerning civil drones.

- **Configuration**

Similarly to the manned aviation, drones can be differentiated according to the applied principle of lift-generation, which is also determining key flight characteristics, like VTOL (Vertical take-off or landing) abilities, emitted fly-over noise, green-house emissions or flight manoeuvrability (Custers, 2016, p.24).

Fixed-wing configurations characterises drones, applying the same lift-generation principle as conventional fixed-wing aircraft. Therefore, a cambered wing is mounted on the fuselage aiming to produce dynamic lift by accelerating horizontally up to a specific take-off speed. Fixed-wing drones are predominantly used by military and especially appreciated for increased endurances, operating altitudes and efficiencies in contrast to multirotor drones (Custers, 2016, pp.24-25). An example for a fixed-wing drone is visible in Figure 8, the AeroVironment RQ-11, or shortly 'Raven'.

Figure 8: The AeroVironment 'RQ-11' exemplary for a fixed-wing configuration (artstation.com, 2020).

Appertaining to multirotor drones, this configuration applies the same lift-generation principle as conventional helicopters. Contrary to fixed-wing drones, multirotor drones generate lift by the fast rotary motion of multiple, small sized rotors, which enhance system reliability (redundancy), flight stability and moreover, enables VTOL-characteristics (Custers, 2016, p.3). Multirotor drones are predominantly used in civilian contexts (recreational, industrial and governmental) and thus, are more emphasized in this thesis than fixed-wing drones. A suitable example for this configuration is the so-called ‘Phantom 3’ produced by the market-leading, Chinese drone manufacturer DJI (Figure 9).

Figure 9: The DJI 'Phantom 3' exemplary for a multirotor configuration (amazon.de, 2015).

Hybrid systems combine principles and characteristics from fixed-wing and multirotor drones. On one hand, these systems use multiple rotors to enable VTOL-abilities and on other hand, fixed-wings to enhance overall system performance regarding velocity, operational range and efficiency, ultimately enabling long-distance flights (Custers, 2016, p.24). An example for a hybrid configuration is visible in Figure 10, the ‘Gx350’ of the Chinese drone manufacturer Keweitai.

Figure 10: The Keweitai 'Gx350' exemplary for a hybrid configuration (keweitai.com, 2010).

- **Degree of autonomy**

Beyond the configuration, another opportunity to classify drones is to distinguish different autonomy levels. In general, autonomous systems mitigate the threat of human error and therefore facilitate various drone applications, but the technology and regulatory development of these systems is still in progress. Nevertheless, it is expected, that in the next decade required technologies in the fields of system-failure responses, dynamic exhibit routing and overall HCI (Human-Computer-Interaction) will significantly mature (Cohn et al., 2017, p.6). However, due to the absence of a pilot, drones always reveal a specific level of autonomy, which range from purely human-controlled to fully autonomous drones (Custers, 2016, pp.25-26). The US defence department distinguishes four different degrees of autonomy (Department of Defense, 2013, p.67):

- Human-controlled systems
- Human-delegated systems
- Human-supervised systems
- Fully autonomous systems

In summary, drones can fly purely human-controlled (remote), along pre-programmed flight routes (automatic) or fully autonomously, so that these systems have the 'freedom of choice' (Culver, 2014, p.49).

- **Size & weight**

In unmanned aviation, especially size and weight are dimensional parameters that significantly influence operational scope, performance, maximum payload and efficiency of a system. In general, drones can weigh from a few grams up to 10 tons and be as large as an insect or like a commercial aeroplane (Nader et al., 2016, p.4).

Referencing to Custers (2016), research and leading drone manufacturers are momentarily focussing on the production and development of smaller and lighter drones for non-military purposes, enabling enhanced endurances, performances and payloads (p.26). Besides that, based on the formula of kinetic energy, regulating authorities make often use of the parameter 'weight' to evaluate the operational risk.

- **Power source**

Referencing to Nader et al. (2016), the endurance of drones can range from a few minutes up to several hours, depending on exact configuration and power source (p.4). Besides that, also system-internal energy consumers like motors, payloads or external, atmospheric influences (e.g. wind, rain) influence the endurance of a system (Landrock et al., 2018, p.8). However, nowadays drones are utilising mainly four different energy sources (Custers, 2016, pp.26-27):

- Conventional aircraft fuel
- Battery cells
- Fuel cells
- Solar cells

Conventional aircraft fuel is nowadays predominantly used in military, fixed-wing drones and therefore not further considered. Beyond that, the energy supply principle of rechargeable battery cells is momentarily most relevant and frequently used in civil, multirotor drones, wherein especially the low energy density causes inadequate system endurances and performance lacks, leading to noteworthy operational drawbacks. In addition, also state-of-the-art fuel cell technology is utilised by drones. Fuel cells are electrochemical devices, converting energy from fossil resources directly into electrical energy. Contemporarily, fuel cells are rarely applied to drones because the pronounced distinctive additional weight is only carriable by suitably dimensioned fixed-wing drones. Another potential energy source are solar cells, which are directly attached on the fuselage, convert solar energy in usable electricity. Apart from the trend of using renewable energies, severe drawbacks in terms of system efficiency are reasoning why solar cells are nowadays seldomly used by drones (Custers, 2016, p.27).

Predominantly the inadequate energy density of battery cells causes severely reduced operational endurances, which is until now a significant barrier for the further development of a civil drone market. Nevertheless, in the next decade it is assumed that capacities and lifespans of lithium-ion batteries will significantly increase and thus, unlock new values so that drones are prospectively capable to fly more than 60 minutes without recharging (Cohn et al., 2017, p.6).

- **Payload**

Referring to all prior statements, predominantly weight, model size and used energy source determine operational capabilities like maximum altitude, endurance, flight range and maximum payload of drones (Custers, 2016, p.36). In general, civil drones are mostly appreciated for their broad applicational scope, which is mainly facilitated by interchangeable payloads (e.g. parcels or medical equipment) or various attachments (e.g. sensors, cameras or Wi-Fi routers).

At this stage, it is worth mentioning that sensory equipment is the most important payload of civil drones. Ranging from biological sensors to chemical sensors up to particle sensors, drones can facilitate or ascertain many different routine operations of the daily civil life or even assist in emergencies or catastrophes (e.g. floods, hurricanes, nuclear accidents). In common, several emerging application fields and the overall market potential is predominantly caused by the impressive operational flexibility, scope and cost-effectiveness enabled by the adjustable payload of drones.

3.2.2. Technological Capabilities

Subsequently, proceeding on insights from the categorisation of civil drones, some examples for fixed-wing, multirotor and hybrid drones are thoroughly analysed and evaluated with the target to validate beforementioned differences regarding technological and operational capabilities (Figure 11).

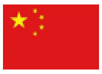
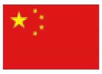
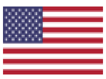
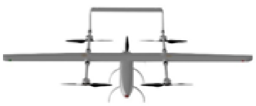
Manufacturer	Model	Configuration	Capabilities	
DJI 	Mavic Air 2 (2020) 	Multirotor - Recreational	Total weight	570 g
			Size (diameter)	302 mm
			Max. climb speed	4 m/s
			Max. descent speed	3 - 5 m/s
			Max. velocity	19 m/s
			Max. altitude	5.000 m
			Max. endurance	appr. 34 minutes
			MTOW	N/A
			Energy source	Battery cell
			Price	960 $
DJI 	Phantom 4 (2016) 	Multirotor - Industrial	Total weight	1.380 g
			Size (diameter)	350 mm
			Max. climb speed	6 m/s
			Max. descent speed	4 m/s
			Max. velocity	20 m/s
			Max. altitude	6.000 m
			Max. endurance	appr. 28 minutes
			MTOW	N/A
			Energy source	Battery cell
			Price	5.000 $ - 6.500 $
AeroVironment 	RQ - 11 (2001) 	Fixed-wing - Military	Total weight	1.900 g
			Size (length x width)	900 x 1.400 mm
			Max. climb speed	N/A
			Max. descent speed	N/A
			Max. velocity	8,9 - 22,5 m/s
			Max. altitude	30 - 152 m
			Max. endurance	60 - 90 minutes
			MTOW	6,3 kg
			Energy source	Battery cell
			Price	25.000 $ - 45.000 $
Keweitai 	GM360 (2001) 	Hybrid - Industrial	Total weight	1.900 g
			Size (length x width)	2.300 x 3.600 mm
			Max. climb speed	N/A
			Max. descent speed	N/A
			Max. velocity	31 / 28 m/s
			Max. altitude	4.500 m
			Max. endurance	4-6 h / 2 h
			MTOW	25 kg
			Energy source	Petrol engine/Battery cell
			Price	10.000 $

Figure 11: Operational and technological specifics of different drone configurations (own work).

As extractable from Figure 11, various drone models are available, and thus, technological capabilities, exact configurations and purchase prices are strongly variegating according to the specific usage context. Exemplary, the recently released ‘Mavic Air 2’ of the Chinese manufacturer DJI is a suitable example for a recreational drone utilisable by the general public. The ‘Mavic Air 2’ is obtainable below 1000$, is camera-equipped and the application of a rechargeable battery cell permits endurances of approximately 34 minutes, which is in comparison to an older industrial drone, the DJI ‘Phantom 4’, an increment of at least six minutes, indicating significant research progress concerning battery cells and a higher system efficiency.

Independently from the intended application, operational endurance is always a key decisive design parameter for drones. As stated above, in early stages drones were exclusively applied for military purposes, wherein endurance is of crucial importance. Therefore, military drones like the RQ-11 that perform mainly military reconnaissance flights deploy fixed-wing configurations to enhance operational efficiencies and consequently also endurances. Thereby, since 2001 military drone flights above one-hour duration are possible. Beyond that, also the purchase price of military drones differentiates significantly from industrial and recreational drones.

On the back of several advantages and disadvantages of fixed-wing and multirotor drones, some specific applications require a combination of both flight properties, which is realizable by utilisation of hybrid configurations like the ‘GM360’ of the Chinese manufacturer Keweitai. Striking advantages of this set-up are not far to seek and are the result of an effective compromise enabling enhanced operational scopes in terms of on demand VTOL-ability, endurance, velocity, maximum altitude and payload compared to conventional multirotor drones.

3.2.3. Applications – Overview and Notable Usages

According to the Austrian Court of Auditors (2020), in past years multicopters have been increasingly deployed in recreational or industrial applications like aerial photography, delivery flights (e.g. relief flights to chalets) or specific inspection flights (p.16).

Significant research progress in technological fields concerning miniaturisation, endurance and reliability have progressively enabled manifold potential applications in many economic sectors and contexts. Beyond that, also the operational capabilities of civil drones have enhanced considerably so that nowadays numerous applications in daily, routine tasks are realizable, also described as the 3D ‘dirty, dull and dangerous’. All this ensures civil drones a decisive position in the prospective international aviation sector (Landrock et al., 2018, p.26). General expectations and requirements on operational capabilities of civil drones vary strongly with the intended usage context and specific industrial sector. Therefore, different model types are necessary to meet diverging market requirements in terms of payload, endurance, sensory equipment in a cost-effective way. However, the impressing variety of available models and configurations provide civil drones with sufficient potential to influence many industries in a sustainable and positive manner, enabling more and more applications (Haylen, 2019, p.4). As visible in Figure 12, civil drones are already yet facilitating a remarkable number of applications in various contexts and economic sectors. Many of these are beneficial for business activities or the common society and thus, will surmount also specific hindrances concerning human availability or regulatory, geographical and societal barriers (Altawy et al., 2016, p.5). In summary, decisive technological progress, lower purchase costs and the increase in operational reliability have recently facilitated the emergence of various applications, which are categorizable by six application contexts: industry, government, assistance, research, leisure and agriculture (Figure 12).

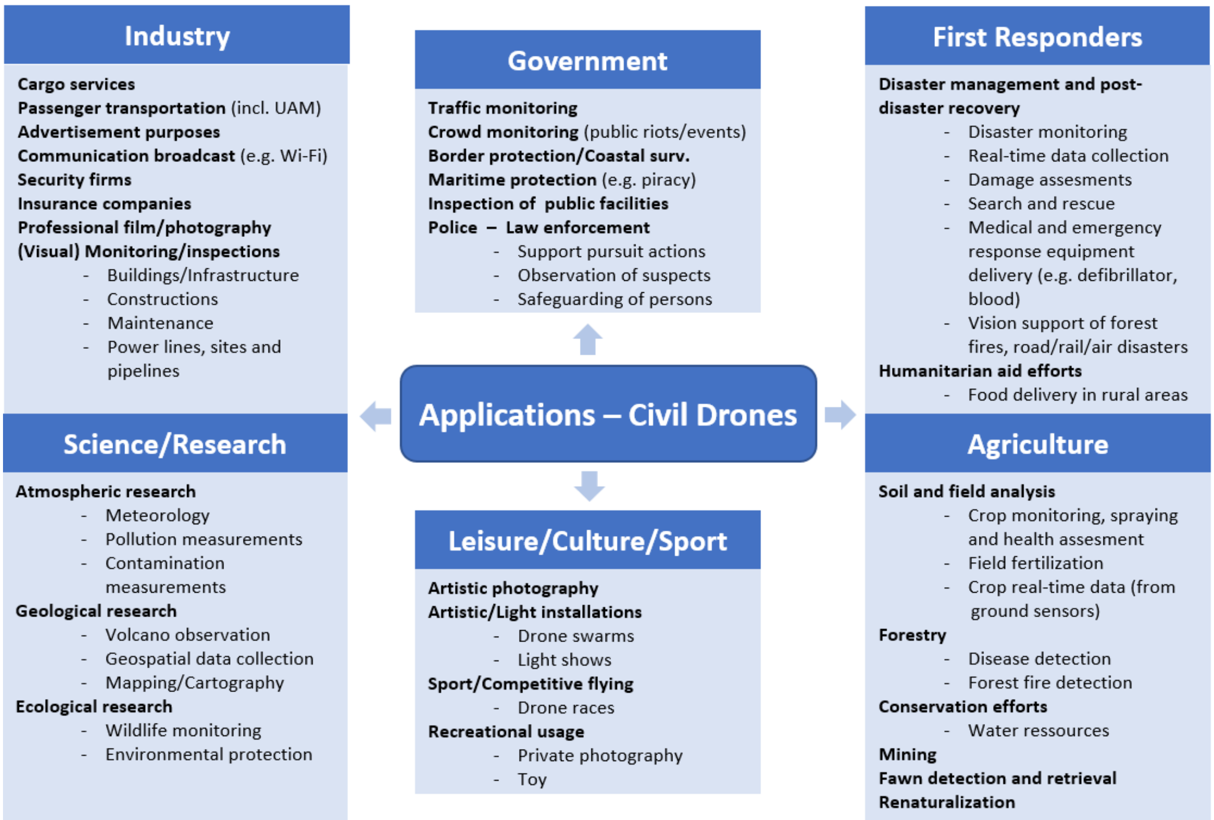


Figure 12: Categorisation and overview of all relevant civil drone applications (own work).

With reference to the previous overview concerning current and prospective civil drone applications, all individual categories are briefly described and elucidated in the following executions.

- **Industrial applications**

A major economic or industrial field for civil drones are potential applications by delivery, transportation or logistics enterprises, affecting the transport of persons and parcels. According to Mcllrath (2019), recent societal changes in shopping behaviour (e.g. online-shopping) facilitate the establishment of civil drones as transport mode, which will generate benefits in terms of transport costs and workforce expenditures (p.42). Backed on some further benefits of cargo drones, like increased operational speed, relief for inner cities and urban traffic reduction, leading companies like Amazon, Google and DHL already initiated projects concerning logistic drones (e.g. Amazon Prime Air) (Haylen, 2019, p.40). Prospectively, also passenger transportation is planned with civil drones, finally enabling UAM (Urban Aerial Mobility).

Besides that, civil drones will also be used for e-commerce package, spare part or food deliveries, and due to the increased speed, technological accessibility, operational cost reduction and the estimated further technological progress, it is assumed, that the economic value of drones in this sector will further intensify (PwC, 2016, p.8).

Another relevant industrial application of civil drones addresses the inspection and maintenance of critical utilities, buildings or constructions. In terms of utilities, which secure the provision of essential public services like electricity and water supply, wastewater (e.g. sewage) or cell reception (e.g. mobile phone mast), drone inspections improve staff safety, network reliability and minimizes inspection expenditures (Mcllrath, 2019, p.38). In total, the following real-time monitoring inspection applications are determinable for civil drones:

- Visual inspection
- Thermal inspection
- Under-build inspection
- Corona detection

Correspondingly, especially the attachable high-resolution or thermal imagery substantiates, why the utilisation of drones for construction and infrastructure monitoring purposes is unlocking significant benefits in parameters speed, quality and cost-efficiency, which will make civil drones 'here to stay' (Haylen, 2019, p.39). In this context, relevant infrastructural sectors utilising drones are predominantly energy suppliers, road operators, telecommunication providers or oil and gas suppliers, which are consentaneous that civil drones can detect local defects more thoroughly, faster and safer than humans. Besides the ability of detecting local defects in a large-scaled inspection area, drones will prospectively also be capable to maintain located defects (PwC, 2016, p.6), enabling a striking reduction of human workload. According to Haylen (2019), especially telecommunication inspections can be effectively enhanced with drones, improving maintenance or inspection processes, carrying out inspection flights to antennas and thus, eliminating any physical threats from employees (p.39).

Insurance organisation are increasingly utilising civil drones to facilitate and enhance daily routines. In this connection, drones are useful devices to counteract on one hand increasing insurance fraud and on the other hand arising damage during natural disasters. On an international level, insurance companies deploy civil drones in the following contexts (PwC, 2016, p.11):

- Risk monitoring (Drones are applied to monitor the local situation and alert residents in case of emergency)
- Risk assessment (Drones are used to gather object information before a policy is issued)
- Claim management (Checking the initial state of a property and its condition after a reported incident)

Another aspect in this coherence elucidates that civil drones are also deployable for promotional purposes, significantly facilitating and improving advertisement, marketing and commercial campaigns. Regarding to PwC (2016), drones can intercept cellular and Wi-Fi transmissions aiming to locate users and to distribute advertisements, based on the search history of the intercepted electronical device (p.13).

Regarding conventional security tasks (e.g. security firms), civil drones can transform or enhance prevalent strategies and approaches in this field. Nowadays, security operations are particular human-intense, but especially the variety of entailed operational capabilities (e.g. speed, manoeuvrability and size) of civil drones are utilisable to support security ground staff, enabling less human exposure and thus, an increased safety, reduced costs and an enhanced security (PwC, 2016, p.18).

A further significant industrial application pertains to professional aerial photography or cinematography utilising drones. In general, drones for cinematographic purposes have been utilised in many movies like ‘The Wolf of Wall Street’ or ‘Harry Potter’, because drones are cheaper, quieter and enable the recording of more dynamic sequences in contrast to helicopters (PwC, 2016, p.12). Besides that, professional drone photography services are already easily bookable for private celebrations like weddings, parties or similar.

- **Scientific applications**

The versatility of civil drones enables a variety of scientific applications. In specific, especially the attachable and interchangeable sensory on drones facilitate various applications in the field of analytical monitoring. The first scientific drone deployment dates from 2002, as a research drone gathered atmospheric probes in northern Europe (Skrzypietz, 2012, p.13). In consequence, civil drone technology matured and to date drones are frequently collecting measuring probes for scientific purposes, regardless if the respective task is risky or harmless. Due to this, drones can take air samples also above active volcanoes, in hurricanes or only conventional atmospheric probes, which massively facilitates weather forecasts or evaluations regarding the current air contamination in terms of fine particles or CO_2.

- **Governmental applications (state operations)**

Many governments intend to take prospectively advantage of the emerging drone market, which incorporates applicational areas like the drone use by trained police staff in non-urgent situations, crowd monitoring at major events (e.g. concerts, demonstrations), traffic monitoring (e.g. traffic jams, issue speeding tickets), homeland security (e.g. border protection) or the protection and inspection of public buildings (e.g. city hall) as well as critical infrastructures (e.g. jails, courts, chancellery).

Thereby, also the monitoring of oil and gas pipelines, rail systems and electricity networks by drones can be interpreted as protection of critical infrastructure. Another already frequently observed application is the surveillance and protection of borders with drones, wherein especially the flexibility and sensor technology is worthwhile and an immense strategic advantage in the creation of an exact situational picture (Skrzypietz, 2012, p.19). Suitable examples of drone deployments for border protection are some FRONTEX missions (e.g. Operation Triton) or the 'Mare Nostrum' (2013) mission by the Italian government to secure the European external border against unauthorized entries by third-country nationals (Custers, 2016, p.118). In several border protection tasks (e.g. Eastern Ukraine, ‘Mare Nostrum’), the ‘Camcopter S-100’ of the well-known Austrian manufacturer Schiebel is internationally highly appreciated for its operational capabilities.

- **First responders**

Backed on the entailed operational flexibility, security and availability, drones can also be a decisive and life-saving factor in emergencies, natural disasters and all types of relief missions. Exemplary, during the Fukushima nuclear plant catastrophe in 2011, civil drones equipped with infrared sensors flew over the damaged reactor to measure the radioactive radiation and heat in the reactor core (Skrzypietz, 2012, p.15). Besides advantages in crisis response management, drones can also supply needed medical equipment like defibrillators or blood supplies, and thus increase the survival rate from 8% to 80% in case of an asystole (PwC, 2016, p.9).

- **Agricultural applications**

According to PwC (2016), due to the estimated global population growth, the agricultural sector will have to produce almost 69% more by 2050 to satisfy global food demand (p.16). For this reason, productivity is already yet a crucial factor in this sector, whereby drones are a promising opportunity for this industry to improve efficiency, as agricultural workers currently have to spend a lot of time on seed spreading, fertilisation, crop and health control (Haylen, 2019, pp.42-43). Based on efficiency advantages entailed by drones in large areas, it is assumed that agricultural productivity will increase and that this sector will prospectively mutate to a highly data-driven multi-billion dollar industry for drones (Haylen, 2019, p.42).

- **Leisure, cultural and sportive applications**

Besides the most known use case of civil drones regarding recreational applications, which do not display discernible societal added value (e.g. ‘Fun flights’), especially applications in the cultural and sportive sector have recently significantly gained societal importance. On one hand, drone races are worth mentioning regarding sportive applications, characterising a segment that already experiences high popularity, incorporates remarkable cash prizes and thus, implicates the potential of getting mainstream in the future (PwC, 2016, p.13). On other hand, artistic light installations are enabled by impressive swarm formations and artificial intelligence so that these are a potential substitute for conventional fireworks (e.g. New year celebrations in Shanghai).

3.3. Civil Drone Sector – Market Overview

In the upcoming chapter, the current and forecasted market situation concerning civil drones is examined and analysed from both an international and Austrian perspective.

The international civil drone market is still in constitution and at the beginning of a certain development, but some applications and industrial sectors already utilise the technological and operational potential of civil drones. However, this potential is currently not completely utilisable on an international and European level, as there is still no uniform European regulation in force that covers all different drone types and applications, so that the further growth of the drone market is slowed down (Molina et al., 2018, p.6). Overall, the positive market development depends mainly on five factors (Cohn et al., 2017, p.5):

- Infrastructure
- Regulation
- Technology
- Public acceptance
- Economic drivers

3.3.1. Shaping an Emerging Market – OEMs & Suppliers

The structure of the civil drone market is influenced by large, international companies, SMEs but also small start-up companies, which intend to fill market-niches (Cohn et al., 2017, p.3). On a global level, the United Kingdom, India, Italy, Azerbaijan, Turkey, France, Singapore and Brazil are currently dominating the import business and countries like USA, Canada, Russia, France, Austria, Italy, Germany and predominantly China the respective export business with drones (Molina et al., 2018, p.27).

- **International market overview**

As visible in Figure 13, the most popular international civilian drone manufacturer is currently SZ DJI Technology Co, based in Shenzhen, China. This company was founded in 2006 and focusses on the production of leisure, industrial and military drones.

On an international matter, the most relevant European drone manufacturer is Parrot SA, based in Paris, France and mainly focusing on the production of recreational drones. Nevertheless, Parrot SA also offers the 'eBee' drone, which is particularly used in agriculture and costs approximately $25.000 (Canis, 2015, p.7).

Besides the current market dominance of China, also the USA play a leading role in this market segment. In specific, especially both US-companies AeroVironment and 3D Robotics are worth mentioning, which produce rather small drones for a variety of applications.

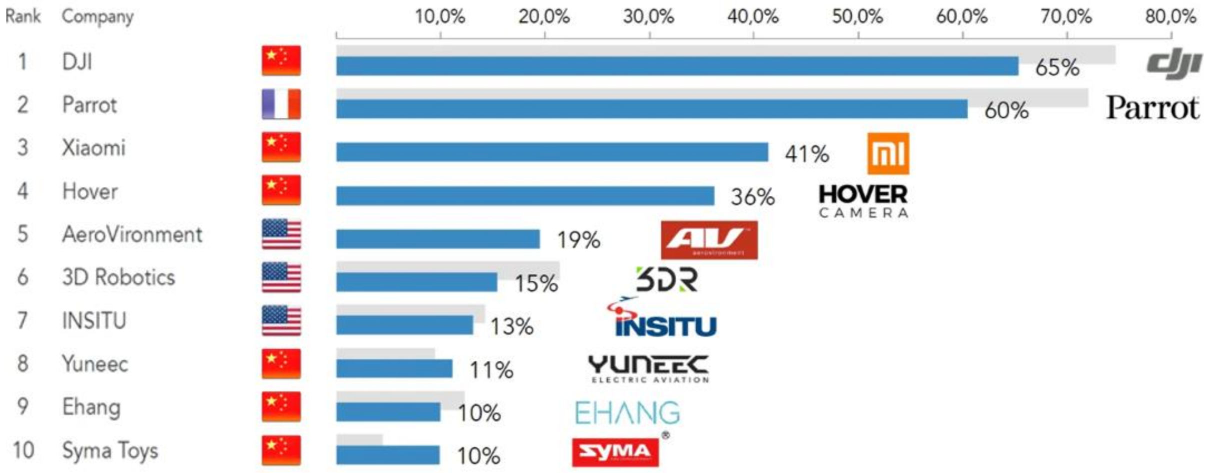


Figure 13: The drone company ranking of 2016 by internet popularity (droneii.com, 2016).

- **Austrian market overview**

The Austrian civil drone market is dominated by established, large manufacturers, SMEs as well as innovative start-up companies, aiming to fill lucrative market niches. In addition to providers of specific drone services (e.g. ViewCopter, Bladescape), mainly the company Schiebel must be mentioned, which is based in Vienna and produces civil and dual-use drones, like the 'Camcopter S-100' (Nentwich et al., 2018, p.27).

In addition to Schiebel as Austrian driving force in an international comparison, there are also other successful national companies that scavenged their position in the Austrian and European drone market.

As visible in Table 3, exemplary the Austrian companies FACC (with partner EHANG), DIAMOND Aircraft, Stromkind, Riegl, Frequentis, ViewCopter, BRP/Rotax, Bladescape, Airborne Robotics, Austrodrones, or DroneRescue, quickly anticipated the potential of this sector and adjusted their business concept or initiated a start-up business.

Enterprise	Sector	Headquarter	Specialisation	Website
Schiebel	Manufacturer	Vienna	Development/production of the CAMPCOPTER® S-100 - Civil & military purposes	schiebel.net
FACC	Manufacturer	Ried im Innkreis	Cooperation with chin. manufacturer EHang - Development/production of UAM-drones in AT	facc.com
Stromkind	Manufacturer	Raab	Development of UAVs for env. protection, disaster response & risk mitigation	stromkind.at
DIAMOND Aircraft	Manufacturer	Wiener Neustadt	Development/production of OPVs (optionally piloted vehicles) - e.g. DA42M-OPV	diamondaircraft.com
Airborne Robotics	Manufacturer	Klagenfurt	Drone manufacturer with focus on film & entertainment industry	air6systems.com
Austrodrones	Manufacturer/Service pr.	Alberschwende	Development/production of UAS & diverse services	austrodrones.com
Riegl	Manufacturer/Supplier	Horn	Development of unmanned laser screening systems & the RiCOPTER drone	riegl.com
Frequentis	Service provider/Supplier	Vienna	Specialized on the development of digital solutions (Voice & data comm./Drone detection & defence/UTM framework)	frequentis.com
Drone Rescue	Supplier	Graz	Development of a parachute safety system for drones	dronerescue.com
Test Fuchs	Supplier	Groß-Sieghart s	Supplier for middle/large drone manufacturer (integrated combustion engines, fuel systems)	test-fuchs.com
ViewCopter	Service provider	Feldkirchen	Service provider - Aerial photography (incl. 3D data, inspection)	vcopter.net
Bladescape	Service provider	Schwechat	Service Provider - Autnomous status assessment & automatic data analysis	blade-scape.com

Table 3: Selection of companies acting in the Austrian civil drone sector (own work).

Beyond all industrial activities in Austria, according to Nentwich et al. (2018), in coordination with national industrial processes, also extensive drone research is carried out in Austria. Leading Austrian drone research institutes are especially the FH JOANNEUM, TU Graz, TU Vienna, Ars Electronica Centre, Joanneum Research, University Klagenfurt, FH Kärnten, FH Kufstein, Lakeside Labs, AIT (Austrian Institute of Technology) and the RailTec Arsenal climatic wind tunnel in Vienna (p.28).

3.3.2. Current International Market Situation

China and the United States are currently the driving forces on the international civil drone market. Nevertheless, Europe is also experiencing a constant increase in annual sale rates of drones, as they reveal an enormous market potential, which estimates the creation of 150.000 additional European jobs until 2050 (BAZL, 2016, p.11).

According to Nentwich et al. (2018), in 2016 approximately 2.2 million leisure and industrial drones were sold worldwide, which implies an increase of 35% in comparison to 2015 (p.23). However, as visible in Figure 14, the recent increase of drone deployments is strongly dependent to model type and usage context (e.g. industrial, recreational, military). As stated above, some drone applications are already realized, but especially the currently inadequate

European regulation of drones noticeably decelerates any further development. Accordingly, some application fields are growing faster than others, and therefore leading manufacturers predominantly specialise on fixed target markets, which mainly consist of momentarily realizable applications in the recreation, energy, construction, agriculture, real estate and transport sector (Molina et al., 2018, p.36).

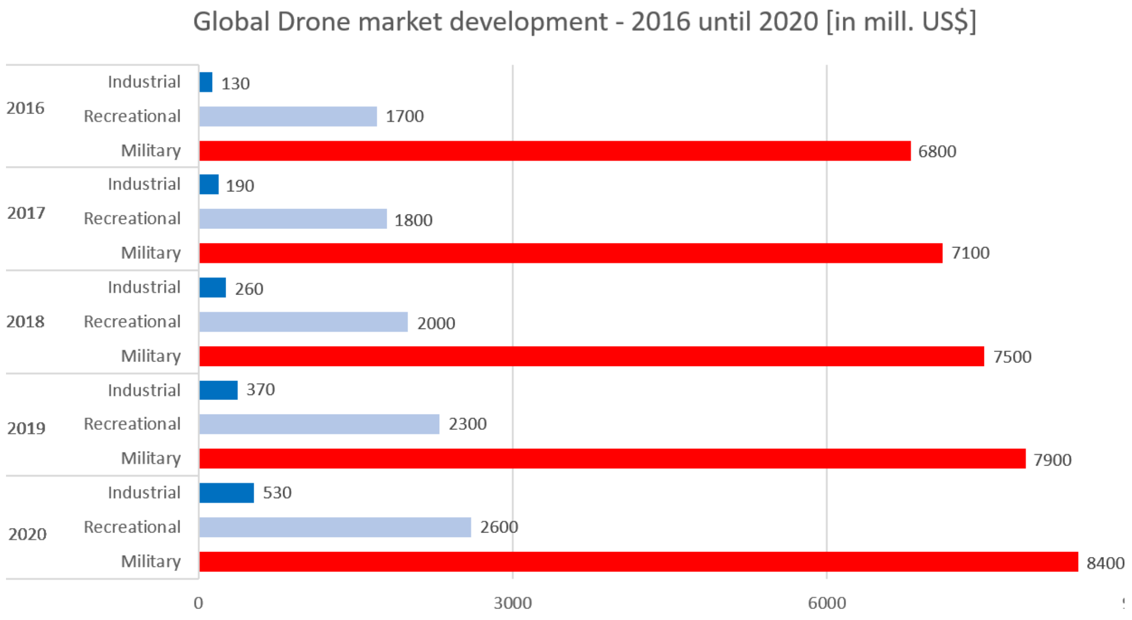


Figure 14: The global drone market development by domain (derived from Molina et al., 2018, p.9)

In accordance with international trends, the number of annual drone approvals has also constantly risen in Austria in the period from 2014 to 2018 (Austrian Court of Auditors, 2020, p.26). As recognisable from Figure 15, it is assumable that in 2020 the Austrian authority (Austro Control) is granting approximately 4.000 approvals, which in turn is an indication for the positive development of the domestic drone market.

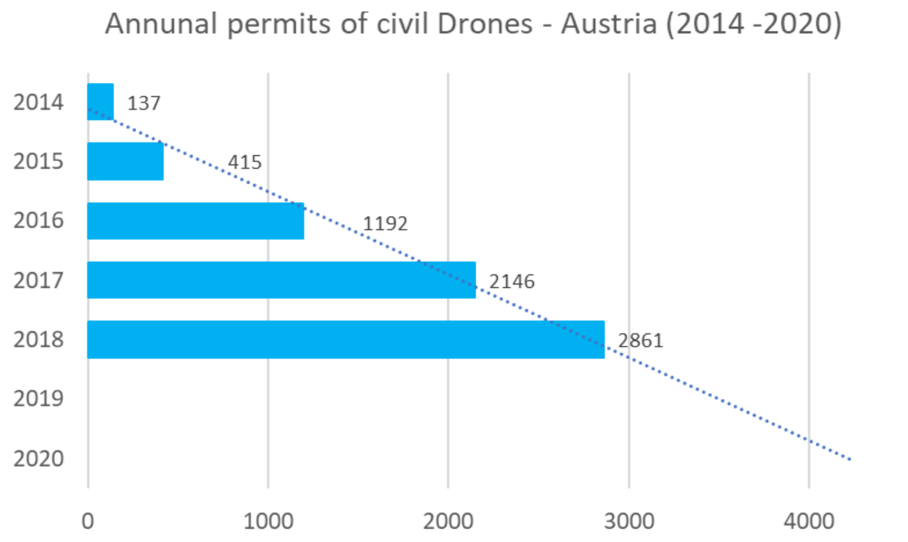


Figure 15: Development of annually granted drone permissions in Austria (austrocontrol.at, 2020).

3.3.3. Future Market Perspective: Worldwide and Austrian Highlights

In the next decade, civil drones will become still more central to our everyday life. According to Molina et al. (2018) and in respect to specific expert forecasts, the greatest market progress will occur in countries and continents, which are already now market leaders, i.e. Asia, Europe and North America (p.13). However, the extent of this development depends predominantly on technological, infrastructural, societal and regulatory factors, including also global economic developments.

Technological developments enable improvements in the field of autonomous flights, battery performances, detect-and-avoid systems and location technologies, to facilitate unmanned traffic management (UTM) and thus, technological progress is essential for further market growth. In addition to already scrutinised regulatory issues, also infrastructural barriers, societal obstacles in acceptance and adoptability must be removed to enable an unhindered drone market (Cohn et al., 2017, p.7).

According to current trends and estimations, as visible in Figure 16, the global civil drone market is expected to grow at an annual growth rate of 13.8% until 2025, whereby then the majority of applications can still be found in the energy or infrastructure sector (droneii.com, 2020). Furthermore, the forecasted European growth is significant, but slightly flatter in comparison to North America and Asia.

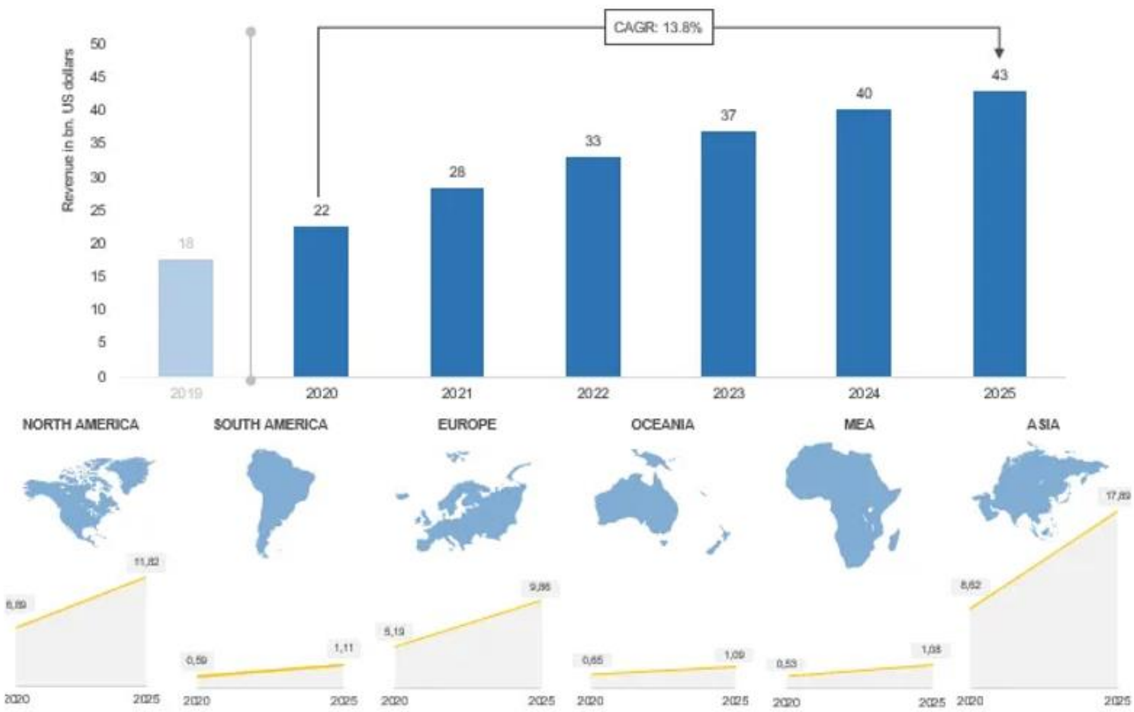


Figure 16: Estimated drone market development until 2025 by annual revenue (droneii.com, 2020).

Recapitulatory, the civil drone market is highly technology-driven and dominated by China, USA and France. Regulatory harmonisations, further technological developments as well as the mitigation of societal barriers are prospectively key for a positive and sustainable progress of this economic sector. However, economists assume further market growth predominantly in countries, which are already today elaborating strategies and concept to overcome beforementioned barriers.

Complementary, in the last years also a presentable Austrian drone market has been developed, including both successful OEMs and suppliers that experience industry-wide reputation due to their field-relevant competence. Thereby, originating from a world-leading product and a currently progressing EASA civil certification process, the company Schiebel holds a purely optimistic market perspective. Beyond that, also several other Austrian market players like DIAMOND Aircraft (e.g. OPVs), Riegl (e.g. Laser measurement systems and on-demand drones) or Frequentis (e.g. UTM solutions) are filling sound market niches so that nothing stands in the way for a positive prospective development of the whole Austrian UAS-community.

3.4. New European Regulatory Framework for Civil Drones from 2021

This chapter deals about the current and prospective legal framework, the regulatory development process and specific process-involved stakeholders with a special focus on European, but also international processes.

3.4.1. European Drone regulatory politics – From Riga to Amsterdam

The currently applicable drone regulation in the European Union is based on the European Parliament's directive (EC) 216/2008, which stipulates that drones with a takeoff-weight (MTOW) of 150kg or more are standardized at a European level by EASA and drones below this threshold are regulated by the national law of each Member State (EASA, 2015, p.2). Subsequently, a fragmented regulatory landscape has been established in Europe for drones with a maximum take-off weight below 150kg because each member state interprets and counteracts potential operational hazards and risks caused by drones differently.

At an Austrian level, the ‘General Aviation Act’ (LFG) was expanded on 1st January 2014 wherein the 4th section ‘Aircraft Models and Unmanned Aircraft’ (§§ 24c ff.) regulates drones below 150kg MTOW. According to the enacted LFG, based on an operational risk assessment and associated licensing or general requirements for drone operations, a distinction principle (Table 4) for all drones is introduced (Austrian Court of Auditors, 2020, p.19).

Type	LFG - Definition	Legal norm	Authorization required?
Toy	– Altitude: max. 30m AGL – Kinetic energy: max. 79 Joule	§ 24d LFG	no
Model aircraft	– Operation type: VLOS – Operational radius: ≤500m – Exclusively free of charge, not commercial in the leisure sector ("for the purpose of the flight itself")	§ 24c LFG	no (≤25kg) / yes (>25kg) - by Aeroclub
Unmanned aircraft (Class 1)	– Operation type: VLOS – Operational radius: ≤500m – For a fee or commercial ("not for the purpose of the flight itself")	§ 24f LFG	yes - by ACG (LBTH 67)
Unmanned aircraft (Class 2)	– Operation type: BVLOS – Handled like civil aircraft	§ 24g LFG	yes - by EASA (>150kg)

Table 4: Applied drone classification in Austria according to LFG (Austrian Court of Auditors, 2020, p.19).

Besides drones considered as toys or model aircraft, according to the LFG, predominantly unmanned aircraft included in class 1 (VLOS) are of utmost importance in Austria. According to Dorfmayr et al. (2018), flying objects that fall into this category have to fulfill the 'Luft- und Betriebstüchtigkeitsnachweis Nr. 67' (LBTH 67), which conducts a risk-based approach to classify the technical, operational and personnel requirements depending on the risk potential of drone operations specified in the categories A, C, D (Figure 17) (pp.2-4).

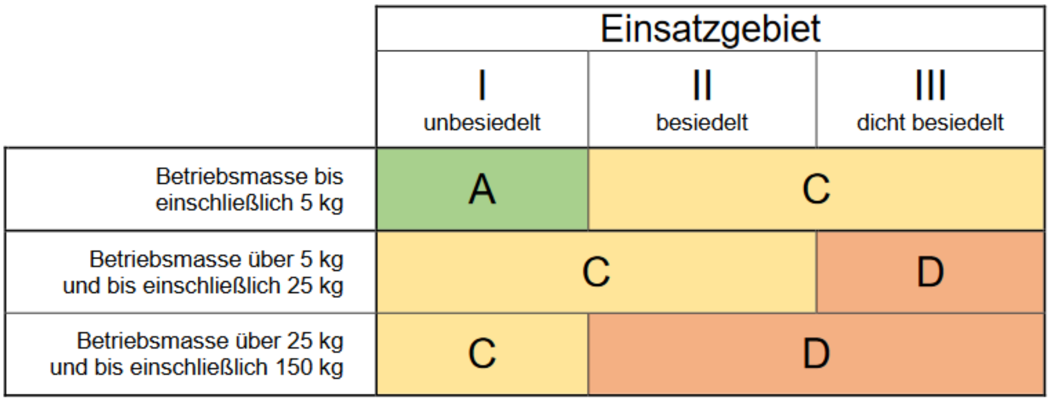


Figure 17: Categorisation of class 1 drones as part of the operating permission process in Austria (austrocontrol.at, 2019).

As noticeable from Figure 17, the population density of the respective drone operation is of key importance in the Austrian risk classification. On an Austrian level the following operational areas are distinguished:

- Unpopulated (‘unbesiedelt’): Only secondary buildings (e.g. no utilisable rooms)
- Populated (‘besiedelt’): Primary buildings (e.g. schools, stores)
- Densely populated (‘dicht besiedelt’): Spatially closed, populated area (e.g. city center)

Despite topographical aspects, also the weight of a drone influences the Austrian operational risk assessment procedure significantly. Accordingly, class 1 drones (VLOS) are subdivided into three weight classes, which still fall in the respective MS (member state) jurisdiction below 150kg MTOW:

- MTOW ≤ 5kg
- 5kg < MTOW ≤ 25kg
- 25kg < MTOW ≤ 150kg

In specific, drones of class 1 must comply with so-called ‘basic requirements’ specified in §164 LFG to get an official approval. These address for example insurance issues, noise restrictions, operational limitations or specific requirements like the minimum age of 16 years (Lappi, 2017, p.16). In ultimate consequence, based on the matrix visible in Figure 17, each drone is assigned to a category of the LBHT (A, C, D), finally determining several detailed operational requirements, issued by the respective authority (ACG).

Backed on insights regarding the Austrian drone regulation, it is verifiable that the nationalistic regulative approach for civil drones below 150kg in Europe currently restricts any further market growth, due to additional administrative and operational hurdles. To demonstrate the currently fragmented European regulatory landscape, for example UK pursuits a more liberal certification approach concerning civil drones, focusing more on pilot competencies (i.e. strict pilot licensing scheme). UK distinguishes drones of three weight classes (Class 1: ≤ 20 kg, Class 2: 20 kg < MTOW ≤ 150 kg, Class 3: >150 kg), whereby for class 1 no airworthiness approval, registration or operating permission is required (Ritzinger, 2014, p.43). In contrast, France law applies seven drone categories, wherein four pre-defined, but fairly unsystematically appearing ‘Operational scenarios’ (S-1–S-4) determine the exact operational scope that is authorized by the national agency (Ritzinger, 2014, p. 50).

Despite the currently fragmented European drone regulation, the European civil drone market has already experienced impressive economic growth during the last years, which was primarily facilitated by the operational versatility, cost effectiveness, efficiency and flexibility of drones. Moreover, it is estimated that the European market continues to grow, becomes more international and thus, implicates far-reaching, positive effects in terms of job creation, global economy and aviation industry (Zavrsnik, 2016, p. 186). However, the exact market development is strongly depending on the establishment of a harmonised European drone regulation by EC and EASA (Figure 18), which is in Europe already closely before entering into force.

Figure 18: Official emblems of decisive European players: The EC and the EASA (easa.europa.eu, 2020).

According to EASA (2015), the European drone market consists of a wide range of stakeholders: operators, industry, national aviation authorities (NAA), air navigation service providers (ANSPs), manufacturers and the common public (p.1). All these actors represent different interests and due to the rapid emergence of civil drones, the current regulation in Europe is fragmented, which means that each member state elaborated and established an individual regulative approach for drones below 150kg MTOW (Molina et al., 2018, p.36). Accordingly, drones above 150kg MTOW are handled uniformly by EASA, which leads to a restricted and harmed European drone market (Haylen, 2019, p.32).

> *Such fragmentation hampers the development of new products and the swift introduction of technologies. Companies - need legal certainty in order to invest and create jobs. Diverging national rules may also create safety hazards.* – European Commission, 2016

For the EU itself, the entire unmanned aviation is of great importance, for the future of the economy, but especially for the aviation industry so that the EU single market will severely benefit from a harmonised European regulation on a social and economic level (BAZL, 2016, p.19). Besides that, the operational scope of the European drone industry is getting increasingly international, so that the market demand towards a harmonised European drone regulation is striking, minimising administrative costs or potential entry barriers of new markets (ITF, 2018, p.19). Considering all governmental, economical and public interests, the EU pursues ambitious goals to open the aviation market for civil drones (Pauner et al., 2015, p.89).

> *…fostering growth and jobs, developing the internal market, strengthening Europe's role in global aviation, increasing competitiveness of the European aviation industry (…) creating a regulatory framework for (…) unmanned aircraft.* – EPRS, 2016

To ensure an adequate process-involvement of all relevant stakeholders, the EASA has been delegated by the European Commission to develop a harmonised legal framework for civil drones in the EU (Haylen, 2019, p.34).

> *Political intervention and industrial engagement is urgently required to address the development of a regulatory framework* – EASA, 2010

In consequence, EASA hosted workshops, conferences and meetings, to consider reasonable stakeholder interests, ranging from political to industrial up to civil opinions, which ultimately shaped EASAs first regulatory approaches. Therein a major milestone was certainly the issuance of the Riga declaration (2015) by EU and EASA, which was supported by representatives of the European Commission, the European Council, all European member states, data protection experts and representatives of the drone industry (EC, 2015, p.1). Therein, the following points were cooperatively determined (Haylen, 2019, p.33):

- Risk-based regulation approach
- Harmonised safety rules on EU-level
- Foster the European airspace integration of drones
- Public acceptance is key for growth
- Pilot or operator identifiability

Referring to essential EASA activities after the Riga declaration, like the Warsaw declaration (2016) or the Amsterdam declaration (2018), an adequate process-involvement of several relevant stakeholders was ensured. Therefore, the finally developed regulatory approach, which is consecutively explicated, has been incrementally developed in a synergistic political-industrial-social cooperation which, despite facilitating the establishment of a powerful European drone market, addresses also issues concerning security, safety, privacy, data protection and environmental protection.

3.4.2. First Legal Acts: Basic Regulation, Implementing & Delegated Act

The following part of this Master´s thesis deals about the most relevant European regulations, which smoothed the way to a harmonised EU drone regulation.

- ***The new EASA Basic Regulation – (EU) 2018/1139***

With the objective to maintain a high level of flight safety in European airspace, on the 12th June 2018 the European Parliament approved the implementation of a new, extensively developed regulation (EU) 2018/1139, the so-called EASA Basic Regulation, while repealing previously applicable regulations (EU) Nr. 216/2008 and (EU) Nr. 552/2004 (Haylen, 2019, p.35).

By adoption of this regulation, the European institutions expand EASAs field of competence by the delegation of additional regulatory tasks, including several aspects of civil drones. Therefore, in succession of this act, EASA has been tasked with the elaboration and development of an EU-wide harmonised drone regulation, covering all drone types, commercial market regulations as well as a ruleset for urban air mobility.

- ***Implementing Regulation – (EU) 2019/947 incl. AMC & GM***

On the 24th May 2019, the European Union adopted the Implementing Regulation (EU) 2019/947, which lays down common rules for civil aviation and, based on the new Basic regulation (EU) 2018/1139, also detailed regulations for the operation of civil drones. Furthermore, profound personnel requirements for pilots, operators or indirectly involved organisations have been determined (EU, 2019, p.1). In line with this, the regulation specifies requirements on airworthiness, pilot or operator competencies, as (EU) 2018/1139 points out (EU, 2018, p.115):

> *Unmanned aircraft must be designed in a way that, or contain features or details that, the safety of the person operating the unmanned aircraft or of third parties in the air or on the ground, including property, can be satisfactorily demonstrated.* – EU, 2018

Beyond that, even if drones are predominantly customized and designed in accordance with operational risks in the envisaged operating range, the (EU) 2019/947 defines essential rules and requirements regarding pilot identifiability or operator registration for drones above 80 Joule of impact energy. Moreover, the regulation introduces in Article 14 also a mandatory registration obligation for operators of drones, attached with relevant sensory equipment (e.g. cameras, trackers) to record personal data and not counted as ‘toys’ (<250g MTOW).

Article 15 of the (EU) 2019/947 deals with enacted relevant requirements, prerequisites and conditions in the determination of geographical zones by respective EU member states. According to the regulation and the applicable sovereignty of the air, each national state possesses the opportunity to define geographical zones, owing to safety reasons, hazard prevention measures, privacy issues or environmental aspects. Therein, each state can either prohibit (e.g. ‘no drone zones’) or restrict (e.g. special restraints) drone operations in respective areas. In line with this, the legal way to declare geographical zones is multifaceted, and its base can range from environmental (e.g. pollution) to technological (e.g. geofencing ability) up to operational requirements (e.g. risk assessment), transforming all this in a complex national process. Additionally, EU prescribes that each MS must publish all national geographical zones in an accessible digital database (EU, 2019, p.12).

Throughout the entire EASA consultation process, the majority of stakeholders supported a risk-based classification of drones, which evaluates the risk exposure to any ‘third parties’, like other airspace users or people on the ground (Nader et al., 2016, p.5). In consequence, on behalf of the European Commission, EASA developed together with all relevant stakeholders a suitable approach, wherein civil drones are categorised into ‘open’, ‘specific’ and ‘certified’ (Figure 19).

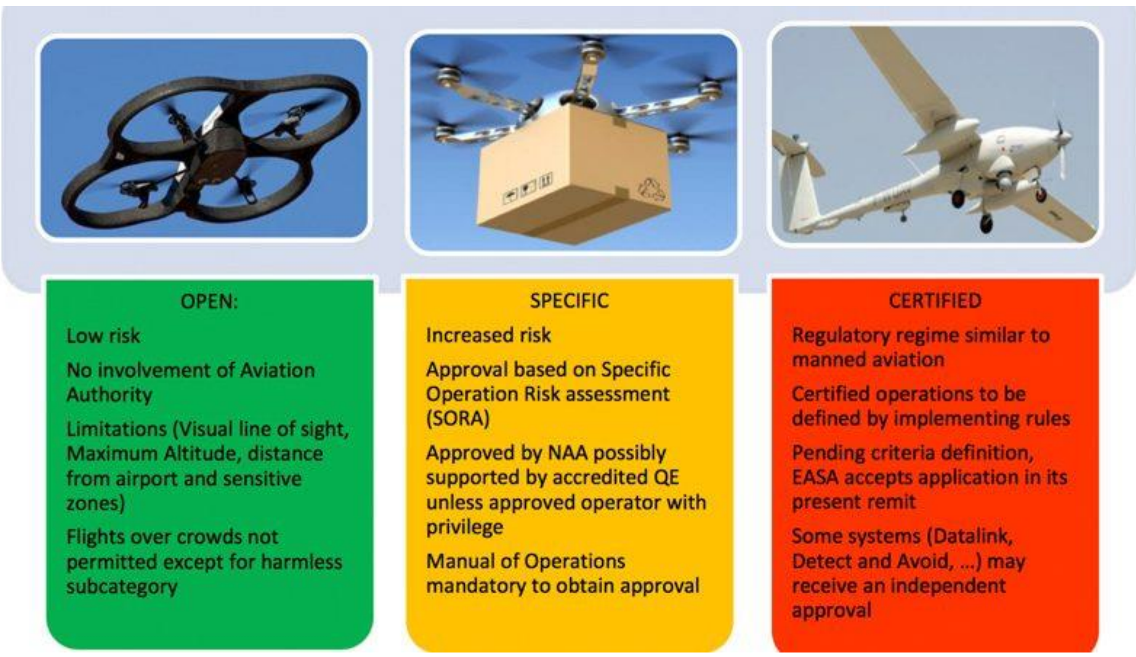


Figure 19: Prospective drone categorisation introduced by (EU) 2019/947 (dronewatch.nl, 2016).

In addition, the implementing regulation introduces a general minimum age of 16 years for drone pilots, excepting drones below 250g MTOW or home-made drones. Beyond that, also aspects regarding cross-border operations are regulated (Frankpotthast.de, 2020).

1. Low risk – The ‘Open’ category

The ‘Open’-category includes drone operations that pose a comparatively low operational risk to the public. Due to this, the prevalent category will primarily apply to drones of individuals, using their drone explicitly for recreational, non-commercial purposes below a maximum take-off weight of 25kg (Haylen, 2019, p.20). Main objective of this category is the creation of lowest regulatory burdens, while still guaranteeing maximum safety to any third parties (ground, air). Civil drones of the ‘Open’-category require no prior authorisation, a mandatory market product legislation (CE-marking) and pilots must consider potential geographical zones, determined by the respective national authority. However, the versatility of drones in this category induced the establishment of three subcategories (A1 - A3), which introduce further operational limitations that depend on the MTOW of the drone (Figure 20).

Catg.	Sub-category		MTOM	CE Class	Type of operation	Training required	Technical requirements to fullfill	Geo awareness	Id - remote identification	Minum age required	Operator registration
Open	A1	Flight over people not involved	< 250 gr	Builded privately	Flight over people not involved in the operations	None - User manual only	N/A	Not required	Not required	No	No, if the drone is without a camera
				C0	Flight prohibited on gatherings of people		User manual, EASA information, Max horizontal speed 68 km / h, No sharp edges			16 years	
					With Follow me mode active - max distance flight 50m from the pilot						
			> 250 gr ma < 900 gr	C1	Inability to fly on uninvolved people, Flight prohibited on gatherings of people, With Follow me mode active - max distance from pilot 50m	User manual, online training course with theoretical exam	User manual, EASA information, Max horizontal speed 68 km/h, No sharp edges, Selectable altitude limits, Mechanical strength, Data Link loss management, Sound power level, Low battery level warning, Lights	Required	Request, with unique serial number compliant with ANSI / CTA2063 standard	16 years	Required
	A2	Flight close to people	> 900 gr ma < 4 Kg	C2	Flight prohibited on gatherings of people, Flight allowed at a maximum distance of 30 m from the people not involved (at 5 m if the speed is <11 Km/h)	User manual, Online training course with theoretical exam, Practical training (autonomous)	User manual, EASA information, Max horizontal speed 68 km/h, No sharp edges, Selectable altitude limits, Mechanical strength, Data Link loss management, Data link protection, Sound power level, Maximum speed limit settable at 3 m/s, Low battery warning, Lights	Required	Request, with unique serial number compliant with ANSI / CTA2063 standard	16 years	Required
	A3	Flight far away from people	> 4 Kg ma < 25 Kg	C3	Avoid putting at risk any person who is not involved in the operations, Flight allowed with a horizontal request of 150 m from residential, commercial and industrial areas	Online training course with theoretical exam	User manual, EASA information, Selectable altitude limits, Data Link loss management, Sound power level, Low battery warning, Lights	Required	Request, with unique serial number compliant with ANSI / CTA2063 standard	16 years	Required
				C4			User manual, EASA information, LimNo automatic flight mode except flight stabilization	If requested by local operators			
				Builded privately			N/A				

Figure 20: Introduced subcategories (Category ‘Open’) specifying operational requirements (4mydrone.com, 2020).

As a result, drones of this category are not allowed to operate above an altitude of 150m (AGL), to overfly crowds or, depending on the exact subcategory, a defined lateral safety distance to any ‘third’ parties must be maintained. Furthermore, drones of this category are exclusively approved for operations within direct visual line of sight conditions (Nader et al., 2016, p.6).

2. Increased risk – The 'Specific' category

Drones and respective operations belonging to the 'Specific'-category are subject to authorisation by the national aviation authority, wherein all operational risks are analysed and, if required, also mitigated (Haylen, 2019, p.34). To determine the respective operational risk level, a SORA (Specific Operational Risk Assessment) is carried out in advance of any operation, wherein, if no already EASA-approved standard scenario (STS) is applicable, operational risks are analysed, evaluated and mitigated in a multi-stage process (Kinghan, 2019, p.24). As part of a SORA, relevant factors like population density, meteorological conditions, operational area, effects on ATM, available pilot competence, general environmental issues and also intended operation are assessed and evaluated to determine the overall operational risk, consisting of 'Ground risk class' (GRC) and 'Air risk class' (ARC) (Figure 21).

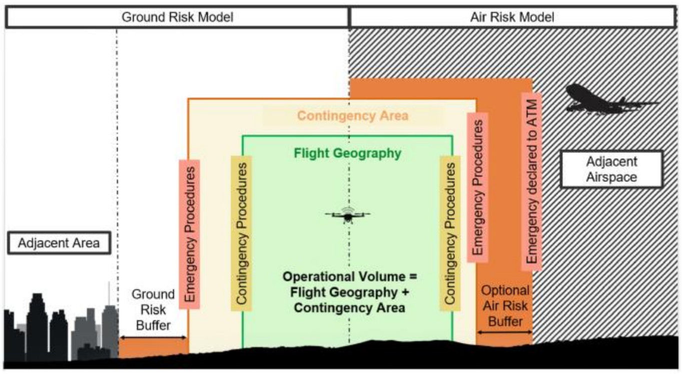


Figure 21: Systematic of the SORA air and ground risk determination process (skyopener.eu, 2018).

Linking to the identified 'Ground risk class' (GRC) and 'Air risk class' (ARC), in an ultimate step, the so-called SAIL (Specific Assurance and Integrity Level) is determined, which consolidates air and ground risk by using a specified matrix (Table 5) that is decisively influencing any further required actions (e.g. mitigation measures like detect and avoid) in a process called OSO (Identification of Operational Safety Objectives) (JARUS, 2019, pp.26-27).

	Residual ARC			
Final GRC	a	b	c	d
≤2	**I**	**II**	**IV**	**VI**
3	**II**	**II**	**IV**	**VI**
4	**III**	**III**	**IV**	**VI**
5	**IV**	**IV**	**IV**	**VI**
6	**V**	**V**	**V**	**VI**
7	**VI**	**VI**	**VI**	**VI**
>7	Category C operation			

Table 5: Matrix determining the final SAIL (JARUS, 2019, p.27).

Furthermore, in advance of each operation, relevant operation-related information (e.g. pilot competence) must be documented in a designated operational manual and provided to the NAA, if requested (Nader et al., 2016, p.6).

3. Higher risk – The 'Certified' category

According to Haylen (2019), the rules in this category are comparable to manned aviation (p.34). In line with this, all 'Certified' drone operations are strictly regulated by EASA (and the NAA), implicating the requirement of a drone certification (type certificate), an airworthiness certificate as well as an officially approved operator and pilot to maintain high safety standards. Several beforementioned requirements mandatorily apply also to UAM-applications.

Drones of the 'Certified'-category must mandatorily comply with all regulations of manned aviation on a technologically matter, because also respective maintenance, design or production organisations of 'Certified' drones must be officially approved by EASA (Lappi, 2017, p.13). Correspondingly, in the run-up to operations in the 'Certified' category an authorisation must be granted by the respective NAA because associated operational risks are comparable to conventional, manned aircraft (Nader et al, 2016, p.7).

- ***Delegated Regulation – (EU) 2019/945***

On the 12th March 2019, the EC, based on regulation (EU) 2018/1139 of the European Parliament, passed regulation (EU) 2019/945, which primarily addresses issues for drone manufacturers in the European single market (EU, 2019, p.1):

1. Requirements for designing and manufacturing drones, which intend to be operated in accordance with prerequisites specified in (EU) 2019/947, as well as requirements for designing and manufacturing remote identification devices.
2. Specifications for the drone type, whose design, manufacture and maintenance are subject to approval.
3. Rules specifying general market accessibility of drones suitable for operations in the 'Open' category as well as accessories for remote identification and the common handling on the EU market.
4. Provisions affecting third-country nationals, operating drones in the single European sky according to the Implementing Regulation (EU) 2019/947.

(EU) 2019/945 introduces specific market obligations and essential economic framework to facilitate an unharmed market development in the EU. Therein, a crucial aspect is the introduction of mandatory CE-markings for drones of the ‘Open’ and ‘Specific’-category. As visible in Table 6, in total seven CE-classes are introduced, whereby the CE-classes 0-4 exclusively apply to the ‘Open’ category and, depending on MTOW and operational risk, incrementally increase. Beyond that, also drones of the ‘Specific’ category that operate according to specific pre-defined and EASA approved standard scenarios (STS-01, STS-02), must be labelled with a C5 or C6-marking (except for PDRA).

CE - Classes (acc. (EU) 2019/945)						
'Open' category					'Specific' category	
C 0	C 1	C 2	C 3	C 4	C 5	C 6
<250g	<900g	<4kg	<25kg; < 3m	<25kg	<25kg (acc. STS-01)	<25kg (acc. STS-02)

Table 6: Introduced CE-marking scheme for drones of the 'Open' and 'Specific' category.

According to the EU (2019), CE-markings are mandatory and must be attached in a clear visible, legible and permanent manner on the respective drone (p.10).

3.4.3. Further Debate: Airspace Integration of Drones – U-Space & UTM

According to EASA (2019), U-Space is a European brand for UTM (Unmanned transport management) and describes a set of digitalized and automated services, which complement ATM/ANS and are available in specific airspace structures to ensure simultaneous unmanned and conventional aircraft operations in a secure, safe, sustainable and efficient manner (p.2).

As clarified in the aftermath of EASAs high level conference (Amsterdam, 2018), the timely delivery of a useful regulatory framework is key to the further development of U-Space and the overall airspace integration of drones. The development of a regulatory U-Space regime is still in progress and as visible in Figure 22, EASA expects final implementing rules by the end of 2020 (EASA, 2020, p.11), which is already questioned by parts of the UAS-community.

Figure 22: Time schedule of EASA regarding a regulatory U-Space framework (EASA, 2020, p.1).

Novel technologies like civil drones are always accompanied by massive challenges in terms of security, safety and airspace integration. Therefore, despite the fact that the airspace is already heavily occupied by conventional manned aviation, the development of a robust U-Space regulative is of crucial importance, since the creation of an U-Space airspace is a prerequisite for the further growth of a sustainable and safe commercial drone market (EASA, 2020, p.42).

In summary, regarding to conventional ATM procedures, prospectively a robust U-Space regulation is required to retain control about the increasing drone traffic, maximising safety for all airspace users and enabling miscellaneous drone operations (e.g. BVLOS) in an competitive U-Space market (EASA, 2020, p.43).

3.4.4. Beyond Europe – Further International Developments

Not only European efforts in creating regulatory framework to facilitate a safe, sustainable competitive drone market have increased recently. On a worldwide level, there are currently distinctive regulatory efforts of many organisations and authorities in progress, displaying diverse competencies or responsibilities. All this can be confusing sometimes so that this subchapter intends to provide an overview of international authorities, organisations and working groups acting in this regime.

- ***ICAO (International Civil Aviation Organisation)***

The ICAO is a specialised UN agency, which was founded on 7th December 1944 as the Chicago Convention was signed. At the moment, the organisation comprises 193 contracting states and according to PwC (2016), the main goal of the organisation is to elaborate so-called SARPs (Standards and Recommended Practices) and common policies in cooperation with all member states and relevant industry representatives, which are appreciated by many states as guideline representing the international norm (p. 36). According to ICAO (Figure 23), all these measures are contributions towards a "*safe, efficient, secure, economically sustainable and environmentally responsible future of civil aviation"* (Molina et al., 2018, p.50).

Figure 23: Official emblem of the ICAO (eturbonews.com, 2019).

Regarding civil drones, ICAO is active since 2005, as the organisation decided to survey selected member states about current and future drone activities in their airspace, which finally resulted in the establishment of the UAS-Study-Group (UASSG) initially hosted by ICAO in 2007 (Dalmagkidis et al., 2012, p.58). In 2011, ICAO issued essential framework by publishing a cooperatively elaborated circular, focussing on civil drones (CIR328) and in 2018, by issuing useful SARPs (Haylen, 2019, p.36). Nevertheless, although important international authorities like EASA, FAA or CAAC support ICAO, this organisation works comparatively slowly and long-winded (Molina et al., 2018, p.47).

- ***JARUS (Joint Authorities for Rulemaking on Unmanned Systems)***

The JARUS Group was founded in 2007 as a worldwide voluntary assembly of experts representing international leading authorities, aiming to create a harmonised regulatory framework determining technical, safety or operational requirements for drone operations. The JARUS group describes itself as follows (JARUS, 2019, p.8):

> *(…) intended to inform the rulemaking authorities on future regulation of UAS (…) provide a baseline regulatory structure to allow technical and operational work efforts to define and standardize individual components of UAS operations* – JARUS, 2019

JARUS consists of seven working groups, wherein publications are developed by representatives of 48 countries, also including delegates of EASA, EUROCONTROL and FAA. The group is accessible for international authorities and several elaborated publications, like the high-level ‘concepts of operations’ (CONOPS), guidance material (GM), certification specifications (CS) and framework concerning SORA serve as guidelines for authorities, targeting the simplification and standardisation of global regulatory processes (Molina et al., 2019, p.50).

- ***FAA (Federal Aviation Administration)***

In the United States, FAA (Figure 24) is responsible for the development and enactment of drone regulations. At the beginning of all activities, the agency initiated the ‘Small Unmanned Aircraft System Aviation Rulemaking Committee’ (sUAS ARC) in 2008, which was entrusted to cope with any early emerging drone issues in the US (Dalmagkidis, 2012 , p.75). In consequence to the ‘Modernisation and Reform Act’ of the US Congress in 2012, FAA has been commissioned to develop and create regulations towards civil drones by the target date

30th September 2015 (Knepshield et al., 2016, p.64). Nevertheless, although represented in international bodies of the ICAO or JARUS, the USA are partially pursuing different regulatory approaches in an international comparison.

Figure 24: Official emblem of the FAA (asbaa.org, 2020).

From a regulatory perspective, since non-commercial drones are regulated according to FAA Part 107 from August 2016, affecting uncomplex drone operations in the leisure or model flight sector, the threshold of 25kg MTOW is currently decisive. Based on that, Part 107 is affecting non-commercial drones below 25kg MTOW and according to FAA, further worth-mentioning aspects are (FAA.gov, 2020):

- Operational limitations:
    - VLOS operations only (daylight conditions)
    - Maximum altitude: 122m AGL
    - Maximum velocity: 161 km/h
    - Weather requirements - Minimum visibility: app. 4.8 km
    - Operations – controlled airspace: ATC permission
    - Operations – uncontrolled airspace: No ATC permission
- Pilot requirements:
    - At least 16 years (physically & mentally fit)
    - Hold a remote pilot airman certificate with sUAS rating:
        - At least 16 years (physically & mentally healthy)
        - Vetted by TSA (Transport Security Administration)
        - Knowledge demonstration (FAA test or Part 61 pilot certificate)
- Aircraft requirements:
    - FAA airworthiness certification not required (only preflight check)

Regarding operations involving drones above 25kg MTOW or for commercial purposes, in the USA either an exemption from the Special Authority for Certain Unmanned Systems (acc. 49 U.S.C. §44807) or a respective FAA-certification is required (FAA.gov, 2020).

In line with this, after the conduction of an operational risk evaluation, perhaps a waiver according to 49 U.S.C. §44807 is granted, because in this case all initiated measures and operational risks are already at an acceptable level thus, the FAA-certification process can be bypassed.

If according to 49 U.S.C. §44807 no exemption is grantable, it must be officially applicated for a FAA certification (acc. 14 CFR Part 21), which initiates a process that manages operational risk by assurance and consists of the following components (FAA.gov, 2018):

- Type certification (Design follows specific standards)
- Product certification (Company is able to produce in compliance with approved designs)
- Airworthiness certification (Aircraft meets the type design to ensure a safe operation)

Regarding UTM or U-Space, FAA has defined six US-test sites, which aim to accelerate the integration of drones into the national airspace. Thereby, the first sites started their operation in 2014 pursuing the enhancement of overall safety as well as the facilitation and promotion of national drone research. The program is envisaged until September 2023 (FAA.gov, 2020).

- ***CAAC (Civil Aviation Authority of China)***

In China, the national authority CAAC (Figure 25) is responsible for the development of a drone regulation. As published in 2017, China is mainly pursuing similar or sometimes even stricter regulatory approaches as EASA or FAA.

Figure 25: Official emblem of the CAAC (logodix.com, 2019).

According to the International Transport Forum (2018), in China drones above 250g MTOW must be mandatorily registered at CAAC. Besides that, manufacturers, operators and pilots of drones are obliged to provide the authority in the run-up to an operation with personal as well as technological information. In consequence, a label with an individual QR-code is produced and issued, which must be mandatorily attached on the drone (p.57). Further noteworthy specifics of the enacted Chinese drone regulation are as follows:

- VLOS operations only (daytime, isolated area)
- Maximum altitude: 120m AGL
- Maximum velocity: 120km/h
- Pilot competency: Meeting of minimum qualification requirements
- CAAC classification scheme:
    - MTOW > 7kg: CAAC license
    - MTOW >116kg: Pilot´s license, CAAC certification
    - Commercial operations: CAAC special license required

4. Public Acceptance of Civil Drones – Key Factors and Stakeholders

In the upcoming chapter, a profound insight into decisive criteria and factors influencing societal acceptance and a comprehensive overview of all relevant stakeholder groups, affected by the introduction of civil drones is provided. Accordingly, after a brief description of the most important stakeholders, profound knowledge about societal acceptance in light of behavioural research is expounded, considering also relevant societal, environmental or technological aspects.

4.1. Relevant Stakeholders for Civil Drone Applications

The increasing relevance of civil drones affects a variety of areas of life and in order to gain a better understanding towards societal behaviours in the end of this work, a brief stakeholder description, integrating several key actors, is essential. According to Molina et al. (2018), the drone market includes a wide variety of stakeholders (Figure 26) and each group is distinguishable by different interests, opinions and concerns (p.37).

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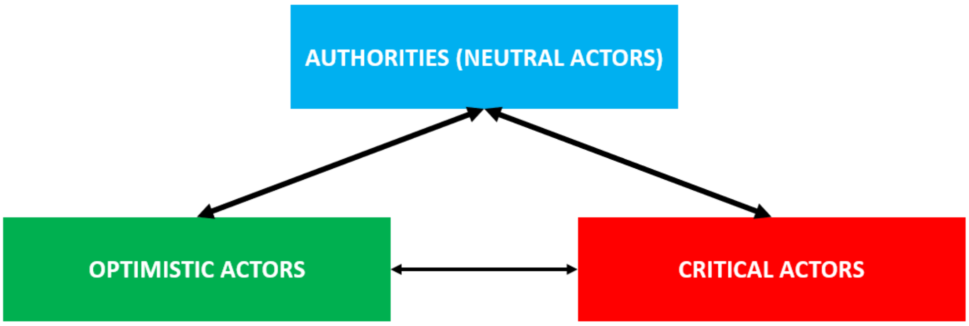

Figure 26: Key stakeholder groups of the civil drone market (own work).

With respect to Figure 26, in the subsequent paragraphs of this Master's thesis, a subdivision into neutral (e.g. authorities), optimistic and critical stakeholder groups is performed. In general, every individual group is actively shaping and influencing the regulatory and economic landscape of the drone sector, due to diverging interests.

4.1.1. Neutral Actors: Authorities, Politics and Others

Beyond its technology-dependency, the drone sector is strongly shaped by the prevalent national or international regulatory and administrative framework. For this reason, so-called "Neutral Actors" are primarily national and international aviation authorities like Austro Control on an Austrian or EASA on a European level, aiming to draft and regulate drones by evaluation and consultation of economic and societal interests. In ultimate consequence, these agencies are proposing several elaborated regulatory drafts to politically decisive bodies on a national or European level. Neutral actors are primarily fostering the enablement of a sustainable civil drone market, wherein aspects like safety, security or personal rights are considered and regulated.

National and international research funding agencies, in connection with respective funding programs, are worth mentioning because these agencies have a key role in the promotion of research and innovation in a business location. On an Austrian level, the Austrian Research Promotion Agency (FFG) must be mentioned with its successful aeronautics research program ‘Take off’, which frequently calls and funds drone projects. Besides this national program, in an international context, reference is made to the EC (European Commission) and its ‘Horizon Europe’ program for the period 2021-2027, aiming to facilitate research and cooperation between EU member states, also in aeronautics.

4.1.2. Optimistic Actors: Adopters, Researchers and Others

As stated above, civil drones reveal respectable market potential, which is particularly responsible for the optimistic attitude entailed by specific stakeholder groups, integrating representatives of industry, research, government or individuals towards the technology, may they be producers or operators of drones.

The majority of this stakeholder group has already initiated a business or prospectively intend to be economically active in this segment. Therefore, it is of key importance to promote regulatory processes in a way that forecasted economic potentials of civil drones are completely exploitable. In consequence, ‘Optimistic Actors’ are occupying a relevant position that is particularly influential in direct exchange with relevant neutral actors (e.g. authorities), as they contribute their positions, interests and concerns and thus, co-create legal framework that promotes a viable market on an Austrian as well as European level.

Besides any economically active stakeholders in this category, also people of the general public that purchase or already use civil drones for recreational purposes are ‘Optimistic Actors’, since they profligated any personal concerns and thus won´t react to new applications or more liberal regulations in such a sensitive way like normal citizens.

4.1.3. Critical Actors: Residents, Privacy or Environmentalist Groups

Civil drones are undoubtedly implicating distinctive changes for our everyday life, which are not welcomed by all societal stakeholders. Accordingly, so-called ‘Critical Actors’ comprise all people and activists, feeling personally or environmentally adversely affected by civil drones. Comparable to the beforementioned ‘Optimistic Actors’, also the critical counterpart is participating in various societal dialogues with the ‘Neutral Actors’, wherein these declare concerns, causing their resistance towards civil drones.

In specific, this stakeholder group has diverging patterns or motives, raising overall or partial resistance towards this technology. In line with this, a subdivision of this group into the following actors is reasonable:

- Privacy groups
- Environmentalists
- Other airspace users (e.g. pilots)
- Aviation service provider (Airport operator, ANSPs)
- Civil rights groups

On the one hand, especially data protection experts anticipate a massive impairment of personal freedoms like privacy or data protection, due to the ability of drones to record large data amounts in a short time. On the other hand, environmentalists are massively criticising the expected environmental impact of drones in terms of generated noise, visual impairments and endangered wildlife. Besides both specific privacy and environmental aspects, especially safety and security aspects are key concerns for other airspace users (e.g. aircraft pilots), aviation service provider and especially citizen groups (e.g. drone accident with uninvolved third parties).

To safeguard that also pessimistic opinions are considered in important legal or regulatory processes, also ‘Critical Actors’ are participating in various dialogues and workshops with ‘Neutral Actors’ and thus, they are also accepting societal responsibility in shaping the prospective civil drone sector.

4.2. Driving Factors for Public Acceptance of Emerging Technologies

The most relevant and largest group to tolerate or accept civil drones is undoubtedly the general public. Therefore, in the upcoming chapter, the term ‘acceptance’ is introduced first and afterwards, relevant issues, concerns and potential strategies to abolish societal barriers are scrutinised.

4.2.1. The Acceptance Building Process

To ensure an economically viable drone market, the public must prospectively accept or adopt civil drone applications. However, from the critical attitude formation to the pure technological toleration up to the final adoption of new technologies are internal cognitive processes to accomplish that depend on external and internal factors, which are explained in the upcoming chapter.

- **Attitude formation**

According to Richards et al. (2018), an attitude is a long-term organisation of values, feelings and behaviours towards objects, groups or events (p.2). Accordingly, an attitude is something that is nearly unchangeable in terms of time. If formed once, it remains stored in the long-time memory and can only alter over a period or by allocation of new knowledge or insights. In line with that, an attitude is exclusively formed by the interpretation of external information, utilising cognitive (e.g. beliefs, thoughts), affective (e.g. feelings, emotions) and behavioural (e.g. experiences) components and, if formed and stored in long-term memory, it is quite difficult to change (Richards et al., 2018, p.2).

- **Types of acceptance**

A positive attitude towards a technology is a prerequisite for the emergence of acceptance, because in contrast to an attitude, acceptance also includes several active components and goes beyond ‘tolerance’. In general, acceptance results from the interaction of inner values on the attitude level, the subsequent adoption on the action level and the voluntary application on the adoption level. (Hermanns, 2012, p.79). Dethloff (2004) recognises the process of accepting or receiving acceptance, particularly in the attitude formation phase, predominantly shaped by factors ‘credibility’, ‘responsibility’ and ‘accountability’ so that granted acceptance can be understood as trust relationship (p. 22). In principle, acceptance formation takes place in three phases, whereby this process depends, besides inner values of the acceptance subject (e.g.

person), also on properties of the acceptance object (e.g. drone) or the prevalent acceptance context (e.g. where or when) and thus, can vary with situation and time (Hermanns, 2012, p.86). According to Hermanns (2012), two different types of acceptance are distinguishable (p.83):

- Adoption acceptance
- Adaption acceptance

Adoption acceptance is prevailing if the respective acceptance object (e.g. drone) is adopted into the value and norm system of a person, without any further technical adaption or modification. This type of acceptance implies a high degree of overall acceptance towards a technology, so that in the further course also the development of a voluntary usage disposition is estimable. In contrast to this, adaptation acceptance indicates that a person formed acceptance solely in consequence to conducted adaptions of specific system properties, afterwards better complying with personal inner values. Nevertheless, adaption acceptance does not automatically implicate any voluntary usage in the further course (Hermanns, 2012, p.83).

- **Determinants of acceptance**

Despite any demographic influences, most relevant factors influencing the ultimate acceptance are primarily the cognitive evaluation of associated benefits and risks, the emotional assessment, the personal technological affinity, the perceived system complexity, system compatibility as well as operational and personal advantages accompanied by a potential system adoption (Hermanns, 2012, p.85). Furthermore, aspects like personal risk awareness, overall system knowledge and expected societal issues influence individual acceptance and therefore, acceptance is a complex function involving different areas of concern (Susini, 2015, p.36).

- **Acceptance building process**

Acceptance develops in a 3-stage process. In the first phase, the so-called attitude formation phase, an individual technology assessment by utilising external information in conjunction with personal values and experiences is conducted to establish an initial attitude. Since a positive course of the first phase is decisive for the whole technology assessment, three components are included in this subjective assessment:

- Affective component
- Cognitive component
- Conative component

Thereby, the affective component is a motivational-emotional component that acts like a ‘gut feeling’, the cognitive component combines already learned things with relevant external information and ultimately, the conative component is considered as an activating, action-oriented component towards the building of a personal usage disposition (Hermanns, 2012 , p.88).

In case that the initial attitude formation phase proceeds positively, a further differentiation is made in the second phase, the so-called ‘purchase decision’, wherein an acceptance subject can develop a personal usage disposition. In the last phase, the ‘usage phase’, permanent acceptance or rejection towards a technology is formed. Furthermore, influenced by the magnitude of evolved usage disposition, an individual risk acceptance towards a technology is tested in this phase by a respective deployment in real conditions (Hermanns, 2012, p.88).

- **Technology acceptance model (TAM)**

Based on beforementioned information regarding the acceptance formation process, this chapter leads over to factors influencing the acceptance of technologies. For this purpose, general factors of technology acceptance and several phases up to a potential system adoption are described (Figure 27). The so-called ‘Technology acceptance model’ (TAM) is an information system developed by Fred Davis and Richard Bagozzi as an extension of the ‘Theory of reasoned action’ (TRA).

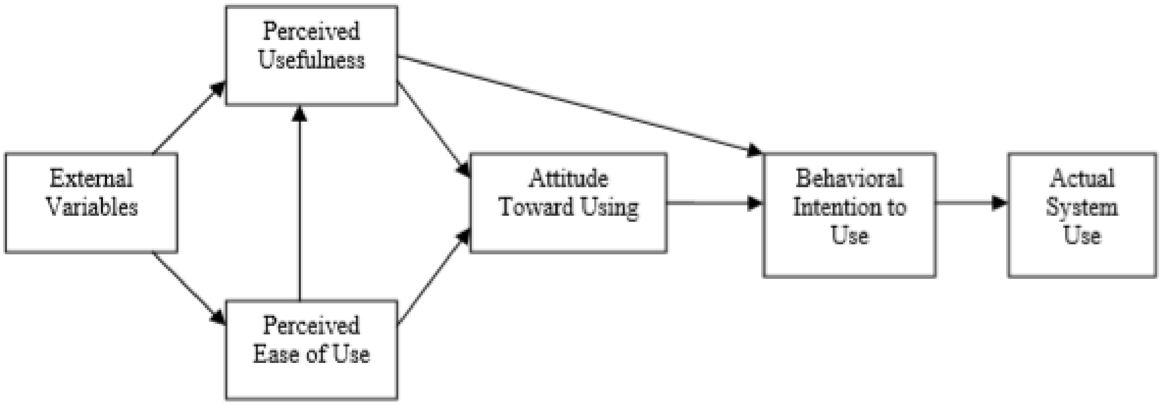

Figure 27: Flowchart illustrating the acceptance formation process towards technologies (Miller et al., 2010, p.3).

As noticeable from Figure 27, at the incipience of an acceptance formation process, predominantly external factors (e.g. information sources) are determining and influencing individual interpretations, affecting individual assessments regarding user-friendliness and overall system usefulness. In respect to all phases of the acceptance formation process, this stage equals the first phase, wherein an attitude is formed in consequence to an individual evaluation of several technological characteristics involving inner values, knowledge and lifetime experiences. Miller et al. (2010) states, that regarding process-relevant external factors, the following parameters are particularly significant (pp.5-6):

- Visibility
- Social norm
- Knowledge
- Trust in content
- Relevance

According to Figure 33, several beforementioned external factors are influencing the individual perception of overall system usefulness and user-friendliness so that, in the next step, based on the individual weighting of system usefulness and perceived ease of use, a personal using attitude towards the technology is formed and stored in the long-term memory. Subsequently, the personal attitude and the perceived system usefulness are determining the degree of behavioural usage intention, which is comparable to the 'purchase decision' phase and not inevitably indicating a real system usage. Ultimately, if all previous phases proceeded positively, in the so-called 'usage phase' a system adoption is achievable.

4.2.2. Subject-related (personal) factors

Distinctive operational reliefs and improved safety and efficiency standards of civil drones facilitate a wide range of applications in our everyday lives. Nevertheless, the increasing operational demand of civil drones is also stimulating significant societal changes, because in contrast to all advantages, drones are almost completely novel to many societal groups, and thus create additional societal challenges, concerns and fears.

Technology acceptance results from an individual assessment process, wherein personal hazards, restrictions and consequences arising from the technology are particularly influential. In line with this, the prevalent chapter focusses on the description of these aspects.

- **Privacy & Data protection**

Due to the technical, constructional and operational variety, combined with adjustable on-board sensors that range from conventional video equipment to microphones up to infrared cameras, civil drones incorporate sufficient capabilities to conduct 'new' surveillance tasks. According to Zavrsnik (2016), mass surveillance is an innovation of the 20th century, since certain surveillance techniques like CCTV (Closed circuit television) in subway stations or body scanners at airports have become indispensable due to internal security policies (p.258). Nevertheless, civil drones also entrust the general public with the opportunity to carry out sousveillance, which is, in contrast to official (e.g. government) surveillance, uncontrolled and causing striking societal concerns regarding privacy and data protection.

In line with this, Knepshield et al. (2016) conducted a focus group study to evaluate most relevant societal concerns or barriers caused by the deployment of civil drones. Therein, the violation of privacy revealed to be the most relevant societal concern (p.319). In general, privacy is a fundamental right, which is ‘an essential part of human flourishing and well-being’ (Pauner et al., 2015, p.92) and according to Article 8 of the European Convention of Human Rights (ECHR):

> *Everyone has the right to respect for his privacy and family life, his home and correspondence.* – ECHR, 2018

Privacy, also including several data protection issues, is a vague concept without a universal definition or legislation (Chen, 2017, p.271). However, privacy features various dimensions, differently affected by civil drones (RPAS, 2013, p.20):

- Bodily or behavioural privacy
- Information privacy
- Privacy of communication
- Location privacy

With respect to privacy concerns, especially ‘Location privacy’ and ‘Information privacy’ are affected by drone operations, because regarding to Chamata (2017), major privacy concerns are related to the recording and distribution of personal data, the interception of personal communications (e.g. E-mail, telephone), the unnoticed intrusion of private spaces (e.g. small drone) or public frustrations about the overall situational uncontrollability (p. 127). Besides that, the violation of both beforementioned dimensions can also cause a ‘chilling effect’ on behavioural privacy, because over a period people might start to feel continuously observed and subconsciously adjust their private behaviour.

From a legal perspective, on a European level, the Regulation (EU) 2016/679 entered into force on 25th May 2018, posing an appropriate instrument to facilitate the transparent treatment and regulation of all privacy and data protection issues (GDPR).

- **Safety**

To create and promote public acceptance it is of key importance that the safety of process-involved (e.g. pilot, observer), but especially uninvolved third (e.g. passers-by) is adequately ensured, so that overall increasing drone activities do not cause an enlargement of adverse events (e.g. annoyances, crashes).

Analogously to manned aviation, safety poses a key facet for the entire society, also concerning civil drones. Although civil drones are only partially used today, there are still existing safety gaps on a technological and organisational level, which must be closed to promote public acceptance and to enable drone deployments on the long-term also in densely populated areas or city centers. According to Susini (2015), a few years ago the accident rate of drones was still 100 times higher compared to conventional aviation, whereby failures and errors often occur in the following areas (p.29):

- Detect & avoid technology
- Human error
- Mechanical defects
- Communication links

Apart from safety gaps, an important prospective challenge for civil drones is definitely the prevention of crashes or near collisions involving any other airspace users (e.g. helicopters), ensuring safety of uninvolved third parties or wildlife by installing an ELOS (Equivalent Level of Safety) (Susini, 2015, p.31).

- **Security**

Due to the current global risk situation in relation to criminal acts, and especially after the socially memorable events and images of, for example, the Nice attack in 2016, the importance of security has become even more a central concern for EU citizens. Correspondingly, with respect to the societal acceptance of civil drones, precautions and strategies aiming to defense and protect the society or critical utilities against misused drones must be envisaged.

According to Chamata (2017), the flexibility, unrestricted market availability and complexity in detection or neutralisation transforms civil drones in potential security threats in relation to criminal or terroristic misuses (p.127). Nevertheless, technological solutions concerning drone protection (counter UAV) have technologically matured in recent years, which safeguards the societal security feeling and thus, also promotes the introduction of civil drones into our everyday life (Zavsrnik, 2016, p.253):

- Hacking to seize control
- Jamming the drone signal
- Physically disabling drones

In line with this, the governmental deployment of effective counter UAV can secure critical infrastructures, airports or public mass events against unauthorized drone incursions and, thus enhance security and public acceptance of civil drones in common.

- **Liability**

Another crucial aspect, influencing public perception, addresses potential liability issues in the aftermath of damages against third parties or foreign goods. In accordance to the expiring Austrian drone regulation, a liability insurance is mandatory in Austria for all drones above 79 joules of impact energy, which implies that currently an insurance for 'toy'-drones is not mandatory. Fortunately, according to Article 14 (2) (d) (EU) 2019/947 entering into force on 1.1.2021, a compulsory insurance (incl. an adequate insurance sum) is required in any official registration process and thus, will cover many drone classes and mitigate public liability concerns.

- **Economic concerns**

Financial, social and economic assurance are also crucial influencing factors. Accordingly, to promote drone acceptance, also associated economic impacts concerning the job market and all its accompanied activity fields must be considered. Chamata (2017) states, that the economic power of drones is already at a respectable, not negligible level, so that influences on special sectors of the job market are already yet noticeable (p.129).

Nentwich et al. (2018) states that, precise economic forecasts regarding impacts on the job market are not yet possible, although some experts forecast noticeable job substitutions in the logistics and transport sector predominantly caused by less personnel-intense parcel deliveries with drones (pp.39-40). In contrast to that, other economic estimations manifest that drones will create new jobs at service providers, manufacturers and maintenance companies, which probably compensate potential losses of blue colour jobs (Boucher, 2015, p.1409).

- **Risk-benefit assessment**

A risk-benefit assessment is carried out to ascertain the personal risk acceptance towards a technological innovation. According to Chamata (2017), risk is a multidimensional construct that occurs due to unpleasant, indefinite and unexpected consequences arising from a decision (p.129). The magnitude of perceived risk and risk acceptance depends on the voluntariness of risk taking, the associated societal benefits and the number of affected people (Hermanns, 2012, p.72).

In contrast to risks associated with drone applications, object-anticipated benefits can increase the individual disposition to accept risks. Exemplary for this, drones are facilitating dangerous, dirty and dull tasks and help to spare human resources, which is beneficial for the society and therefore conducive towards individual risk acceptance. Furthermore, if the individual risk-benefit analysis results into inadequate risk acceptance, targeted risk-handling measures like information campaigns, training courses or demonstration flights can minimize societal scepticism and ambivalence by raising individual knowledge and awareness levels, finally aiming to increase the respective level of risk acceptance (Chamata, 2017, p.129).

Individual risk perception is influenceable in many ways, but especially age and gender are significantly relevant. Regarding gender effects, as visible in Figure 34, regardless of the context, women have a more sensitive risk perception than men, since men generally interpret risks as a challenge and accordingly intend to take them (Hitchcock, 2001, p.191). In contrast, women always try to maintain social integrity and thus, assess risks primarily as a threat that they want to avoid (Arch, 1993, p.8). As verifiable in Figure 34, differences in risk perception are indispensable in terms of age and gender.

Regarding age effects, as visible in Figure 28, Rolison et al. (2013) ascertained that, younger age groups are on average less risk sensitive than older ones, because younger are often influenced and pushed by their peers and older adults are often more cautious based on lifetime experiences and increased frailty (p.3).

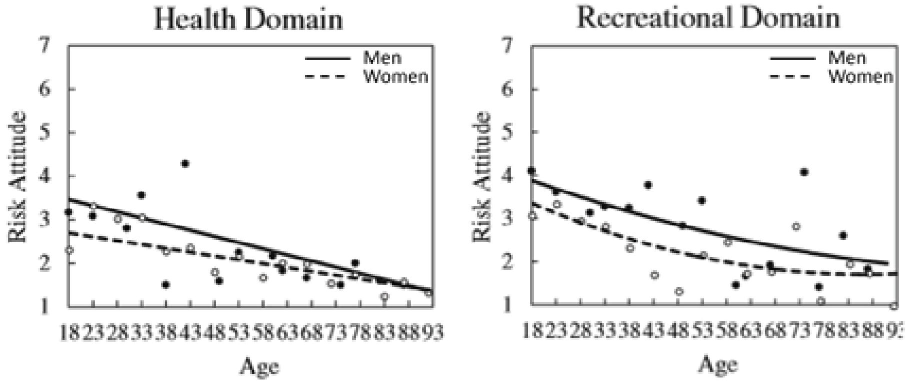

Figure 28: Risk perception differences between age and gender by domain (Rolison et al., 2013, p.7).

In summary, differences in risk perception are identifiable by comparing individual results of men and women at different ages. Therefore, especially women and older people are often perceiving higher risk levels as men or younger people. Nevertheless, individual risk perception is always depending on the exact risk domain, individual lifetime experiences and inner values, so that also exceptions are possible.

4.2.3. Object-related (technical-operational) Factors

Complementary to previously explained subject-related acceptance factors, also properties, capabilities and appearance of the acceptance object influence the societal acceptance and perception of technologies.

According to Pauner et al. (2015), drones entail a magnitude of different construction and buoyancy concepts, are adjustable by different sensors (e.g. radar technology, video equipment, night vision equipment), so that these are complex, multimodal systems, integrating a range of technologies and capabilities (p.90). Due to the prevalent variety of drones, public acceptance of drones is strongly influenced by prevalent technological properties. All this is hardly standardizable and leading to the fact that individual acceptance of drones is ultimately depending on the individual evaluation of drone type, application and context.

Nonetheless, also perceived technical system complexity or environmental system interoperability influences the public acceptance. According to Hermanns (2012), the more complex a system becomes, the more interaction between users and developers is needed, which influences acceptance aversely (p.64). Moreover, drones are associated with more risks, the more unregulated and concise their appearance in terms of size, noise, weight or payload. In line with that, especially the regulation of heavier industrial drones is particularly important since acceptance towards such acceptance objects is much more difficult to create.

4.2.4. Context-related (environmental) Factors

Already noticeable effects regarding climate change, combined with green movements like 'Fridays for Future' have nowadays led to the circumstance, that the economic and societal success of emerging technologies is predominantly shaped by environmental aspects, combined with parameters like eco-efficiency, eco-friendliness and all its associated issues.

As a result, civil drones must entail sufficient technological capabilities that safeguard environmental sustainability and efficiency and thus, mitigate any societal barriers. According to Hermanns (2012), an acceptance object (e.g. the drone) is a system that affects many environmental subsystems and thus can cause complex faults, impairments or annoyances that affect further sub-components (p.75). In general, drones indicate the following environmental effects (Nentwich et al., 2018, p.38):

- Threat to wildlife
- Noise
- Debris
- Air pollution (e.g. NO_x, CO_2)

With respect to any wildlife threat, it must be mentioned that especially birds or other animals often misinterpret and either attack, collide with drones or fly away startled (Netwich, 2018, p.38). Beyond that, a further environmental aspect pertains the emitted noise by drones, which is partially audible from distances about 100 m and increases stress-levels of animals and humans. In addition, so-called debris poses an environmental threat, because in case of an accident during the transportation of environmentally harmful substances, it is hardly possible to prevent the entrance of these substances into the environment (e.g. food chain). A last considerable point, since this also determines the ultimate environmental CO_2 exposure, concerns the energy consumption or energy efficiency of drones. According to Nentwich et al. (2018), drones for parcel delivery up to a parcel weight of 0.5kg are more efficient than the conventional post-delivery (p.38).

Nevertheless, state-of-the-art drone technologies do not cause significant environmental issues in comparison to cars or other. Moreover, further technological advances will entail an increased operational efficiency and thus, mitigate concerns regarding noise emissions, debris and potential CO_2-issues.

4.2.5. How to Shape These Factors?

Based on the explanations above, public perception is significantly influenced by object-related (e.g. capabilities), subject-related (e.g. privacy issues) and context-related (e.g. pollution) factors. However, since attitude and acceptance formation towards drones is primarily corresponding to the individual assessment of information, impressions, knowledge or experiences, especially innovative technologies like drones, with which normal citizens had not yet contact, are strongly influenced by media, authorities, research or industry.

- **Media**

Information provided by media, for example in the form of newspapers, social media or television, is the most ordinary and easiest way to obtain information or to connect with general public. Backed on this, mainstream opinions of the general, non-specialist population in terms of associated usability, knowledge and risk perception are strongly influenced by information type (e.g. news, specialist article), media type (e.g. tabloid) and reporting style of the consumed source.

In consequence, especially the reporting style and reputation of the respective source determine objectivity, information content, quality and the manner how information is presented towards the readership. All this, also considering any characteristics regarding the educational and social strata of the readership, influence the likelihood that the respective content is also read. According to countless surveys regarding the readership of various media, especially tabloids attempt frequently to attract attention with exuberantly worded articles and headlines, which are predominantly read by poorly educated, societal groups (Richards et al., 2018, p.3).

Besides societal influences causing diverging media consumption habits, also demographic influences are non-negligible. Therein, especially the age of a person influences the type of consumed media. As visible in Figure 29, people above 55 years are predominantly consuming television and written press (e.g. newspaper). In contrast to that, younger people below the age of 24 are mostly consuming internet and social media. In line with this, age differences are also causing significant differences regarding media consumption behaviours so that older people continue to use traditional media and younger generations almost exclusively online resources.

All in all, these differences can cause variances in information access regarding civil drones (e.g. written press can´t show any videos of drones). Furthermore, it is assumable that younger people are due to the use of new media (e.g. internet use) more open-minded and optimistic (incl. privacy concerns) towards new technologies than older people, which is perhaps also displayed in acceptance differences between various age groups.

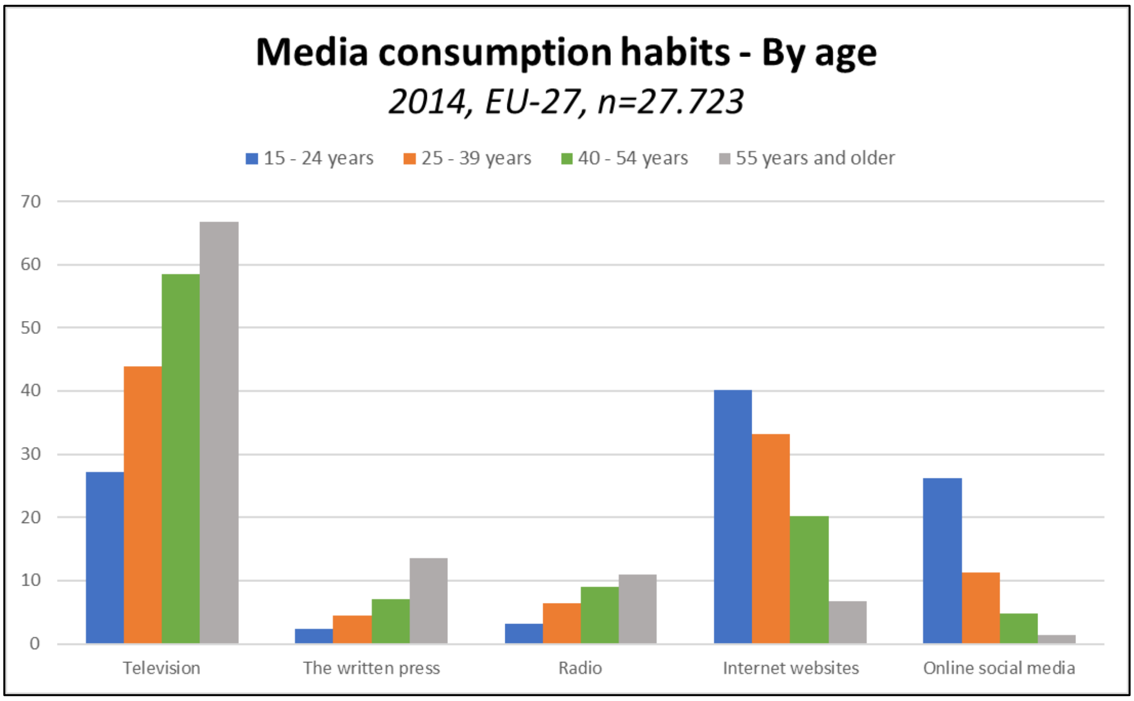

Figure 29: Differences in media consumption habits by age (zacat.gesis.org, 2014).

Backed on this, media type and reporting style are significant, because media information can influence especially the general public in the formation of basic attitudes or acceptance towards a new technology. According to Richards et al. (2018), mainly tabloid press focused in the past on military events and assassinations involving drones, so that the likelihood that especially the usual readership of tabloids, which is characterisable as less educated or members of the traditional laboring class, are still anticipating drones with militarily applications is striking (pp.2-3). In contrast to the highlight-oriented reporting style of tabloids, quality papers should handle the term ‘drone’ in a more differentiated and objective manner, thus they are not misusing it for any headlines.

Figure 30: Media reports after the drone incident involving M. Hirscher on 22nd December 2015 (futurezone.at, 2015).

In summary, media are seriously influencing the attitude and acceptance formation process of people, but especially those previously completely unaware about civil drones. At this stage, it must be emphasized that attitude or acceptance are closely linked to external information and that acceptance differences can be the result of different media consumption habits of various societal groups. Nonetheless, negative reports about accidents or incidents involving drones trigger a huge media echo that only wears off over time and remains in people's minds (Figure 30).

- **Information campaigns**

According to Boucher (2015), knowledge is a prerequisite for responsibility and acceptance (p.1392). For this reason, based on the previous chapter, acceptance should be mainly created by the distribution of objective, official, correct and transparent information about civil drones to the general public, as a population that is actively process-involved can highly benefit from a clear communication and thus, any misinformation from media or internet can be prevented and acceptance barriers surmounted more easily (Boucher, 2014, p.17).

In consequence, broad public information campaigns, utilising information folders, official newspaper articles, demonstration flights or television spots, are potential ways to establish positive attitudes towards drones.

- **Technological enhancements**

Technological improvements affect all dimensions of public acceptance, since they increase safety, security, protection of personal rights or anticipated system benefits, and moreover, they enhance various operational performances.

Privacy-enhancing (PET) or privacy-by-design (PbD) technologies like mandatory emitting lights or signals utilised in private drones are potential ways to mitigate privacy concerns and prospectively facilitate societal acceptance.

Technological progress causes improvements in terms of safety, to counteract increased air and ground risks. In this context, air risk considers risks posed by drones to other airspace users, like manned aircraft, paragliders, gliders or equivalent. In contrast, ground risk characterises prevalent risks for people, animals, goods or properties on the ground, which could be affected in case of a crash or accident. Regarding ground risk, for example, sophisticated drone emergency systems like drone rescue systems (e.g. parachutes) could prospectively maximise perceived safety by ensuring safe drone landings also in case of engine failures. Addressing air risk, matured technologies like detect-and-avoid or sense-and-avoid principles can abolish many risks posed by drones to other airspace users in form of collisions, near-collisions or annoyances, and thus soft societal safety concerns.

In correspondence to the security-endangerment by drones at the airport London-Gatwick in December 2018, prospective technological improvements can alleviate security concerns regarding intentional misuse in the context of criminal or terrorist acts. At this point, special reference is made to technological advancements in the field of geo-fencing, signal jamming, or other drone protection systems, which are going to increase the overall societal security perception in conjunction with drone operations.

Apart from technological influences on subject-related concerns, technological enhancements can also mitigate potential context-oriented (environmental) concerns in terms of more efficient, quieter and environment-sparing technologies, enabling less environmental impact on nature, animals, climate and humans.

- **Regulatory enhancements**

An ultimate relevant aspect affecting the public perception and assessment of drones concerns the regulation of drones on a legal level.

According to latest insights, a decisive aspect influencing public acceptance is the individual desideratum for protection against damage of third parties. Therefore, a compulsory liability insurance obligation in accordance with the new EU regulation, combined with national possibilities to specify geographical zones, define pilot requirements, product standards, certifications or e-identification, will remove significant social hurdles, although without respective societal communication about prevalent personal rights and insurance obligations, significant positive societal effects involving the level of perceived risk will stay away.

5. International Drone Acceptance Studies – Overview & Selection

In the following sequence all researched international drone acceptance studies are presented, geographically structured and finally sorted according to their scientific value and relevance for Austria by application of the CASP-tool, which has been introduced in Chapter 2.3.6.

5.1. Introduction to International Drone Acceptance Studies

Comprehensive scientific research enabled the allocation of a remarkable magnitude of international studies that evaluate societal drone acceptance in different continents, countries and cultures.

In correspondence with several established research methods, the quantitative part utilises a total of 137 international studies on drone acceptance, which maximises geographical coverage, contentual integrity as well as overall research quality and scientific plausibility of any implications regarding Austrian drone acceptance. As visible in Figure 31, the quantitative part takes recourse to drone acceptance studies from all continents, but in order to guarantee clarity and structure and to be able to determine the relevance of individual studies more effective, all 137 studies are initially sub-sorted into three segments, based on their origin.

The quantitative part is divided into drone acceptance studies from the following geographical regions: Europe, America and other regions (including Africa, Asia and Oceania).

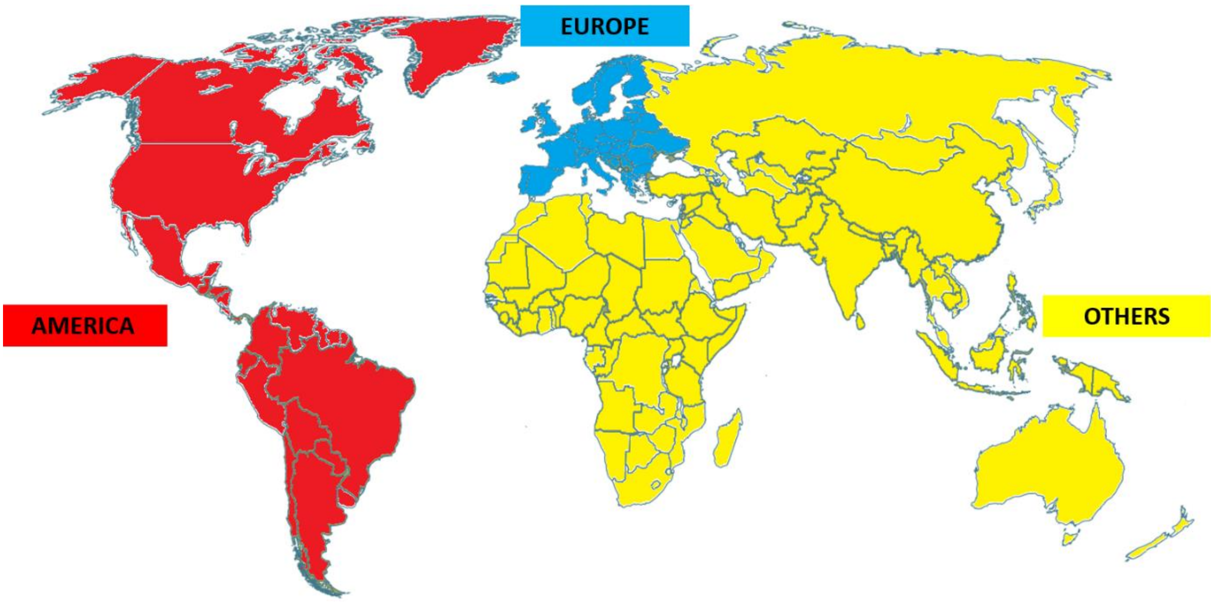

Figure 31: Applied geographical subdivision in this script (FSD, 2016, p.11).

- **Status of international Drone acceptance studies**

Ensuing from the established geographical segmentation, which is mainly characterised by strong regional differences in the density of available drone acceptance studies, the elaboration of plausible statements for all geographical areas and especially Austria is safeguarded. Nevertheless, as noticeable from Figure 32, the striking differences in the amount of conducted drone acceptance studies between all geographical areas must be highlighted. In detail, European and American countries conducted in total 120 studies so far, which represents a remarkable magnitude. Besides that, only the geographical section including Asia, Africa and Oceania unveils with 10 locatable studies a distinctive lack in the evaluation of public drone acceptance, which is a significant finding, especially with respect to the size of this geographical area.

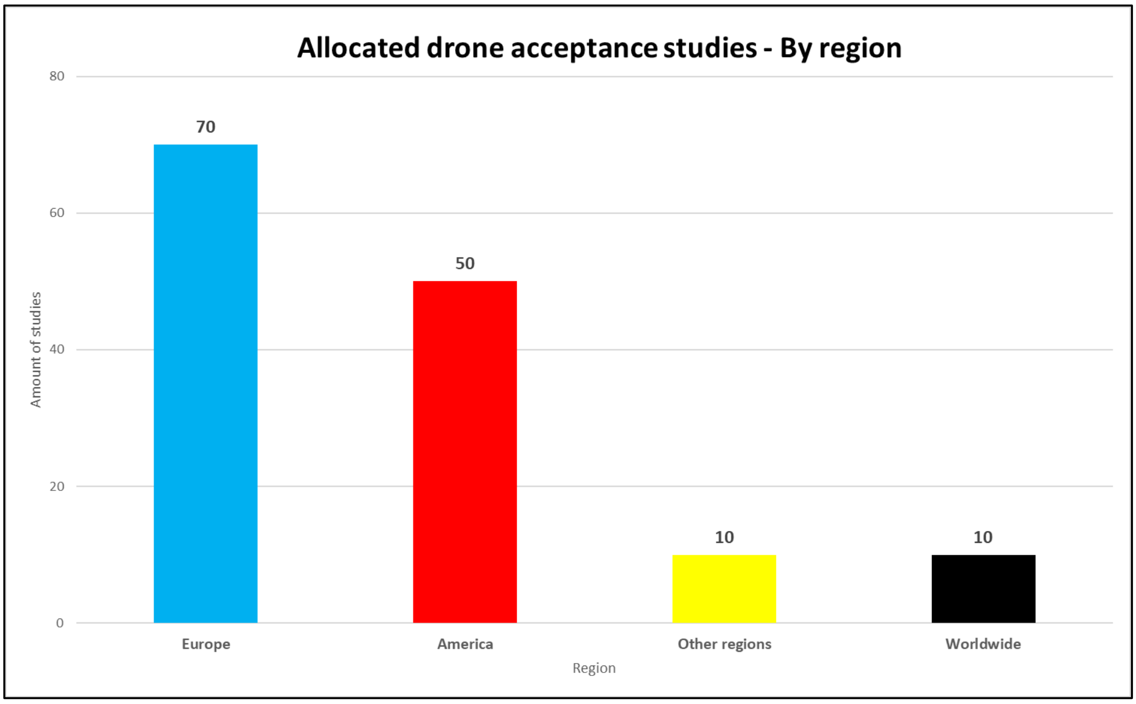

Figure 32: Researched international drone acceptance studies by region (own work).

In a European comparison, according to Figure 32, UK is currently precursor with 18 publicly available evaluations, closely followed by Germany (14) and Switzerland (7). Regarding the situation in America, the United States provide in total 43 drone acceptance studies, while Canada (4) and Latin America (3) are trailing behind with a respectable distance. In conclusion, all remaining regions beyond Europe or America, are summarised in the group ‘Other regions’, which encompasses in total 10 studies (New Zealand: 3, Africa: 3, Asia: 2, Australia: 2).

The respectable growth of the drone sector in the past decade, already described in the qualitative part, has both increased regulatory activities as well as the interaction between society and technology in everyday life. All this caused, that public drone acceptance has taken on greater significance and that incrementally more evaluations have been conducted, in step with first regulatory approaches and driven by respective authorities. As recognisable from Figure 33, first noteworthy public studies regarding drone acceptance, apart from both Boeing-studies with UAM-focus in 2002 and 2003, have been carried out in 2009. From then onwards, the rate steadily increased from two up to 25 annual studies in 2019, which corresponds to a value which is still increasing.

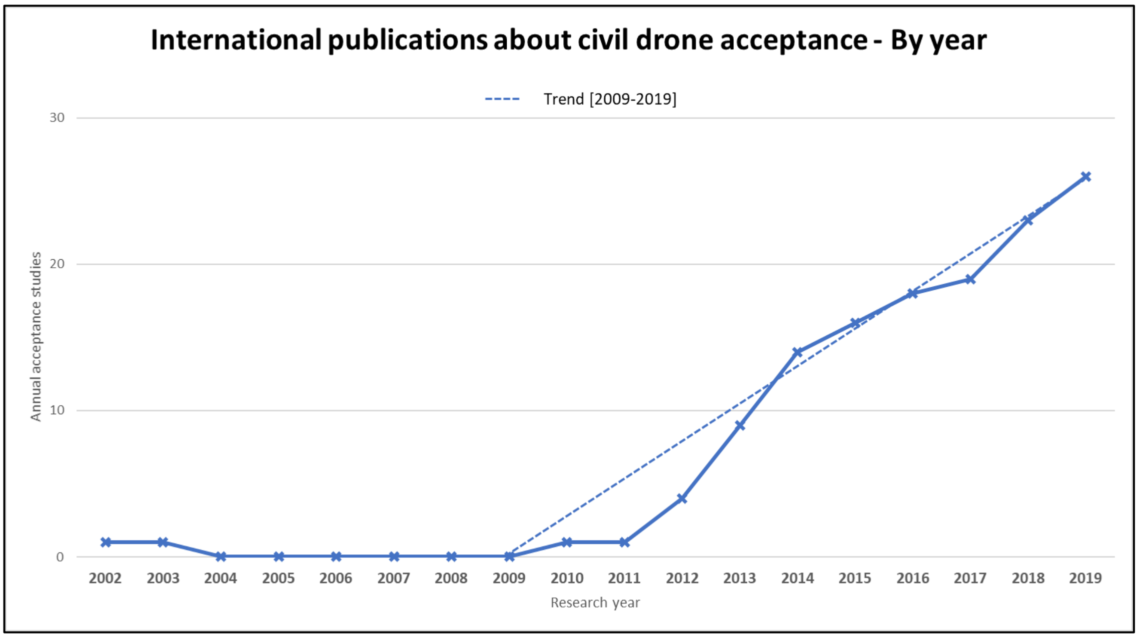

Figure 33: International publications about civil drone acceptance by year (own work).

Backed on these insights and by assessing several publication years (Figure 33), it is ascertainable that the entire agency work, in particular by EASA and FAA in recent years, and the continuous societal communication of drone acceptance as a prerequisite for a sustainable drone market, like in the Riga Declaration (2015) of EU and EASA, promoted a steady increase in the annual study rate and thus, also the overall societal dialogue has intensified.

Another achieved implication signifies, that civil drone acceptance in geographical areas like for example Asia or Africa is not yet considered equally important or even relevant by respective national authorities (NAAs), or that national studies are simply not published with unrestricted public access.

- **Study selection criteria – CASP-Tool**

To guarantee the quality and neutrality of statements and evaluations regarding drone acceptance in Austria, in the upcoming chapter of this scientific work the so-called CASP-tool is applied, see also Chapter 2.3.6.

By deployment of the CASP-tool, this thesis experiences an adaptive, efficient and almost impartial possibility to determine a final study selection, which satisfies several scientific requirements. This process is based on a defined assessment scheme, which has been adapted to the context of this script and quantifies each study according to five pre-defined categories, including survey scope, region, survey year, sample size and client, whereby in the end the overall score is mainly responsible for the final assessment of study usability and quality. All this ensures, that several study aspects are considered, the selection takes place transparently, and that scientifically inadequate studies in terms of sample size or background of the ordering party are not considered in upcoming chapters.

According to the adapted evaluation scheme, as shown in Table 7, it is worth mentioning that several higher weighted ‘disciplines’ like survey scope (5 points), ordering party (4 points) or sample size (3 points) ensure scientific plausibility, and that especially the prevalent international study variety is also represented in the final study selection (e.g. region, survey year).

	Survey scope	Region	Research year	Sample size	Ordering party
0 pts	0/5 criteria	>10 national surveys	>10 annual surveys	< 100	Private
1 pts	1/5 criteria	5-10 national surveys	5-10 annual surveys	100 ≥ x < 500	University
2 pts	2/5 criteria	<5 national surveys	<5 annual surveys	500 ≥ x < 1.000	Industry/Business
3 pts	3/5 criteria	/	/	≥ 1.000	Off. Associations/Institutes
4 pts	4/5 criteria	/	/	/	Authority/Government
5 pts	5/5 criteria	/	/	/	/

Table 7: Applied CASP evaluation scheme.

As recognisable from the determined point distribution (Table 7), several defined selection criteria are considering, despite the context of the ordering party, especially the respective survey scope with a maximum of five achievable points. Therein, in the run-up to the CASP-assessment, five especially relevant selection criteria to assess the survey scope have been defined, covering particularly important aspects on a global but also Austrian level:

- UAM (Urban air mobility)
- Acceptance of specific applications
- Influencing factors
- Societal concerns
- Improvement possibilities

By applying the CASP-principle in this work, a maximum sum of 16 points from all disciplines is achievable, whereby only studies with a total score of at least 8 points are considered for the quantitative investigation. However, this research pre-reserves the right of granting case-by-case exceptions towards previously negatively CASP-evaluated studies of sparsely researched regions (e.g. Asia) or studies that address aspects not already covered by other positively assessed studies (e.g. UAM).

Regarding positively evaluated studies (≥8 points), the study entailing the highest national total score is always initially used to enable interpretations regarding the respective national situation. In case that, apart from the highest rated national study, also other studies of a country achieve a positive CASP-rating, they serve consequently as supplementary studies to ease the formulation of scientifically valid statements. In addition, if only a single national evaluation is available, the respective study is automatically considered, independently from the achieved total CASP-score.

To recapitulate, the consequent application of the CASP-tool ensures a plausible and transparent selection process of relevant international drone acceptance studies by evaluating and grading these by means of five parameters. In consequence, the CASP-final score determines the further relevance and leverage of studies in this work. Therefore, the CASP-tool ensures, apart from granted case-by-case exemptions, the exclusive consideration of studies entailing sufficient geographical, temporal and content-oriented coverage, adequate survey samples and trustworthy ordering parties to elaborate reasonable implications, statements and recommendations regarding civil drone acceptance in Austria.

In advance of utilising the CASP-tool, the applicated colour scheme must be explained briefly (Figure 34). Therein, green highlighted drone acceptance studies are representing studies with the highest national CASP-score, so that green highlighted studies are automatically considered and serve as starting point for each national evaluation. Furthermore, yellow shaded drone acceptance studies achieved a positive CASP-score, but not the highest in a national comparison. In consequence, these are also taken into consideration and serve as complementary studies, if certain aspects are not covered by the top-rated study of this country. Lastly, all unconsidered and excluded studies are highlighted in red and case-by-case exemptions in blue.

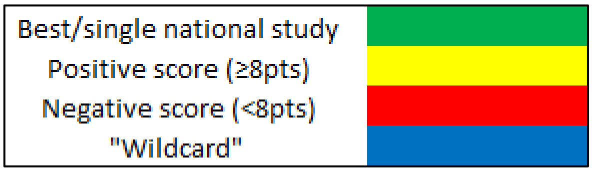

Figure 34: Applied colour scheme in the final CASP study selection process.

In the upcoming sequences, firstly the CASP-tool is applied to studies from all geographical research areas (Europe, America and others). Subsequently the highest-rated national studies are briefly examined and combined with potential complementary studies and case-by-case exemptions. In the end, the study selection of 137 international studies is completed and all selected studies are available in the upcoming chapters. Complementary to that, detected Austrian surveys on civil drone acceptance are not considered in Chapter 5, due to the intend of this Master´s thesis. A comprehensive overview of the respective Austrian research state is provided in Chapter 7.1.

5.2. European Acceptance Studies on Civil Drones

As stated above, this section evaluates all researched European drone acceptance studies according to predefined selection criteria. In the end, several studies are arranged by usefulness and relevance according to the achieved CASP-scores. All this ensures the selection of exclusively useful studies with reference to potential statements and implications for the drone acceptance in Austria.

Subsequently, in Table 8 several selected and relevant European studies are listed and arranged according to their achieved CASP total score, so that these are considered in this scientific work. In line with this, from 70 researched European drone acceptance studies, in ultimate consequence, 31 studies originating from 10 countries and three overall European studies were selected.

Nr.	Nat.	Year	Survey method	Survey scope	Region	Research year	Sample size	Ordering party	Total Score
			Which survey method is applied?	*Are all aspects of drones covered in the survey?*	*Is many research available for this region?*	*Is many research available for this year?*	*Does the sample ensure representiveness?*	*What´s the context of the ordering party?*	
				0 (none) - 5 (all)	0 (many) - 2 (less)	0 (many) - 2 (less)	0 (undersized) - 3 (adequate)	0 (private) - 4 (government)	
94	UK	2019	Online	5	0	0	3	4	12
7	GER	2017	Online	5	0	0	3	3	11
62	EU	2014	Online	4	0	0	3	4	11
84	FRA	2018	Online	4	2	0	3	2	11
137	GER	2020	Telephone	5	0	2	3	1	11
5	GER	2016	Online	4	0	0	3	3	10
29	UK	2016	Online	4	0	0	3	3	10
88	GER	2019	Online	4	0	0	3	3	10
3	UK	2014	Online	3	0	0	3	3	9
6	GER	2016	Online	3	0	0	3	3	9
9	GER	2018	Telephone	4	0	0	2	3	9
12	GER	2018	Telephone	4	0	0	2	3	9
27	UK	2016	Online	2	0	0	3	4	9
63	GER	2019	Paper	3	0	0	3	3	9
66	NED	2019	Telephone	2	2	0	3	2	9
68	UK	2019	Online	3	0	0	3	3	9
69	UK	2019	Online	3	0	0	3	3	9
103	EU	2012	Online	0	0	2	3	4	9
105	UK	2017	Online	3	0	0	3	3	9
4	SUI	2019	Online	4	1	0	1	2	8
21	SUI	2018	/	2	1	0	3	2	8
59	GER	2019	Telephone	2	0	0	3	3	8
90	POL	2019	Online	3	2	0	1	2	8
138	EU	2017	Online	1	0	0	3	4	8
56	FIN	2018	Online	3	2	0	1	1	7
61	ESP	2017	Paper	2	2	0	2	1	7
93	SUI	2017	Online	3	1	0	2	1	7
116	FRA	2018	Online	2	2	0	1	2	7
24	SUI	2015	Paper	2	1	0	2	1	6
87	SLO	2019	Paper	3	2	0	0	1	6
123	DEN	2018	Paper	2	2	0	0	1	5

Table 8: Final study selection for Europe after application of the CASP-tool.

Based on Table 8, this work utilises studies from the following European countries except Austria: Germany (9), United Kingdom (7), Switzerland (4), the European Union (3), France (2), The Netherlands (1), Poland (1), Finland (1), Spain (1), Slovenia (1) and Denmark (1), which will be briefly introduced in the upcoming sub-chapters.

5.2.1. The United Kingdom (7 out of 18)

With a magnitude of 18 conducted studies, the United Kingdom is in an international comparison the region with the most conducted drone acceptance studies, behind the United States, but with a respectable distance to other European countries.

In accordance with achieved CASP-results, a total of seven British studies were considered for further examinations and detailed interpretations in the upcoming chapters of this work. Starting point for each national evaluation is consequently the British study with the highest CASP-rating, which was conducted by the British aviation authority, CAA, in 2019. In their ‘Drone Tracker Report’, a respectable sample size (n=2.003) was surveyed about all essential aspects of drones and combined with the adequate sample size, the prevalent study poses a suitable initial point for national examinations.

As recognisable from the CASP-results, the United Kingdom can take recourse to a large variety of relevant supplementary studies (6), which mainly date back to different years (2014, 2016, 2017, 2019), and thus facilitate scrutinised in-depth analyses on a national level.

5.2.2. Germany (9 out of 14)

With a total of 14 detected studies, Germany attends in terms of already conducted studies the second position in a European comparison. Regarding the CASP-selection process of ultimately relevant studies, nine trustworthy and scientifically plausible studies have been defined in consequence to the application of the CASP-tool. Especially the selection of the most relevant German studies displays a decisive step in this script, because as direct geographical and cultural neighbour, including the German-speaking ability as common feature, Germany is in a close connection to Austria.

As visible in the CASP-results, the highest-rated German study is an evaluation originating from 2017, which was conducted by the ‘German Aerospace Industries Association’ (BDLI) including a respectable sample of n=2.020 and its unique coverage of all noteworthy civil drone aspects.

Comparable to the previously explained situation in UK, also Germany can take recourse to a remarkable amount of available supplementary studies (8). Backed on this, in case that an essential aspect is not addressed by the top-rated BDLI study, several complementary studies can have either a beneficial effect on content or also in regard to an examination of the acceptance development in recent years, because German studies are available for each research year in the period from 2016 to 2020.

5.2.3. Switzerland (4 out of 7)

Switzerland has recently put impressive efforts in evaluating public drone acceptance and is - especially due to the geographical vicinity and cultural similarity to Austria - of crucial importance in this thesis. In consequence, a total of seven Swiss studies has been allocated, which are mainly resulting from academic research projects (e.g. ETH Zurich).

Nonetheless, the Swiss study with the highest CASP-rating is an evaluation conducted by the European aircraft manufacturer Airbus in 2019 including a sample of n=385 and focusing on UAM-applications. Thus, especially the reputation of the ordering party and the covered survey scope in comparison to other Swiss studies reasoned the remarkable CASP-score and its consideration as initial point for the national evaluation.

Besides the Airbus study, several remaining Swiss studies often feature only insufficient sample sizes, originating from academic projects or simply covering inadequate survey scopes. All these aspects are affecting the CASP-score adversely, causing that only one additional study conducted by ‘AXA insurances’ meets the established scientific requirements of this work. However, to enable reliable statements for Austria from a variety of Swiss studies, case-by-case exceptions have been introduced for two studies published by Neuchatel University (No.93 and No.24).

5.2.4. The European Union (3 out of 13)

Due to the increasing relevance of civil drones for the single market, the European Union has recently scaled up its activities regarding the evaluation of drone acceptance in Europe. In this regard, a total of 14 studies relating to societal drone acceptance have been detected in the research phase, although only three are considered relevant by the CASP tool.

Several considered European studies are so-called ‘Eurobarometer’ studies, which are commissioned or initiated by the European Commission and conducted in almost all member states of the European Union. Thereby, in particular the ‘Special Eurobarometer 427’ study (Figure 35) dating back to 2014 must be mentioned, wherein aspects like societal concerns, demographic influences and current societal awareness towards drones was evaluated in 27 EU member states, including also the UK, at a total sample of n=27.801. Based on sample size, available national results and the proper reputation of the ordering party, the prevalent study is the most important one on a European level.

In addition to the highest-rated Eurobarometer study, addressing many aspects of civil drones, both remaining and CASP-considered European studies are also Eurobarometer studies

(No.102/138, No.382/460), displaying adequate sample sizes, but evaluating societal acceptance only for common technologies and thus, address drones only indirectly.

Nevertheless, due to the facilitation of cross-national comparisons concerning aspects like technological affinity, technology or risk perception, also these European surveys are of relevance for ultimate implications.

5.2.5. France (2 out of 2)

In contrast to other, in terms of size and relevance of the national aviation sector comparable European countries (e.g. UK, Germany), only two French studies regarding drone acceptance have been located.

Nevertheless, the relevance of both studies is determined by application of the CASP-tool, reasoning that the national assessment of French drone acceptance is based on a study from 2018 with a sample of n=1.000 and commissioned by the state-run company ‘Enedis’, which is an important stakeholder concerning critical infrastructure (electricity) in France.

Similar to the situation in Switzerland, in order to enable valid scientific statements regarding societal drone acceptance in France, a case-by-case exception is established for the second available French study (No. 116), so that, even if previously inadequately CASP-assessed, this study is also available in the upcoming chapters.

5.2.6. The Netherlands (1 out of 4)

In total four Dutch studies regarding drone acceptance have been collected, which are predominantly results of academic student projects or conducted by agricultural stakeholders at rather inadequate sample sizes or unrepresentative survey demographics, so that these are only evaluating a few drone aspects and do not capture the entire societal situation.

Despite that, at least one study with adequate sample size (n=1.000) that focusses on the evaluation of public acceptance and advantages of agricultural drone applications has been researched and is utilised as starting point for any Dutch investigations.

Furthermore, remaining Dutch studies are, due to their deficient scientificity, also not suitable for case-by-case exemptions, so that any assessments regarding national drone acceptance will probably have to be made in conjunction with worldwide and European results.

5.2.7. Others: Poland, Finland, Spain, Slovenia & Denmark (5 out of 5)

Besides European countries that already conducted a magnitude of national evaluations to date, some countries either did not carry out any evaluations yet, or only very few.

Nonetheless, a single national study has been found for Poland, Finland, Spain, Slovenia and Denmark, so that, regardless of the scientific quality, these are used as an initial point for national statements or comparisons. As stated in Chapter 5.2.6., in case that distinctive contentual gaps during the evaluation of respective national results occur, pan-European or worldwide study results will be used to maximise scientific plausibility.

5.3. American Acceptance Studies on Civil Drones

Apart from the European situation, also the second important geographical region, consisting of North America (USA, Canada) and South America, has recently put efforts into the conduction of national surveys to evaluate societal drone acceptance (Table 9).

Nr.	Nat.	Year	Survey method	Survey scope	Region	Research year	Sample size	Ordering party	Total Score
			Which survey method is applied?	*Are all aspects of drones covered in the survey?*	*Is many research available for this region?*	*Is many research available for this year?*	*Does the sample ensure representiveness?*	*What´s the context of the ordering party?*	
				0 (none) - 5 (all)	0 (many) - 2 (less)	0 (many) - 2 (less)	0 (undersized) - 3 (adequate)	0 (private) -4 (government)	
79	CAN	2012	Telephone	2	2	2	3	4	13
3	CAN	2014	Online	3	2	0	3	3	11
80	CAN	2014	Online	1	2	0	3	4	10
81	USA	2018	Online	4	0	0	2	4	10
3	USA	2014	Online	3	0	0	3	3	9
34	USA	2013	Online	2	0	1	3	3	9
41	USA	2016	Online	3	0	0	3	3	9
48	USA	2015	Online	3	0	0	3	3	9
104	USA	2012	Telephone	3	0	2	3	1	9
135	USA	2020	Online	1	0	2	3	3	9
4	LAM	2019	Online	4	2	0	1	2	9
32	USA	2015	Online	2	0	0	3	3	8
33	USA	2014	Online	3	0	0	2	3	8
51	USA	2016	Online	2	0	0	3	3	8
96	USA	2019	Online	3	0	0	2	3	8
106	USA	2013	Telephone	3	0	1	3	1	8
110	USA	2013	Telephone	1	0	1	3	3	8
111	USA	2013	Online	2	0	1	3	2	8
112	CAN	2014	Online	2	2	0	3	1	8
4	USA	2019	Online	4	0	0	1	2	7
77	USA	2014	Online	2	0	0	2	3	7
100	USA	2002	Paper	2	0	2	1	2	7
102	LAM	2018	Online	3	2	0	0	2	7
99	USA	2003	Paper	1	0	2	1	2	6
60	LAM	2015	Online	3	2	0	0	1	6

Table 9: Final study selection for America after application of the CASP-tool.

In correspondence to Table 9, in total 50 national studies of this geographical area have been researched, so that in comparison with Europe or other regions the disclosure of potential societal differences is ensured. Mainly responsible for the remarkable number of conducted American studies is the USA with 43 studies, followed by Canada with 4 and the entire South America with merely 3 studies.

Simultaneously to Europe, the CASP-tool is also applied to several American studies, enabling a study differentiation by scientifically sound criteria to ensure that only reliable studies are selected for the following chapters. In consequence, 25 studies are ultimately selected and considered for final statements concerning this region.

5.3.1. United States of America (18 out of 43)

In the United States, the national aviation authority FAA has recently expedited a social dialogue concerning civil drones due to the 'Reform and Modernization Act' in 2012, so that to date a total of 43 national evaluations regarding drone acceptance are available and entail an unrestricted public access. Nevertheless, albeit due to its geographical size, the USA conducted to date the greatest amount of studies in a worldwide comparison.

According to national CASP-results (Table 9), starting from the impressive number of 43 US-studies, ultimately 18 relevant studies are considered. Thereby it is safeguarded, that none or only reliable studies resulting from academic projects or individuals are considered to facilitate the elaboration of scientific reliable conclusions and statements concerning public drone acceptance.

Premising on the total CASP-scores of Table 9, a study conducted by the Department of Wildlife, Parks and Tourism of the US-state Kansas in 2018, including a sample of n=800 is selected to be most relevant in terms of content, scientificity and methodology for the entire country. Hence, this study is utilised as initial point for any national investigations.

Beyond that, in case that the highest rated study displays any contentual gaps, also the USA can take recourse to many supplementary and thus positive CASP-rated studies. However, despite potential gaps in content, also two UAM-studies conducted by BOEING (No. 99, No. 102) in the years 2002 and 2003 have been found, which are of interest due to their publication year and the opportunity to compare respective results with up-to-date studies. Accordingly, combined with two other relevant studies (No. 4, No. 77), case-by-case exceptions are granted.

5.3.2. Canada (4 out of 4)

In total four Canadian studies have been collected during in-depth research, wherein most of them have been commissioned by official Canadian governmental agencies.

In accordance with several achieved CASP-results, all Canadian studies date at least back to 2014, have sufficient sample sizes and address most aspects of civil drones. Nevertheless, study No. 79 of 2012 has been commissioned by the Privacy Commissioner of Canada utilising a large sample of n=1.513, and thus is considered as most relevant study, even though also two other Canadian studies emerge among the top three in America.

In consequence, sufficient study data is available for Canada to enable a scientific in-depth analysis. In case that some problems in correspondence to the publication year and thus the validity of the data emerge, this research can take recourse to data from worldwide studies.

5.3.3. Latin America (3 out of 3)

Moving from North to South America, it must be noted that the scientific relevance of societal drone acceptance is hardly comparable between both regions. Although both regions are similar in geographical size, only three studies from Latin America have been found signifying that social acceptance in Latin America is not addressed with that much relevance as in other regions. Furthermore, all this demonstrates the possible result of missing official communication by authorities or governments.

However, to enable valid statements for South America regarding civil drones, the CASP-score is in this case only of secondary importance, because a selection by means of the CASP-criteria would only be a hindrance in enabling any statements. Therefore, in the following sections of this thesis, it is targeted to enable assertions mainly in combination with suitable worldwide studies.

5.4. *Other Regions (Asia, Africa, Oceania)*

Extensive research has been conducted regarding the third and ultimate geographical area in this scientific work, which ultimately resulted in the detection of acceptance studies for Oceania (5), Africa (3) and Asia (2).

Analogically to the other geographical areas, the CASP-tool is also applied to several studies of this region. In correspondence to that, out of 9 studies ultimately 7 studies are considered for the remaining chapters of this script. The detailed CASP-results for each study and country are presented below (Table 10).

Nr.	Nat.	Year	Survey method	Survey scope	Region	Research year	Sample size	Ordering party	Total Score
			Which survey method is applied?	*Are all aspects of drones covered in the survey?*	*Is many research available for this region?*	*Is many research available for this year?*	*Does the sample ensure representiveness?*	*What´s the context of the ordering party?*	
				0 (none) - 5 (all)	0 (many) - 2 (less)	0 (many) - 2 (less)	0 (undersized) - 3 (adequate)	0 (private) -4 (government)	
67	NZL	2018	Online	4	2	0	2	4	12
95	AFR	2017	Online	2	2	0	3	3	10
4	NZL	2019	Online	4	2	0	1	2	9
73	AFR	2015	Paper	2	2	0	1	3	8
2	AUS	2015	Online	3	2	0	1	1	7
124	AFR	2015	Paper	3	2	0	1	1	7
57	AUS	2019	Paper	2	2	0	0	1	5
107	PAK	2018	Online	0	2	0	1	1	4
1	MAL	2018	/	0	2	0	0	1	3
44	AUS	2018	/	0	2	0	0	1	3

Table 10: Final study selection for 'Other regions' after application of the CASP-tool.

5.4.1. Oceania (4 out of 5)

The region Oceania is mainly consisting of Australia and New Zealand, which both already conducted extensive research on civil drones. Therefore, according to the results of the CASP-tool, a study from New Zealand, conducted by the domestic air navigation service provider (ANSP) called 'Airways' in the year 2018 (n=882) has been located and considered as most relevant for this region.

Besides this highest-rated survey, another survey from New Zealand and two Australian studies have been researched and considered as complementary studies to mitigate potential contentual gaps in the highest-rated 'Airways'-study.

5.4.2. Africa (3 out of 3)

Profound internet and literature research enabled also the allocation of three African evaluations on drone acceptance. In consequence, according to the CASP-results, all African studies are considered in this research and therein, the most relevant African study (No. 95) is a survey conducted by CTA (Centre for Agricultural and Rural Cooperation), which is a joint organisation of the African, Caribbean and Pacific (ACP) Group in cooperation with the European Union. The respective poll surveyed all African regions and incorporates an agricultural focus with a total sample of n=1.432. The significance of this study is especially indispensable in the light of maximising the geographical coverage in this research.

Recapitulatory for Africa, primarily study No. 95 in combination with both other allocated complementary studies (No. 73, No. 124) enable plausible statements for this, mostly rural region.

5.4.3. Asia (0 out of 2)

In an international comparison, Asia is the only region, in which no drone acceptance studies have been found. In line with this, reference is made to two publications from Malaysia and Pakistan, which are impractical for a quantitative evaluation.

Thereby it should be noted, that China as one of the world market leaders in this domain, has not published one single drone acceptance study yet.

However, in the further course of this script it is intended to gather and process potential Asian results from worldwide studies like Deloitte or Pew research (No. 134, No. 126), enabling perhaps also valid statements for this region.

6. International Drone Acceptance Studies – Analysis & Evaluation

The quantitative part initiates with an exhaustive description of determined and located similarities, distinctions or trends in all considered international drone acceptance studies to elaborate a foundation that enables in the upcoming Chapter 7 - in combination with sociodemographic, topographic and common national specifics - arguable results and implications for Austria.

In the run-up, a comprehensive quantitative analysis is conducted in MS Excel, to create a profound, comparable and interchangeable data base, which facilitates the determination of plausible similarities or distinctions in several geographical regions and countries.

6.1. Similarities of Relevant Studies by Application Category

In general, the scrutinised comparison and investigation of several considered international drone acceptance studies revealed in total three criteria, which incorporate both similarities and distinctions on a national, continental as well as global level. In the upcoming section, several detected similarities are highlighted in conjunction with the related application categories.

A decisive influencing factor for the public acceptance of civil drone applications is the application category. In line with this, to enable the determination of similarities or differences regarding public perception, it is necessary to categorise the large number of different application domains into a more comprehensive manner.

Therefore, after entering all available study data in MS Excel, a distinction has been established between four significantly different application categories: emergency (EMS), governmental (GOV), commercial (COM) and recreational (Private) applications. In correlation to that, all available international survey data have been assigned to a category, whereby especial emphasis has been put on the fact that all categories differ in terms of societal added value, involved societal groups or background of the operator (e.g. official, private).

Based on this, 'Emergency applications' address primarily drone deployments to save human lives in the event of natural disasters, catastrophes or accidents, so that in these cases parameters like time, efficiency and safety of rescue workers are decisive. ‘Governmental applications’ are always initiated and monitored by official constitutions (e.g. authorities) and are exclusively conducted by professional personnel, so that potential societal concerns in terms of privacy, security are of less significance (e.g. border control). 'Commercial applications' incorporate commercial drone services offered to specific customer segments for business purposes (e.g. aerial photography) and 'Recreational applications' address drone flights conducted by general public without a specific purpose.

- **Similarity 1: Emergency applications – Global acceptance leader**

As obtainable from Figure 35, several categorisation criteria are now coherently applied to several studies from all three geographical areas, so that in ultimate consequence acceptance values for each geographical region are calculated by combination of all available data.

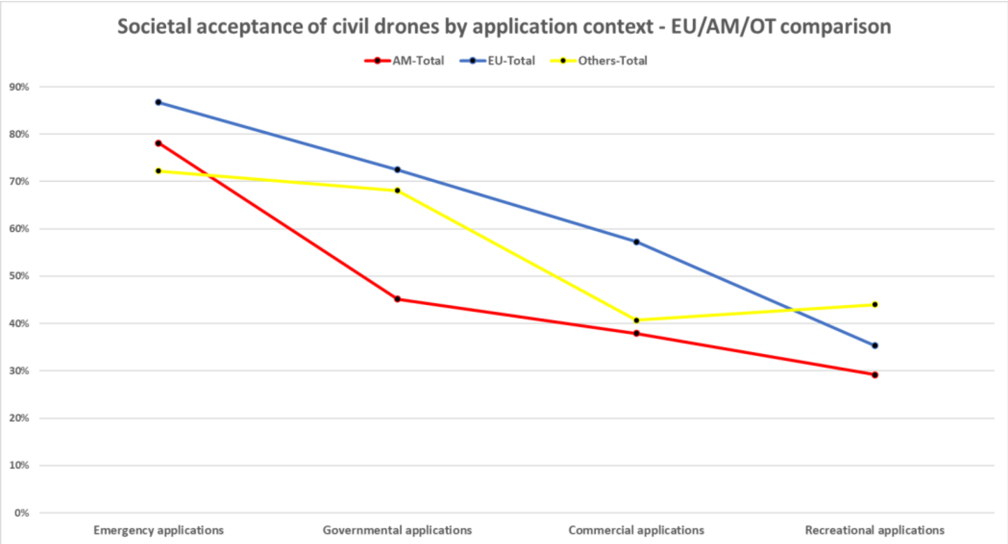

Figure 35: Societal acceptance of civil drones in a global comparison by application category.

An evaluation of all received acceptance values in all three geographical regions reveals that 'Emergency applications' experience worldwide always the greatest amount of societal tolerance and acceptance, whereby rescue missions are especially most accepted in Europe (86%), followed by America (79%) and the 'Other Regions' (72%).

In correspondence with this similarity, it is worth mentioning that civil drones are almost unreserved accepted by all global societies in the context of rescue operations, as they create enormous societal added value by saving human lives, are explicitly operated by trained personnel and, above all, are only deployed for a limited time during an emergency. Beyond that, especially the acceptance difference between Europe and America must be highlighted and is arguable by both completely different welfare and social systems. In specific, Europe is mainly consisting of social welfare states, in which citizens enjoy an intact social rescue network, independently from social class, which is almost completely absent in America. In summary, all this leads perhaps to a more cautious behaviour of American citizens towards emergency services and in consequence perhaps to a different attitude towards drone deployments in disaster response missions.

- **Similarity 2: Governmental applications – The second best**

'Governmental applications' should not be confused with emergency operations, because these are covering predominantly applications characterised by the absence of any time pressure, like border patrol, public surveillance or law enforcement. Since these application scenarios are not aiming to preserve any human life, the public associates not the same magnitude of personal and social relevance compared to ‘Emergency applications’. As recognisable from Figure 35, the decrease in operational urgency and the absence of an emergency in the direct sense, are also perceivable in uniformly lower acceptance values towards this application category in a worldwide comparison.

Nevertheless, drone flights conducted by an official body (e.g. authority) give the population sufficient confidence that respective drones will not be misused for illegal purposes wherein privacy, safety or security of individuals is adversely affected. Complementary to that, governmental applications are predominantly serving national interests, like public surveillance to enhance societal security or to counteract crime or terrorism. Backed on this, 'Governmental applications' represent coherently the most accepted application category on a global level, after ‘Emergency applications’.

Besides the fact that the ultimate acceptance depends strongly on the exact governmental application (e.g. border control task are more relevant as the issuance of speeding tickets with drones), these applications are mainly serving security-enhancing purposes in the complete absence of any time pressure while rescuing humans. Therefore, such applications are not experiencing the same magnitude of societal relevance, but the fact that such flights are exclusively conducted by official bodies and trained staff, gives the population enough confidence to support these. ‘Governmental applications’ are in Europe accepted by 72%, followed by America with 45%, wherein the difference between Europe and America is primarily caused by the general mistrust of US-citizens in ‘the state’.

- **Similarity 3: Commercial applications – The logical third**

In correspondence with several detected worldwide similarities in emergency and governmental applications, 'Commercial applications' are on a global level, except 'Other regions', uniformly third most accepted. Thereby, especially the significant acceptance difference in comparison to the 'Governmental applications' must be highlighted, which accounts in Europe approximately 24% and in America 10%.

This difference can primarily be justified by the fact that commercial drones are either used by companies to ease and enhance routine processes (e.g. inspection of buildings) or offered as service to specific customer segments (e.g. wedding photography). In accordance with that, several process-involved parties experience significant personal or operational added value from commercial drones, but in opposite to all prior described applications, the general public not. In consequence, these applications are globally distinctively less accepted, although people appreciate that commercial drones are operated by professionals, so that at least no intentional or unintentional misuse is to expect.

- **Similarity 4: Recreational applications – Outweighing scepticism**

An in-depth analysis of the global societal acceptance towards 'Recreational applications' facilitates the establishment of another similarity. In accordance with that, recreational drones are especially in America and Europe societally less supported, so that these applications are denoting in both regions the least accepted application category. In terms of numbers, approximately 35% of European and 30% of American citizens support drone applications for recreational purposes.

However, this phenomenon appears not unexpected as especially the unprofessional, uncontrolled application of leisure drones by the general public expedites societal concerns, creates exclusively personal added value and insufficient societal relevance. In addition to that, the society associates drones applicated by the general public intuitively with more threats in terms of privacy, security and safety, causing a deficient societal acceptance. Nevertheless, in Europe recreational drones are more positively perceived as in America, where people perhaps have already been more exposed to privacy, safety or security threats caused by recreational drones.

- **Similarity 5: European comparison – The same order**

Besides the implications from the worldwide comparison, 'Emergency applications' experience in all evaluated European countries the greatest societal acceptance, closely followed by 'Governmental applications', 'Commercial applications' and ultimately 'Recreational applications' (Figure 36).

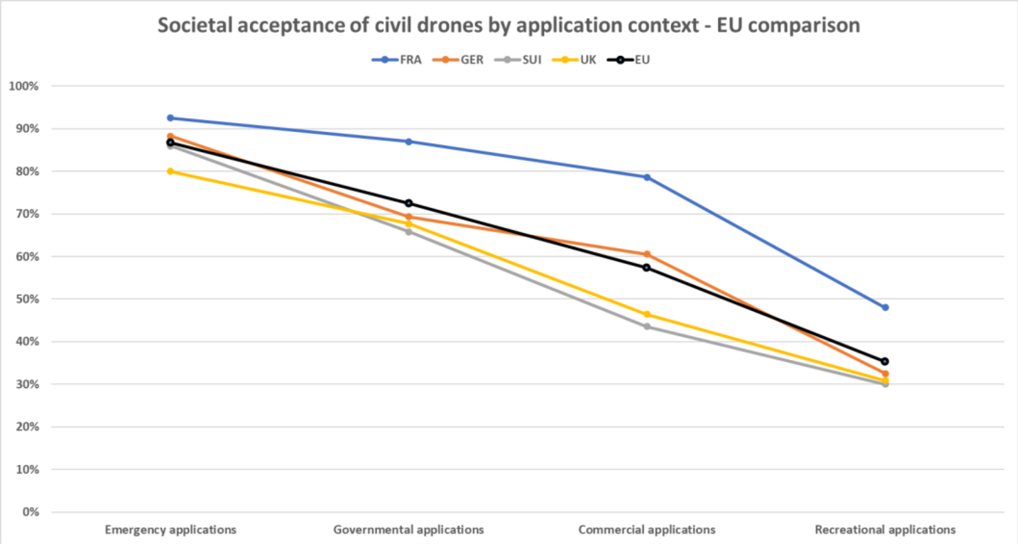

Figure 36: Societal acceptance of civil drones in a European comparison by application category.

In consequence and in line with the already obtained similarities on a global level, especially drones for commercial and recreational purposes experience also on a European level only deficient societal acceptance, so that the worldwide established similarities are also conveyable to several investigated European countries (Figure 36).

6.2. *Similarities of Relevant Studies by Social Demographics*

Complementary to identified similarities in relation to application categories, also socio-demographic influences on the individual acceptance of civil drones are subsequently examined on a global level. In correspondence to this, decisive similarities between several geographical regions have been determined.

6.2.1. Gender

As already described in Chapter 4.2.2., the gender of the respective person is particularly influential and decisive, especially for the perception of state-of-the-art technologies that affect everyday life. At this stage, international studies wherein acceptance values for men and women are separately specified, are highlighted and analysed to enable estimations regarding the gender influence on the public acceptance. In general, several conducted examinations revealed that, on average, no single drone application is more supported by women than by men.

- **Similarity 1: Emergency & security applications – Slight gender correlations**

An in-depth investigation of potential gender influences reveals that some applications display only slight gender-correlations in an international comparison. As observable in Figure 37, less gender-influenced is the acceptance at drone applications that generate remarked societal added value and do not serve exclusively personal purposes. Based on this, only marginal gender influences are ascertainable at drone operations in the context of emergency flights in case of accidents, disasters or emergencies (gender-correlation: 3%). This assertion is primarily justifiable by highlighting the created societal added value of these applications, ultimately causing societal relevance and acceptance, which is almost independent from gender.

Emergency & Disaster Response	Surveillance - Security public areas	Police surveillance (Borders)	Environmental conservation
3%	4%	4%	5%

Applications with LESS gender correlations

Emergency response / Governmental applications / Environmental beneficial

Figure 37: Applications of civil drones with no significant gender correlations ('+': men more supportive).

In addition to emergency operations, also applications that serve to improve overall public security are adequately accepted by both genders (gender-correlation: 4%). Complementary to that, especially in times of green movements like 'Fridays for Future' it must be mentioned that drone operations in the context of nature conservation tasks are also more or less equally supported by both genders (gender-correlation: 5%).

- **Similarity 2: Infrastructure & for-profit applications – Moderate gender correlations**

In addition to less gender-influenced applications, some drone applications experience moderate gender-correlations. According to several achieved results, predominantly applications that increase commercial efficiency (gender-correlation: 8%), military applications (gender-correlation: 9%), commercial services (gender-correlation: 11%) but also futuristic and highly innovative air taxis (gender-correlation: 11%) and recreational drone deployments (gender-correlation: 11%) are distinctively better accepted by men.

As visible in Figure 38, especially applications that implicate an increased operational complexity are societally associated with a higher level of uncertainty and, due to differences in risk perception, more ambiguously assessed by women. Exemplarily, the calculated gender-correlation of air taxis (gender-correlation: 11%), signifies that this concept is still in development and nowadays especially for women just a futuristic project, associated with high and currently intolerable risks.

Infrastructural management	Military usage	Commercial drones | Air taxi (UAM) Recreational usage
8%	9%	11%

Applications with MODERATE gender correlations

Infrastructure / Military applications / UAM / Recreational drones

Figure 38: Applications of civil drones with moderate significant gender correlations ('+': men more supportive).

On one hand gender-specific acceptance differences are almost negligible at applications that generate remarkable societal added value. On other hand, especially an increasing technological or operational complexity, combined with a decreasing societal added value and in consequence also personal relevance, cause significantly increased gender differences.

- **Similarity 3: Recreational & agricultural applications – Highest gender correlations**

Apart from several detected similarities concerning applications that feature only slight or moderate gender-correlations, another similarity addresses predominantly applications without any societal added value. These are exclusively serving personal or business interests and amusements (e.g. recreational flights), what ultimately leads to considerable differences in societal acceptance and increased gender-correlations.

Logistics (e.g. parcel delivery) | Agriculture	Film/Photo
13%	14%

Applications with HIGH gender correlations

Logistics / Agriculture / Film/Photo

Figure 39: Applications of civil drones with high significant gender correlations ('+': men more supportive).

Based on influences on the public acceptance, societal information as well as a proper affinity towards common technologies are essential for a successful acceptance formation process.

Especially in these two areas striking gender differences are ascertainable, so that women have increased concerns regarding the usage of drones for photography purposes (e.g. privacy, safety, security) or even highly innovative applications like logistics (cargo) drones (Figure 39).

- **Similarity 4: Men-dominated private drone society**

A further observed similarity in an international comparison implies that the private drone society is exceedingly dominated by men. In line with this, in an international comparison approximately 38% more men as female are owners of private drones.

All this confirms already provided insights in this work, signifying that women are more sceptical about the societal and personal added value of drones and therefore also hesitating in the personal adoption or purchase decision.

- **Similarity 5: Different information & knowledge levels**

According to Boucher (2015) 'Knowledge is a precondition for responsibility' (p.1392), this work examines potential influences and reasons for several detected gender differences. In line with this, subsequently also prevailing gender-correlations on influencing factors for the public acceptance are examined.

An established international similarity and influence regarding the abolishment of concerns is in this context the societal level of information. Therein, the calculated gender-correlation of 36% signifies that men are distinctively better informed as women and thus still a lot of effort must be put on societal information campaigns, since information facilitates to overcome societal barriers and to improve acceptance levels. Nevertheless, all this implicates that men are currently much better informed about drones than women, or at least think they are.

Subjective information state	Common technology affinity	Awareness
36%	33%	9%

Figure 40: Gender correlations by influencing factors ('+': men more informed).

As mentioned before, also the common technology affinity influences the public perception of drones and thus shapes ultimately also the personal need for information towards a topic. According to Figure 40, men feature on average a higher affinity towards common technologies than women (gender-correlation: 33%). In correspondence to that, men are on average significantly more aware about drones than women (gender-correlation: 9%).

- **Similarity 6: Diverging perception & interpretation of concerns**

In conjunction with several identified gender-correlations, women are predominantly more supportive towards security-enhancing and societally beneficial applications, which is subsequently also observable in an investigation regarding the prevalent gender-correlations at societal concerns. Accordingly, in an international comparison woman are on average distinctively more concerned about drones than men.

With reference to Figure 41, women are by 7% more concerned about security issues, which is also reflected in ascertained applications displaying low gender-correlations (Figure 37). In line with this, mainly governmental, security-enhancing applications are almost similarly accepted by men and women.

Identifiability	Noise	Safety
-1%	-4%	-5%
Privacy	**Commerical sensitivity**	**Security**
-5%	-6%	-7%

Figure 41: Gender correlations by concerns ('-': women more concerned).

Other noticed gender-correlations regarding societal concerns are safety (gender-correlation: 5%), privacy (gender-correlation: 5%) and noise (gender-correlation: 4%), which coherently discomfort women to a greater extent than men. In contrast to this, especially identifiability (gender-correlation: 1%) is of almost equal importance to both genders, which is probably in close connection with potential liability issues in case of damaged goods or others.

6.2.2. Age

Analogously to the conducted examination of gender-correlations and respective influencing factors on the acceptance of drones in Chapter 6.2.1., in this part prevalent age-correlations are described and analysed to determine in ultimate consequence global similarities.

- **Similarity 1: High-tech & leisure – Playground for younger generations**

As part of the investigation of predominant age-correlations, several available international data, displaying differences between younger and older generations are firstly identified and analysed, finally enabling the calculation of age-correlations of various drone applications.

In consequence to this, as visible in Figure 42, younger people significantly evaluate innovative, pioneering and exclusively personal value adding applications more supportive than older ones, independently from geographic region, cultural or societal background. In this context, predominantly applications that currently appear to be highly innovative, like parcel delivery with drones (age-correlation: -29%), recreational usages (age-correlation: -27%), air taxis (age-correlation: -26%) or photos with drones (age-correlation: -11%), are distinctively more accepted by young generations.

Logistics (e.g parcel delivery)	Recreational usage	Air taxi (UAM)	Film/Foto
-29%	-27%	-26%	-11%

Applications - Younger people like significantly more

Parcel delivery / Recreational use / Air taxi

Figure 42: Applications of civil drones more supported by young people ('-': younger more supportive).

In connection with several obtained age-correlations and regarding gained insights on risk perception in this work, these results are plausible, since young people are generally less risk-sensitive due to lacking lifetime experiences and potential peer influences. Especially young people interpret novel, innovative and high-risk applications more positive than older. Furthermore, the parameter 'added personal value' is significantly more influential to young people as the 'added societal value'. As noticeable from Figure 42, especially recreational applications are relevant for this societal group, not considering any adverse effects for the common society (e.g. privacy invasion).

- **Similarity 2: Infrastructure & agriculture – Unaffected by age**

In addition to several detected similarities in respect to the perception of drones by young people, in an international comparison there are also applications, wherein public acceptance is less influenced by age.

As recognisable from Figure 43, such applications are primarily serving commercial, for-profit purposes or perform infrastructural tasks, so that, due to their indispensable societal relevance (e.g. emergency response), they are almost uniformly accepted by all age groups. With special reference to Figure 43, considering commercial (age-correlation: -5%), agricultural (age-correlation: 4%) and industrial (age-correlation: 11%) drones, these applications are generating exclusively added value for a company and its incorporated business processes, causing distinctively less age influences.

Commercial drones	Agriculture	Emergency & Disaster Response	Infrastructural management
-5%	4%	9%	11%

Applications with LOW age correlations

Infrastructure / Agriculture / Emergency

Figure 43: Applications of civil drones equally supported by all age groups ('+': older more supportive).

Especially the marginal age-correlation at emergency applications (age-correlation: 9%) is in an international comparison primarily reasonable by means of the prevalent awareness across all age groups, that emergency response activities always require expeditious, efficient and coordinated actions and that the retrieval of human lives is paramount.

- **Similarity 3: Surveillance & security – Favourites of older generations**

In the aftermath of a scrutinised analysis, a further similarity involving older population groups is ascertainable for selected applications in the context of security-enhancing drone deployments by police or military.

In correspondence with already explained risk perception specifics in Chapter 4.2.2, acceptance results primarily from an individual evaluation process, in which external information is weighed, interpreted and combined with subjective insights, experiences and knowledge from the long-term memory. Therefore, with increasing age display people more lifetime experiences and, combined with an increasing physical weakness, are increasingly cautious in personal actions. In consequence, older people have an increased risk perception, less disposition to take risks and thus an increased personal security need.

The beforementioned similarity is also traceable in the context of public drone acceptance in older age groups. As visible in Figure 44, older people are on average distinctively more supportive towards official applications that serve to improve public security standards, compared to younger people. Besides this, especially military drone applications exhibit with an age-correlation of 29% a severe age influence, signifying that older adults accept this use-case much more than younger generations.

Surveillance - Security public areas	Environmental conservation	Police surveillance (Borders)	Military usage
13%	14%	22%	29%

Applications - Older people like signifcantly more

Surveillance / Environmental conservation / Military

Figure 44: Applications of civil drones more supported by older people ('+': older more supportive).

Older adults are predominantly more supportive towards drone applications that aim to comply with their increased personal security needs. In accordance with that, military applications are causing the greatest age-correlations, although they are not fully in the focus of this thesis.

- **Similarity 4: Young people are typical private drone users**

Based on available international drone studies, the age also influences whether someone purchases a drone and thus shapes the drone market or community, although the observed influence is not as pronounced as the calculated gender-correlation (38%).

With reference to the already manifested male-dominance in the private drone community, another similarity is obtainable. In line with this, the age-correlation accounts approximately 17%, signifying that predominantly young people between 18-24 adopt drones. In consequence, the typical private drone user in an international comparison is male and aged between 18-24 years, or even below 18 years which is not captured by usual survey demographics

- **Similarity 5: Different information & knowledge levels**

Analogously to the conducted gender-evaluation, also the age is influencing the individual acceptance building process and thus significantly shaping personal attitudes like common technology affinity, level of information or personal awareness.

As obtainable from Figure 45, the personal information level concerning drones is significantly age-influenced. The calculated correlation of 27% implicates that older generations are feeling increasingly insufficient informed compared to younger generations and that also factors like personal affinity towards common technologies or diverging media consumption habits have a reinforcing effect.

Subjective information state	Acceptance/attitude	Common technology affinity
-27%	-16%	-10%

Figure 45: Age correlations by influencing factors ('-': younger more informed).

Older people are on average 10% less affine towards common technologies than younger, so that this a major influence and directly related to the age-correlations regarding common drone acceptance (age-correlation: -16%).

- **Similarity 6: The age shapes concerns**

Also concerns and the individual perception of threats are in an international comparison subject to age influences.

In an international comparison, several studies display impressive age-correlations at societal concerns, so that older adults, due to their personal physical weakness, have an increased personal security need. Regarding the age-correlation in terms of security concerns (20%), this is primarily justifiable by referencing to already obtained age differences in security applications (Figure 46).

Security	Safety	Privacy
20%	8%	4%

Figure 46: Age correlations by concerns ('+': older more concerned).

On the other hand, the overall increased security need and level of concern of older people is also arguable by the increased risk perception in older ages, which is mainly reasonable by increased lifetime experiences, frailty and an overall more sensitive risk perception.

6.2.3. Topography

Complementary to subject-based influences on the acceptance of drones by means of gender or age, another not neglectable influence addresses the respective topography (e.g. urban, rural), wherein either the operation is intended or the person in question has its place of residence.

- **Similarity 1: Increased acceptance for rural and remote operations**

As recognisable from Figure 47, the tendency that drone operations are always the more accepted and supported by society the more rural or remote the respective location of operation is obtainable, because less inhabitants, properties or common infrastructures are adversely affected by rural or remote drone operations.

Rural Areas	Thinly occupied areas	Small-town	City (>100k residents)
78%	54%	43%	36%

Figure 47: Changes in societal acceptance by changing the venue of an application (DLR, 2018, p.29).

In accordance with that, individuals are probably less concerned of rural or remote (e.g. mountainous) drone operations, because this environment offers more space to land or crash without involving any third parties in case of technological or operational failures. Beyond that, also privacy and security concerns are almost neglectable in this case. In consequence, all this ultimately causes increased public acceptance for rural or remote operations that diverge significantly from urban applications.

With reference to Figure 47, a relocation of a drone operation from an urban to a more rural or remote location causes marked increases in public acceptance up to 42%, so that, as mentioned in Chapter 4.2., exact public acceptance is also strongly dependent on the topographical context of an operation.

- **Similarity 2: Rural population more sceptical towards drones**

Contrary to an increased public acceptance towards rural drone operations, also the acceptance of the rural population towards drones must be considered.

At this stage it must be noted that rural population has on average a slightly reduced interest towards new technologies, lives in proximity to the nature and in accordance with traditional values. Accordingly, especially highly innovative drone concepts, like air taxis (venue-correlation: 7%) and delivery drones (venue-correlation: 14%) are less accepted by the rural population. In consequence, a further international similarity is determinable as people living in rural areas are less open-minded towards drone deployments, affirm innovations more cautious so that at this point targeted information campaigns are needed.

6.3. Noticeable Distinctions of the Most Relevant Studies

In contrast to Chapter 6.1, wherein several detected similarities between individual geographical regions and countries are presented, in the following section all detected distinctions are displayed and expounded.

6.3.1. Distinctions by Application Category (EMS, GOV, COM, Private)

In the upcoming sequences, distinctions regarding the public acceptance of application categories are presented, whereby in advance of addressing some continental or regional details, preliminary statements on a global level are expedited.

- **Distinctions 1: Europe has a remarkably higher acceptance as America**

Regarding detected distinctions by comparing societal acceptance of different application categories. As visible in Figure 48 (marking '1'), Europe displays in all application categories, excluding recreational drones, a markedly increased public acceptance compared to both remaining geographical regions (America, 'Other regions'). In particular, the obtained difference in the acceptance of governmental applications must be emphasized, which is perhaps induced by variant social welfare systems, ultimately causing lacks in governmental trust in respective societies.

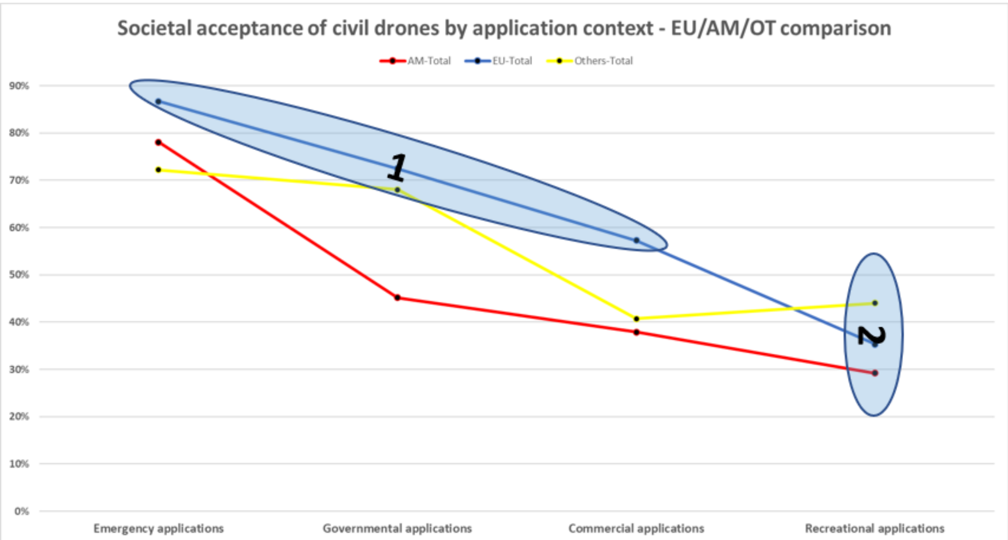

Figure 48: Determined (global) distinctions in societal acceptance by application category.

- **Distinction 2: Recreational drones are most accepted in ‘Other regions’ (Africa)**

As obtainable from Figure 48 (marking ‘2’), the international comparison of public acceptance towards specific drone categories enables the determination of a second distinction, which signifies that, recreational drones are most accepted in ‘Other regions’ (43%) followed by Europe (35%) and America (29%).

The difference between the regions of highest and lowest acceptance accounts in total 14%. In specific, the 'Other regions' are exhibiting the highest acceptance, followed by Europe and America with the lowest public acceptance towards recreational drones. A potential cause for this difference is that, especially in the USA, many people have been already harassed by recreational drones, so that the public ambivalence towards this use case is expedited. Another reason for the increased public acceptance level in the ‘Other regions’ towards recreational drones is probably, that especially in Africa public acceptance towards this use case is excessive, which is maybe reasonable by the magnitude of available remote space, so that even in the event of a crash no ‘third’ parties gets involved. Furthermore, also inhabited area is very rare and probably not so many drones are already utilized or available in Africa, so that maybe also societal concerns are not as evident as in Europe (e.g. privacy).

- **Distinction 3: Canadians are more sceptical towards drones in common**

In a more precise regional comparison between American countries, including the USA, Canada and Latin America, it is visible in Figure 49 (marking '1') that predominantly Canadian citizens are causing several aforementioned acceptance differences between Europe and America. Canadian citizens evaluate several drone applications and especially recreational drones less supportive than citizens of other regions.

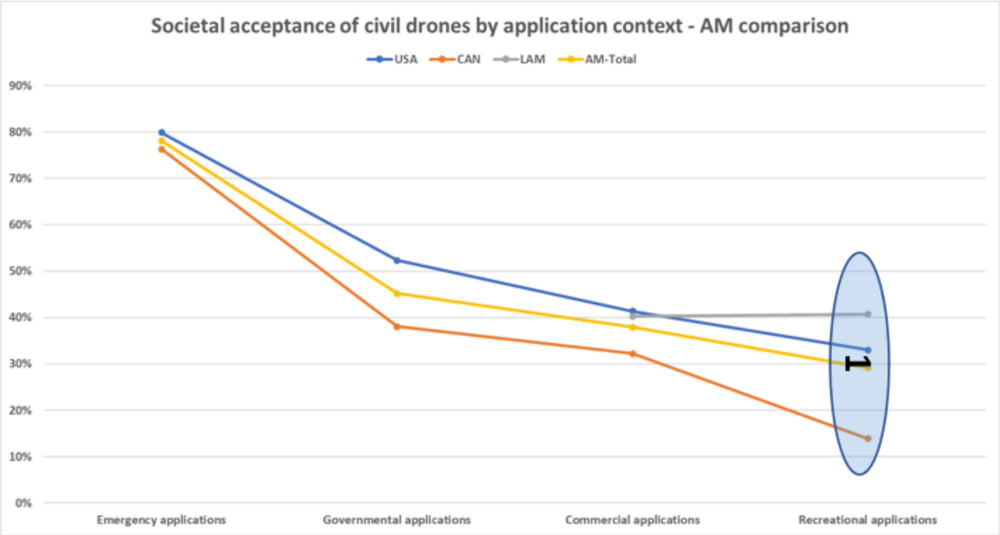

Figure 49: Determined (American) distinctions in societal acceptance by application category.

Recreational drones are significantly better accepted in South America, which is primarily arguable by differences in mentality, culture and individual awareness between North and South American citizens (e.g. less concerns).

- **Distinction 4: French are European acceptance leaders**

A scrutinised comparison involving all European countries reasons to highlight considerable acceptance specifics of French citizens, as visible in Figure 50 (marking '1'). On closer consideration, it is noticeable that civil drones in France coherently achieve the highest acceptance values in Europe, independently from the application category, whereby the distinction is particularly significant for commercial applications, wherein a difference to Germany of about 18% is ascertainable.

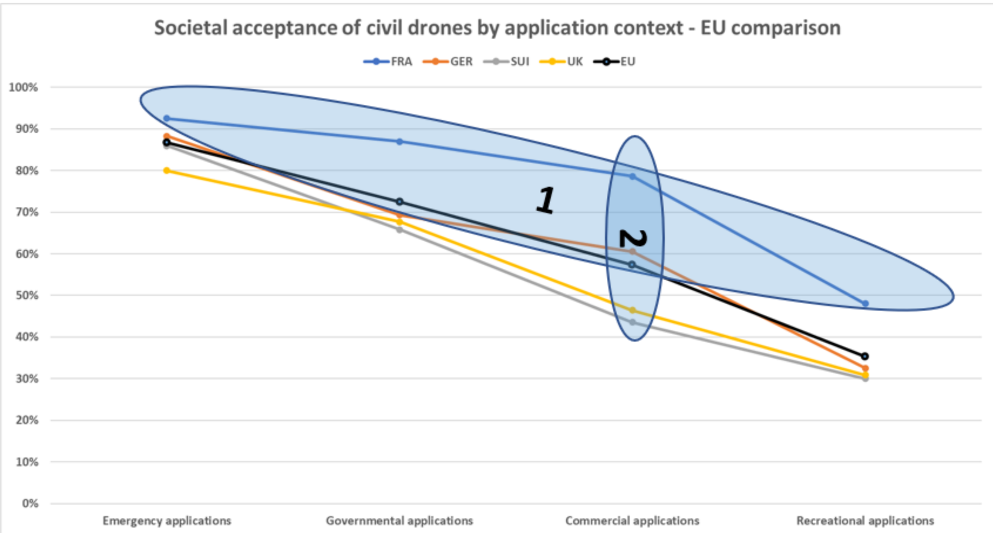

Figure 50: Determined (European) distinctions in societal acceptance by application category.

In general, several French acceptance values appear to be very high, but on closer consideration especially the French aviation industry takes recourse to a long and successful history, inducing societally beneficial effects, thus probably also civil drones are blessed with additional public acceptance. In correspondence to that, subsequently a quotation with reference to Austria, describes this situation in a suitable manner:

> *The French acceptance numbers are quite reasonable, as aviation and the entire aviation industry are as relevant and admired in France, as it is the case for skiing and all related economic branches in Austria. This is confirmed by the huge efforts and amounts of money that the French state invests in all branches and institutions of its Aeronautical Industry –*
> R. Fortner (AAI), 2020

Based on this quotation, it is concludable that the French drone industry is already better accepted yet, societally established and thus facing a positive market development.

- **Distinction 5: Switzerland and UK are the most sceptical European nations**

Regarding Figure 50 (marking '2'), a scrutinised analysis of several achieved acceptance values for commercial applications leads to the conclusion that citizens of Switzerland and the United Kingdom are most sceptical and less supportive towards civil drones in a European comparison.

This difference becomes particularly noticeable by analysis of respective acceptance levels for 'Commercial applications', wherein Switzerland and UK are displaying a remarkable difference of about 15% in comparison to Germany and about 35% to France. Addressing the acceptance of civil drones in Germany, it must be mentioned at this point, that within Europe, German acceptance values are often in-between of France and Switzerland.

6.3.2. Distinctions by Various Application Domains and Country

In the following explanations, previously entailed statements are specified and refined regarding the social acceptance of individual drone applications and additional distinctions are introduced.

- **Distinction 1: 'Other regions' have a significantly different public perception**

As stated above, the 'Other regions' include also African regions and accordingly, the observed societal acceptance towards drones signifies, that some use cases display significant acceptance differences compared to western, industrialised countries.

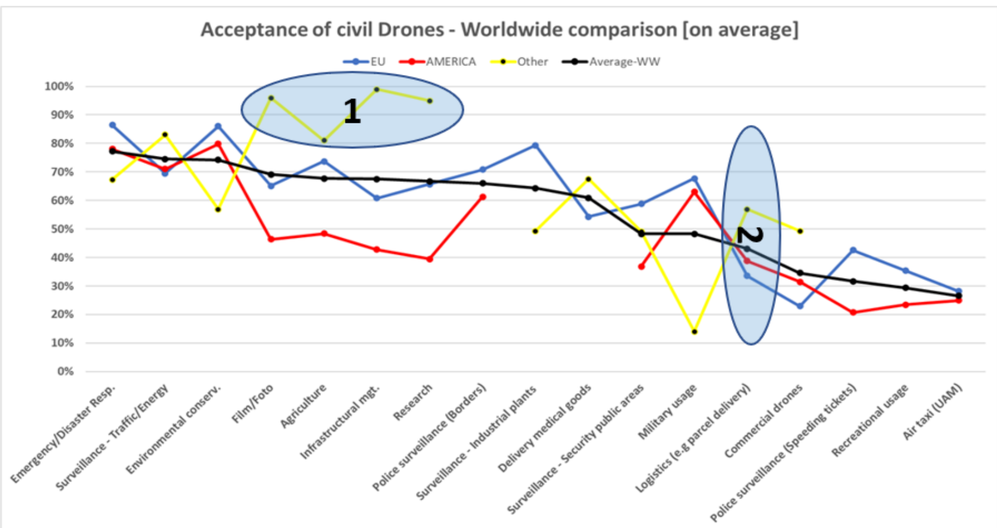

Figure 51: Determined (global) distinctions in societal acceptance by application domain.

In correspondence with this and by consideration of Figure 51 (marking '1'), especially remote or rural societies associate often divergent interests and opportunities with novel technologies and thus, public acceptance is sometimes deviating from western, industrialised regions. Exemplary, this fact is also confirmable by analysing the public acceptance towards the application domain 'Infrastructural management', which is by societal members of the 'Other regions' better accepted than any ‘Emergency applications’. A possible explanation for this is that emergency rescue services are nowadays hardly available in Africa and thus, this use case is not of upmost societal importance.

- **Distinction 2: ‘Parcel delivery’ – More accepted in USA as in Europe**

Based on Figure 51 (marking '2') it is derivable, that specific applications are on average more supported by US-citizens than by Europeans. Most important in this context are especially determined differences at parcel deliveries (8%) or overall commercial services (9%) involving drones.

However, this situation is not that surprising, since the conceptual development of parcel deliveries has been mostly initiated and promoted by leading US logistic and online mail order companies (e.g. UPS, Amazon) and accordingly, US residents had already more contact with this concept than European citizens, finally enabling higher acceptance.

- **Distinction 3: Germans and Swiss are accepting drones for research purposes**

As recognisable from Figure 52 (marking '1'), drone deployments for scientific purposes are in Europe significantly more accepted by societies in Germany and Switzerland compared to citizens of the United Kingdom.

In specific, the observed difference accounts approximately 61%, which indicates a remarkable magnitude, especially by consideration of the large and well-established aviation industry in UK.

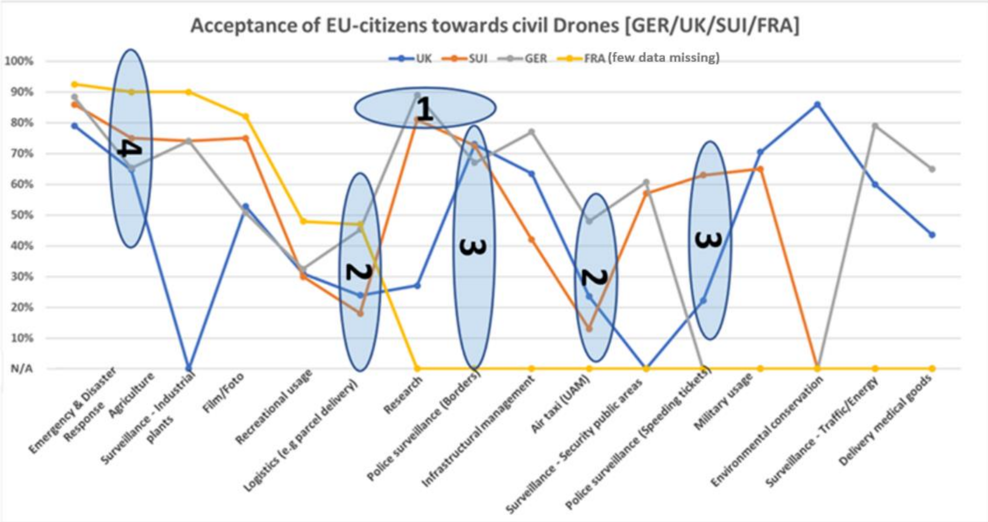

Figure 52: Determined (European) distinctions in societal acceptance by application domain.

- **Distinction 4: Swiss are most sceptical towards parcel deliveries and air taxis**

As recognisable from Figure 52 (marking '2'), Swiss citizens are generally less supportive towards drones, although this effect is particularly reinforced at futuristic, highly innovative concepts involving drones (e.g. taxi drone).

Based on this statement and by analysis of Figure 52, only 19% of Swiss society support parcel deliveries, implicating a difference of 26% compared to Germany (45%), which is a distinctive finding due to the geographical proximity and mainly caused by topographical differences. In line with that, this effect is reinforced again if people are transported instead of parcels. However, this use case is supported by 13% of Swiss society, which corresponds to a difference of 35% compared to Germany (48%).

- **Distinction 5: Swiss are supportive towards official surveillance applications**

Considering marking '3' of Figure 52, official police surveillance in the proximity of border regions experience an average acceptance value of about 70% in all evaluated European regions.

However, compared to the United Kingdom (21%), the Swiss society also displays acceptance towards drone applications aiming to issue traffic fines. In this case, the prevalent difference of 40% in comparison to the UK is striking, even though the national acceptances towards general monitoring purposes are similar. All this represents specifics of the Swiss mentality, which is strongly risk sensitive, cautious and supportive towards all kinds of risk prevention measures, which also perceivable in the Swiss traffic policing with very high fines.

- **Distinction 6: French and Swiss are more supportive towards agricultural usages**

France and Switzerland are not only characterisable by their geographical proximity to each other. Like Austria, both countries are topographically also shaped by the Alps and value their agricultural sector quite highly.

From this point of view, the observed differences in the acceptance of agricultural drone applications, as visible in Figure 52 (marking '4'), must be highlighted. Accordingly, French society is most supportive towards agricultural drones with about 90%, followed by Swiss society with 77%. Besides that, the obtained acceptance of Swiss citizens towards agricultural drones is significantly varying from the remaining European countries, and implicate that especially the increased rural society of Switzerland and the topographical specifics of Switzerland (Alps) distinctively reinforce the relevance and usability of agricultural drones. In contrast to this, German society supports this use case only by 54%, corresponding to a difference of 23% to Switzerland, which maybe implicates already perceived advantages of drones deployed in mountainous terrain. In further consequence, it is confirmable that public acceptance of specific drone applications is influenced by topographical and societal conditions.

6.4. Summary & Further Specifics of The Examined Studies

The following part of this scientific work seamlessly ties on already gained insights regarding drone acceptance and introduces national demographics and topographies to facilitate an understanding towards specific acceptance differences.

6.4.1. Geography & Topography by Country (most significant)

In the upcoming explanations, several countries (CAN, USA, GER, SUI, UK, FRA) are examined by their national geographic and topographic specifics, aiming to identify reasons that cause the prevalent acceptance differences in Figure 52. For this purpose, publicly available topographical data of these countries is utilised.

- **Switzerland**

Switzerland is the western neighbour of Austria, located in the centre of Europe and is topographically, comparable to Austria, strongly shaped by the Alps. Therefore, only a few plains can be found in the south of the national territory.

Topography	Key facts
Description	Mountaineous (Alps)
Urban pop.	73.90%
Mean elevation	1.350m
Lowest point	195m
Highest point	4.634m

Table 11: Topographical specifics of Switzerland (cia.gov, 2020).

With reference to Table 11, the landscape of Switzerland is dominated by high mountains reaching maximum elevations up to 4.634m, so that only in the southern part of the country plains are observable. However, 80% of Swiss territory is dominated by mountainous landscape, which is noticeable on the one hand by the considerable mean elevation (1.350m) and on the other hand by the enlarged rural population, as only 74% of the Swiss live in urban regions.

In correspondence with several achieved acceptance values in various application domains, the Swiss attitude towards drones is heavily influenced by national specifics. Firstly, especially agricultural applications are predominantly accepted by Swiss citizens (75%), which displays, after France, the highest value in this research and is mainly arguable by the enlarged rural population (26.10%), the mountainous topography and status of agronomy in Switzerland. All this probably leads to an increased societal added value for rural societal parts, as drones enhance agricultural processes and the accessibility of remote or rural areas.

- **Germany**

Germany is the direct, north-westerly geographical neighbour of Austria and topographically shaped by the Bavarian Alps in the south, the hilly landscape in centre and plain and coastal landscapes in the north of the country.

Topography	Key facts
Description	Alps (s)/Plains (n)
Urban pop.	77.50%
Mean elevation	263m
Lowest point	0m
Highest point	2.963m

Table 12: Topographical specifics of Germany (cia.gov, 2020).

In correspondence with Table 12, the initially described multitude of prevalent topographical facets is also noticeable from the exact topographical data, as the difference between the highest and lowest elevation accounts remarkable 3.000m. Nonetheless, Germany is mainly dominated by plain landscapes, which is also recognisable by the mean elevation, which is with 263m significantly lower than in Switzerland. Besides that, Germany features a lot of more big cities and a slightly larger urban society (77.50%) than Switzerland (73.8%).

However, in terms of German specifics concerning drone acceptance (Figure 52), topographical facts are primarily arguing the observed societal acceptance of Germans towards agricultural drones, which is with 65% still high, but distinctively lower compared to Switzerland (75%) or France (90%). In line with this, Germany is not that much dominated by mountains, societally not that men-dominated and possesses a larger urban society than Switzerland. Another explication concerns, that in absence of mountains many agricultural or remote areas are already yet easily accessible, so that agricultural drones maybe implicate societally not an equal amount of added value as in other, mountainous countries (e.g. Switzerland, France, Austria). Furthermore, the significance of agronomy is in Germany lower, compared to France as other economic sectors are more important here (e.g. automotive industry).

- **France**

Located in Western Europe, the state territory of France displays mountainous landscapes (Alps) in the south-east with summits up to 4.810m (Massif Central), plain landscapes in the center and stretched coastal regions in the north, west and southwest of the country.

Topography	Key facts
Description	Plains (n)/Mountains (s)
Urban pop.	81.00%
Mean elevation	375m
Lowest point	0m
Highest point	4.810m

Table 13: Topographical specifics of France (cia.gov, 2020).

Addressing the increased mean elevation (375m) of France (Table 13), the topographical contrast between mountains and plains is more striking than in Germany since the western Alps are higher than the central or eastern Alps. Complementary to that, French population is more urbanised (81%) than German (77.5%) or Swiss (73.9%) societies, which is probably caused by the job scarcity on the French countryside. Nevertheless, French agronomy is a substantial economic sector in France.

Regarding topographical influences on the French drone acceptance, it is to highlight that the remarkable acceptance of French towards pathbreaking and futuristic innovations, like air taxis or delivery drones, is probably mainly deducible to the influence of the above-average urbanised French society (81%) because, as explained in Chapter 6.2.3., urban citizens are assessing technological innovations always more supportive than rural residents, aside of the status of their aviation industry.

- **United Kingdom**

In contrast to Switzerland, France, Austria and Germany, in absence of very high mountains, the topography of the UK is predominantly characterisable by rolling hills and plains. In general, the country is located on an island in the north-western of the European mainland and therefore no direct geographical neighbours are determinable.

Topography	Key facts
Description	Hills/Plains
Urban pop.	83.90%
Mean elevation	162m
Lowest point	0m
Highest point	1.345m

Table 14: Topographical specifics of UK (cia.gov, 2020).

Referencing to topographical specifics of the United Kingdom (Table 14), the country features the highest societal urbanisation (83.9%) of all examined European countries and the lowest mean elevation with 162m.

In the context of observed topographical influences on the acceptance of civil drones, regarding Figure 52, due to the highly urbanised population and the plain landscape agricultural drone applications are less accepted by the UK society. However, total agronomy experiences in the UK less societal as well as economic significance.

- **Canada**

The North American country Canada is in terms of size the second largest country in the world and a direct northern neighbour of the USA. Due to its considerable size displays the country almost all types of landscape, featuring highly urbanised regions in the center and plains and mountains in the northern parts.

Topography	Key facts
Description	Plains/Mountains
Urban pop.	81.60%
Mean elevation	487m
Lowest point	0m
Highest point	5.959m

Table 15: Topographical specifics of Canada (cia.gov, 2020).

As visible in Table 15, the landscape of Canada is predominantly shaped by high mountains in the north of the country (5.959m), but also by plains in the urbanised regions. Accordingly, the mean elevation is with 487m slightly increased, although hardly comparable with Switzerland (1.350m). As already obtained in France, also Canadian citizens prefer to live in cities, which is arguable by the heightened societal urbanisation of 81.6%.

In correspondence to several topographical data, some acceptance specifics of Canadians towards drones are now better reasonable. At first, predominantly the increased societal urbanisation causes, that less people of the agricultural sector have been surveyed, because urban citizens simply do not associate the same added value as stakeholders of the respective sector. Therefore, the obtained acceptance of 36% towards agricultural uses is the lowest in this research and signifies a highly urbanised and a technologically less interested Canadian society.

- **United States**

The US-topography is primarily describable by a large national territory, including almost all conversant types of landscape. In greater detail, the central region is mainly characterised by plains, the west and northeast of the country by massive mountains including summits up to 6.190m and by coastal regions (Atlantic and Pacific Ocean).

Topography	Key facts
Description	Plains (c)/Mountains (w/e)
Urban pop.	82.70%
Mean elevation	760m
Lowest point	0m
Highest point	6.190m

Table 16: Topographical specifics of USA (cia.gov, 2020).

With reference to Table 16, the USA represent with an average elevation of 760m, after Switzerland, the country with the highest mean elevation in this work. Nevertheless, societal urbanisation ranks just behind the UK with 82.7%, so it is statable that US-citizens predominantly live in cities.

In correspondence with acceptance specifics of American citizens, the USA is featuring the second largest urban society (82.7%), which is also obtainable in the public acceptances of some drone applications. Therein, US-citizens support agricultural drone applications by 57%, which is the second lowest value before Canada (36%) and primarily arguable by the enlarged urban US-society.

6.4.2. Socio-demographics by Country (most significant)

In the following chapter, complementary to the topographical descriptions of Chapter 6.4.1., an overview regarding national sociodemographic specifics is provided.

- **Switzerland**

Upon closer examination of Table 17, essential socio-demographic statements for Switzerland are derivable. Accordingly, the Swiss society is mostly characterised by people between 25-54 years (42.05%). Especially dominant are age groups above 65 years with a share of 18.73%. All in all, Swiss society is mainly characterised by middle-aged to older generations.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	15.34%	1.06 m/f
15-24 years	10.39%	1.05 m/f
25-54 years	42.05%	1 m/f
55-64 years	13.48%	1.01 m/f
65+ years	18.73%	0.8 m/f

Table 17: Socio-demographic specifics of Switzerland (cia.gov, 2020).

In addition to a more detailed analysis of the prevalent age structure, an analysis of the gender distribution is also relevant to enable statements regarding Swiss drone acceptance. Therein, Swiss society is socio-demographically male-dominated, which is more pronounced among young generations and alleviates with increasing age.

Based on several established socio-demographic specifics of Switzerland, subsequently regarding Figure 52, observed Swiss acceptance specifics are reasonable. In line with this, the application domain ‘Film/Photo’ is proper accepted by Swiss citizens, which is probably attributable to the men-dominated Swiss society combined with the liberal Swiss mentality, predominantly shaped by mutual respect and tolerance.

A further aspect addresses recreational drones, air taxis and logistics drones, which are in an international comparison coherently far less accepted by Swiss citizens. In this context especially the Swiss society, shaped by older generations, combined with the marginal disposition of Swiss citizens to take risks are probably responsible for these differences (kalaidos-fh.ch, 2018).

Lastly, overall Swiss mentality always expedites risk prevention measures so that, in combination with the overall increased societal age, especially governmental security-enhancing applications are proper accepted, as obtainable in the societal support of official applications like 'Border patrol' (74%) and 'Issue speeding tickets' (67%).

- **Germany**

In comparison to Switzerland, the German society is less dominated by middle aged generations. Therefore, the population of Germany is strongly shaped by older generations. As part of a scrutinised assessment, young age groups (0-24 years) make up a fifth of the total society and older age groups (55+ years) more than a third.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	12.89%	1.06 m/f
15-24 years	9.81%	1.04 m/f
25-54 years	38.58%	1.01 m/f
55-64 years	15.74%	1 m/f
65+ years	22.99%	0.79 m/f

Table 18: Socio-demographic specifics of Germany (cia.gov, 2020).

Besides that, the societal gender distribution (Table 18) in Germany is comparable to Switzerland, where men dominate young age groups and women especially older age groups. In line with the socio-demographic specifics of Germany, also observable influences on the acceptance of specific drone applications must be scrutinised at this stage. Firstly, as already stated above, Germany features the oldest society of all examined countries in this research and therefore, due to the increased security and safety need of older age groups (as already explained in 6.2.2 and 4.2.2.), especially 'Emergency & Disaster Response' applications utilising drones are highly accepted by German citizens (89%).

Another finding is the acceptance of German citizens towards 'Film/Photo' (51%) and 'Recreational usages' (32%). Both acceptance values are on average the lowest of several examined countries, which is probably deducible to the older German society as well as the national culture, wherein personal rights like privacy and data protection are very important for citizens and probably cause less acceptance. Another point to mention is, that the prevalent acceptance difference between 'Film/Photo' and 'Recreational usages' of 19% is primarily the effect of recreational and uncontrolled drone operations by the general public, which intuitively lead to increased societal concerns (e.g. Frankfurt airport).

Lastly, especially surveillance applications experience adequate public acceptance, comparable to Switzerland, which signifies the dominance of older generations in Germany, signifying a societal security need.

- **France**

The societal age structure of France is less dominated by middle and older age groups than in Germany or Switzerland (37%). Especially the age group ‘0-24 years’ corresponds to 30% of the total society, which highlights a respectable difference to Germany (22%) and signifies a younger mean age of the French population.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	18.36%	1.05 m/f
15-24 years	11.88%	1.05 m/f
25-54 years	36.83%	1.02 m/f
55-64 years	12.47%	0.93 m/f
65+ years	20.46%	0.77 m/f

Table 19: Socio-demographic specifics of France (cia.gov, 2020).

Regarding gender distribution, France features societally a marked surplus of women, which is particularly striking in the age group ‘65+ years’. In younger age groups there are no abnormalities observable in comparison to Germany, Switzerland or UK.

Backed on several socio-demographic facts, some determined influences on obtained acceptance values must be scrutinised. Firstly, due to the national sectoral status, the French society reveals by nature an increased acceptance towards several aeronautical innovations, and thus also drones. Nevertheless, especially at ‘Emergency & Disaster Response’ applications the French support (92%) is only slightly increased compared to Germany (89%), which is most certainly an effect of marked sociodemographic differences between both countries, because especially the young French society features, in comparison to the older German society, less personal needs regarding emergency or security-enhancing applications, causing less acceptance advances of the French society in these areas.

Another point addresses acceptance advances of French society, which are especially at ‘Film/Photo’ (91%) and ‘Recreational usages’ (49%) significantly in comparison to other examined countries and are mainly the result of a French society, dominated by young age generations.

- **United Kingdom**

In UK's society only a slight transition towards older age groups is observable, because 29% of all societal members are aged between 0-24 years and 31% above the age of 55 (Table 20).

Socio-demogaphics	Age structure	Sex ratio
0-14 years	17.63%	1.05 m/f
15-24 years	11.49%	1.05 m/f
25-54 years	39.67%	1.05 m/f
55-64 years	12.73%	0.98 m/f
65+ years	18.48%	0.82 m/f

Table 20: Socio-demographic specifics of UK (cia.gov, 2020).

The UK gender distribution displays a higher proportion of men in younger age groups, which, however, alleviates with increasing age, so that from the age group '55+' onwards there are more women than men in British society.

With respect to several calculated and averaged acceptance values, UK society is by nature fairly sceptical towards drones, but especially applications like 'Recreational usage' (31%) and 'Film/Photo' (52%) are in an international comparison not that highly accepted, which is probably the result of recent media reports regarding drone annoyances on UK airports (e.g. Gatwick 2018).

UK citizens currently reveal a sceptical attitude towards futuristic drone applications like 'Air taxis' or 'Delivery drones', although not that much as citizens of Switzerland, which displays a smaller urban society and an older societal age structure as the UK.

- **Canada**

In general, the age structure of the Canadian society differs not significantly from European countries. Therefore, also in Canada a tendency towards older age groups is recognisable. In line with this, the age group '55+' accounts for 33% and the age group '0-24' corresponds to 27% of the total Canadian society, signifying an increased societal mean age.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	15.99%	1.06 m/f
15-24 years	11.14%	1.07 m/f
25-54 years	39.81%	1.01 m/f
55-64 years	14.08%	0.98 m/f
65+ years	18.98%	0.84 m/f

Table 21: Socio-demographic specifics of Canada (cia.gov, 2020).

As visible in Table 21, the prevalent gender distribution in the Canadian society displays an increased men-dominance compared to other examined countries. This effect is especially pronounced among younger generations, but also in older age groups are men more dominant, although women represent the majority.

The attitude of the Canadian society is by nature more critical towards civil drone applications, mostly comparable to Switzerland. This fact, combined with the second oldest society besides Germany are reasons, why Canadians support ‘Recreational usages’ only by 15%, which displays the lowest acceptance. All this is primarily arguable by the Canadian societal structure, which is predominantly shaped by older generations, causing severe acceptance differences in the recreational category. In specific, Canadians also feature less acceptance towards emergency (76%), governmental (38%), commercial (31%) and recreational (14%) applications.

- **United States**

Regarding societal structure, the USA is the only country in which the age group ‘0-24 years’ is larger than the age group ‘55+’. In consequence, the USA displays the society with the largest proportion of young people in this research.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	18.46%	1.04 m/f
15-24 years	12.91%	1.01 m/f
25-54 years	38.92%	0.94 m/f
55-64 years	12.86%	0.94 m/f
65+ years	16.85%	0.81 m/f

Table 22: Socio-demographic specifics of USA (cia.gov, 2020).

Regarding the gender distribution (Table 22), the US-community reveals already in the age group ‘25-54’ a female majority, although the proportion of men is already in younger age groups considerably lower than in other countries.

Considering several socio-demographic facts of the USA, especially the societal acceptance of agricultural (57%) and recreational (33%) drones is remarkable. Agricultural applications are strongly gender-influenced so that the observed difference to other countries mainly results from the higher proportion of females in society. Regarding the acceptance of recreational drones, the acceptance off US citizens is comparable to Germany. Highlighting both diverging societal structures, this finding is remarkable and signifies that US-citizens have already collected more adverse experiences with recreational drones.

6.4.3. Regulatory Regime by Country (most significant)

In the upcoming part of this scientific work, currently enacted national drone regulations are briefly highlighted and described.

- **Switzerland**

In Switzerland, according to the Implementing Regulation of (EU) 923/2012, national law applies to drones up to 30kg MTOW, which states that drones up to this weight do not require an BAZL approval. However, several drone operations in this category must be conducted within VLOS conditions and below an altitude of 120m AGL (admin.ch, 2020).

Addressing the regulatory handling of drones above 30kg MTOW, in the run-up to each operation a permission must be granted by BAZL, a liability insurance concluded as well as safeguarded that the operation adheres to established limitations of (EU) 923/2012. In summary, the Swiss drone regulation is quite liberal compared to other countries. Besides that, the Swiss police conducts frequent checks (admin.ch, 2020).

- **Germany**

Civil drones in Germany are currently regulated rather restrictively compared to other European countries. According to the enacted regulation, a labelling obligation applies already to drones above 250g MTOW, whereby name and address of the drone operator must be denoted in a clear and legible manner.

With respect to civil drones above 2kg MTOW, according to §21 (4) LuftVO, a sufficient level of knowledge must be demonstrated ('drone pilot license') at institutions, appointed by the German aviation authority. Beyond that, already for drones above 5kg MTOW, an individual permission must be granted by NAA, which indicates a significant regulatory tightening in comparison to other countries (drohnen-camp.de, 2020).

- **France**

In France, civil drones are currently regulated in a rather opaque manner. In general, seven different drone categories are applicated by the French aviation authority, wherein four pre-defined 'operational scenarios' (S1 - S4) determine the exact approved usage scope. Moreover, the operation of multicopters by individuals and the general public is unrestrictedly allowed in France up to 25kg MTOW (drohnen-camp.de, 2020).

- **United Kingdom**

Momentarily the UK drone regulation differentiates three drone categories. Therein are drones below 20kg MTOW classified as class 1 drones, above 20kg but below 150kg MTOW as class 2 drones and ultimately above 150kg MTOW uniformly as class 3 drones.

In specific, class 1 drones (< 20kg MTOW) do not require an approval or certification by the British aviation authority, signifying a considerable difference in comparison to other countries, like Germany (< 5kg MTOW).

- **Canada**

Drone operations are in Canada exclusively permitted below an altitude of 122m AGL, within VLOS conditions, but without an insurance obligation. Canadian law distinguishes in total three drone weight classes.

The CAR (Canada Aviation Regulation) specifies, that no authorisation is required for operations with drones below 250g MTOW, implicating that only specified CTRs must be considered. Regarding drones above 250g MTOW but below 25kg MTOW, respective subcategories 'Basic' and 'Advanced' are introduced to establish further operational limitations. Lastly, for operations with drones above 25kg MTOW, a 'Special Flights Operations Certificate' is required from the Canadian aviation authority (drohnen-camp.de, 2020).

- **United States**

In the USA, drones are currently regulated according to FAA Part 107, which stipulates that drones below 25kg MTOW are permitted to operate up to a maximum altitude of 122m AGL without a FAA authorisation (uncontrolled airspace). Referencing to Chapter 3.4.4, only operations with drones below 25kg MTOW in controlled airspace or drones above 25kg MTOW require a FAA approval in the USA.

6.4.4. Civil Drone Community by Country (most significant)

In the upcoming sequences, the structure and position of several domestic drone communities and markets, involving all examined countries, is briefly descripted and examined.

- **Switzerland**

The Swiss drone community is dominated by small start-up businesses and SMEs that pursue various concepts and plans involving drones on a national and international level. Exemplary, some companies already specialised on the development of efficient and powerful sensor technologies for collision avoidance (e.g. FLARM), while others primarily offer services with drones (e.g. Aeroscout). According to BDL (2018), Switzerland displays the 4^{th} largest drone market in a European comparison. Nonetheless, one of the main strengths of the Swiss drone industry is the successful cooperation with relevant universities and institutions that specialised on drones (e.g. ETH Zurich), also enabling research on innovative ideas (e.g. autonomous drones).

- **Germany**

The German drone market has recently developed itself as an important national economic factor. Approximately 500.000 civil drones are currently utilised in Germany, whereby current main applications are assignable to surveying (79%), inspection (53%) and filming (35%) activities (bdl.aero, 2018). All this implicates in economic terms, that already 400 companies specialised in drones and created 10.000 additional jobs. Nevertheless, the German drone market is still an emergent economical branch, signified by the low average age of companies (3.1 years). Most companies are in Bavaria, forming an overall market that corresponds to the second largest in Europe after France (bdl.aero, 2018).

- **France**

In contrast to the drone markets of Switzerland or Germany, which are predominantly shaped by SMEs and start-ups, in France are the headquarters of three leading drone manufacturers in a worldwide comparison (Parrot, DELAIR; DeltaDrone), which facilitates impressive export rates that transform the French drone sector to the leading one in Europe (businesswire.com, 2019).

- **United Kingdom**

In a European comparison, the UK displays the third largest drone industry after France and Germany (bdl.areo, 2018). Accordingly, a total of 700 entities are active on the British drone market, wherein many specialised on the provision of drone services (600), in total 161 companies on technological developments and 20 national institutes on drone research (nesta.org.uk, 2018).

- **Canada**

The Canadian drone sector accounts for $5.3 billion of the total gross domestic product and is strongly shaped by start-ups and SMEs, because leading aircraft manufacturers based in Canada like Airbus or Safran still did not enter the market successfully. Complementary to that, many national universities or research institutes like the University of Toronto, Ryerson or Carleton already specialised on drone research. It is expected that the Canadian drone market will prospectively generate 22.000 additional jobs (ospe.on.ca, 2020).

- **United States**

The US drone sector is currently the largest and most important one on a worldwide level. In line with this, on the one hand the US-market is shaped by a well-established national aviation industry and on the other hand, also by leading drone companies like AeroVironment or 3D Robotics, entailing expertise in civil and military drones. The US drone market is expected to triple in size by 2024 (businessinsider.com, 2020).

7. Implications for the Drone Acceptance in Austria

In the following chapter, several examined and identified aspects from both qualitative and quantitative methods are summarised and examined to enable implications regarding drone acceptance in Austria and answers to several research questions.

7.1. Relevant Characteristics & Specifics of Austria Regarding Drones

Analogously to several examined countries, in the upcoming sequence topographical, sociodemographic and market specifics or Austria are introduced.

7.1.1. Geography & Topography

The topography of Austria, comparable to Switzerland, is mainly shaped by the mountainous landscape of the Alps. As recognisable from the mean elevation (Table 23), Austria is the country with the highest mean elevation after Switzerland in this research. Nevertheless, it must be mentioned at this point that Switzerland is almost exclusively characterised by karst mountains of the western Alps, which are higher than the central and eastern Alps of Austria. Therefore, especially the east of Austria is characterised by hilly landscapes, enabling also densely populated regions at the eastern end of the Alps (e.g. Vienna).

Topography	Key facts
Description	Mountaineous (Alps)
Urban pop.	58.70%
Mean elevation	910m
Lowest point	115m
Highest point	3.798m

Table 23: Topographical specifics of Austria (cia.gov, 2020).

Regarding size of the urban population, Austria reveals with 58.7% the smallest urban population in comparison to all other examined countries. In specific, compared to the country with the second smallest urban society (Switzerland (73.9%)), this corresponds to a difference of 15.2%.

7.1.2. Socio-demographics

In terms of socio-demographic specifications (Table 24), Austria is most comparable with Switzerland, as the Austrian society is particularly dominated by the age group ‘25-54 years’ (41.35%). Besides Germany (22.7%), Austria features the smallest age group ‘0-24 years’ with 24.37%. Consequently, the age group ‘55+ years’ is with 35% also very pronounced, albeit a little smaller than in Germany. Nevertheless, the Austrian society displays the second highest societal mean age compared to all other investigated countries.

Socio-demogaphics	Age structure	Sex ratio
0-14 years	14.01%	1.05 m/f
15-24 years	10.36%	1.03 m/f
25-54 years	41.35%	1 m/f
55-64 years	14.41%	0.99 m/f
65+ years	19.87%	0.78 m/f

Table 24: Socio-demographic specifics of Austria (cia.gov, 2020).

The prevalent gender distribution in Austria is quite balanced and comparable to France. In accordance to that, younger age groups feature a slight surplus of men, which is less pronounced as in other examined countries and also traceable in older age groups. Recapitulatory, Austria has the most balanced population in terms of gender, especially in younger ages.

7.1.3. Regulatory Regime

Austria is a democratic republic in the heart of Europe, which is mainly characterised by stable societal and political conditions. Accordingly, Austria features an exceptional societal system, which provides also weaker social classes with a protection against poverty.

Referencing to a more detailed description in Chapter 3.4.1. of this thesis, civil drones in Austria are currently regulated by the national aviation law (LFG). Corresponding to this Austrian regulation, drones are categorized in four different types: ‘Toy’, ‘Model aircraft’, ‘Unmanned aircraft (Class 1)’ and ‘Unmanned aircraft (Class 2)’.

7.1.4. Drone Community

The Austrian drone sector is mainly shaped by innovative start-ups and SMEs, which established themselves recently on the market. In addition, some companies were originally active in other aviation segments and expanded their field of activity with drones. However, the Austrian internal market is currently only of secondary economic interest for domestic companies, as it is yet not adequately established. In line with this, Austrian companies predominantly focus their activities on the world market, which is more profitable and entails advanced opportunities. Therein, as already scrutinised in Chapter 1.3.2., especially the AAI-UAS-WG holds up an essential role as expertise exchange point for representatives of industry, development, research, key operators and even from the Ministry of Defense (MOD), targeting the simplification of processes and the establishment of an Austrian drone market.

Beyond that, important players of the Austrian drone market are especially Schiebel, Riegl, DIAMOND Aircraft and Frequentis, because these already established worldwide reputation in their market segments. Profound drone research is conducted in Austria, so that already sustainable synergies have been created between research institutes and industry, safeguarding the success of the domestic market in the long term, see Chapter 3.3.1. (Table 3).

7.2. Current State of Relevant Surveys for Austria

No studies exclusively focussing on the evaluation of drone acceptance have been conducted in Austria yet. However, in course of the conducted research on international studies, also four Austrian surveys have been allocated, addressing only some specific drone aspects with individual questions integrated in a study, focussing on another topic. The most significant Austrian surveys are briefly listed below.

- **Saturn (2016)**

In 2016 the technical retailer 'Saturn' conducted a study (n=1.500) to evaluate the social acceptance of Austrian citizens towards new technologies. In the context of this study, the attitude of Austrians towards civil drones was also briefly evaluated.

In accordance to obtained results, 6% of all participants indicated to own a drone, 23% stated that it is imaginable to use prospectively drones for personal purposes and 17% evaluated recreational applications (e.g. ‘Fun flights’) as relevant (Saturn, 2016, p.9).

- **SPECTRA opinion research (2017)**

In 2017, the Austrian opinion research institute 'SPECTRA' evaluated the attitude of Austrian citizens towards new technologies (n=1.051), also including a question regarding civil drones.

The respective question evaluated the attitude of Austrians towards delivery drones. In specific, the achieved results implicate that in total 26% of Austrians associate delivery drones with positive and 50% with negative societal effects (Spectra, 2017, p.1).

- **Marketagent (2019)**

'Marketagent', an Austrian opinion research institute, conducted in 2019 two studies to evaluate the attitude of Austrians towards future technological trends. Both respective studies also incorporated single questions concerning civil drones, focussing on the public evaluation of delivery drones.

In the first study (n=1.004), in total 18.7% indicated that they view the topic very negatively and even 19.2% assumed negative economic consequences (Marketagent, 2019, p.5). In the second 'Marketagent' study from 2019 (Figure 53), the focus was again on evaluations regarding the public opinion towards delivery drones. Therein, exclusively young people up to 30 years were surveyed (n=2.263) and consequently 51% evaluated delivery drones positively, whereby in specific 61.2% male and 39.4% female participants entailed a positive attitude. In addition to that, 44% expect that drones will be established on the market in the next 10 years (Marketagent, 2019, pp.11-12).

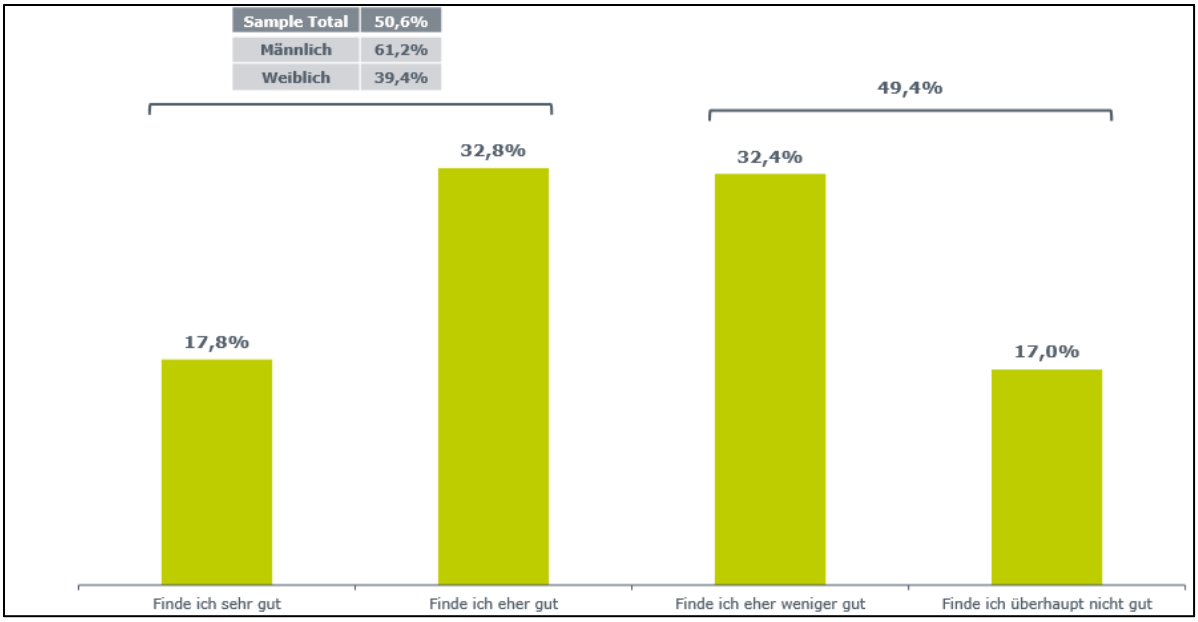

Figure 53: Results displaying the attitude of Austrians towards parcel deliveries with drones (marketagent, 2019, p.11).

- **KFV (2019)**

The Austrian Road Safety Board (KFV) conducted in 2019 a brief survey (n=1.000) to evaluate drone acceptance**.** The results of this study showed that already 6% of all Austrians own a drone and 57% of all societal members are supportive towards drones, whereby men assessed drones distinctively more positive than women. Regardless of this, 62% of all parties affirmed strict state measures to regulate several drone flights (kfv, 2019, p.2).

7.3. *Subsequent Implications for Drone Acceptance in Austria*

Derived from experiences in other countries (as outlined in chapter 6) the subsequently listed implications for drone acceptance in Austria can be found reasonable.

7.3.1. Approach Viewing Austria as Member of the D-A-CH Region

Based on several topographical, socio-cultural and linguistic similarities between Austria, Switzerland and Germany, subsequently (Figure 54) ensuing from all available data, a comparison and examination involving Austria is conducted by calculation of averaged acceptance values. Therein, public acceptances of Germany and Switzerland are utilised to estimate the acceptance of drones in Austria. All this is reasonable, because in terms of gender distribution several countries do not display any significant differences and demographically Austria features in the age groups '0-24' (24.47%) and '55+' (34.28%) the median between Germany (22.7%, 38.73%) and Switzerland (25.73%, 34.22%). Backed on these facts, it is expectable that especially for highly age-correlating applications (Chapter 6.2.2.) the acceptance of Austrian citizens is somewhere intermediately, featured by the curve 'D-A-CH' in Figure 54.

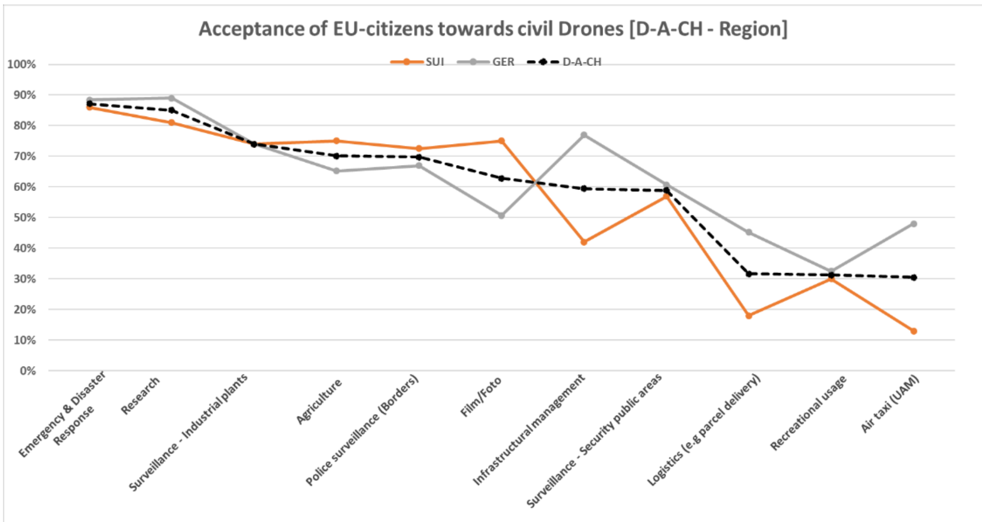

Figure 54: Averaged acceptance values of GER and SUI, approaching drone acceptance in Austria.

In consequence, according to Figure 54, it is assumable that emergency applications are also in Austria the most accepted use case of drones with approximately 89%. Besides that, also research (85%), surveillance (73%) and agricultural (70%) applications are adequately accepted. In contrast to that, especially recreational drone applications or futuristic drone concepts like air taxis or delivery drones are ambiguously viewed by Austrians. Exemplary for that, is the approximated acceptance of about 30% towards air taxis.

7.3.2. International Similarities and Their Implications for Austria

Based on several determined similarities during the examination and investigation of all international studies, subsequently all similarities are listed and linked to statements regarding the public acceptance of drones in Austria.

- **Emergency applications – Global acceptance leader**

According to the first determined similarity, 'Emergency applications' are in several investigated geographical region the most accepted application category, consequently the same is also expectable on an Austrian level.

Therefore, especially by considering the increased age of the Austrian society in comparison to other countries and Austria as a European country, it is expectable that the described similarity is also prevalent in Austrian society, so that 'Emergency applications' are societally most accepted and experience in Austria an acceptance of approximately 90%.

- **Governmental applications – The second best**

Another established similarity addresses 'Governmental applications', which include tasks like border protection, public surveillance or law enforcement activities. In general, this application category achieves in an international comparison coherently second highest acceptance levels, behind 'Emergency applications'.

In correspondence to this and especially by considering the increased societal average age (older adults are predominantly supporting security applications) and the stable trust in governance of Austrian society, 'Governmental applications' experience not only in an international comparison, but rather certainly also in Austria second best acceptance values of approximately 70%, depending on the detailed application domain.

- **Commercial applications – The logical third**

Due to the fact that commercial applications are primarily aiming to offer drone services that satisfy specific customer needs or assist established businesses in enhancing internal processes, this application category is not addressing any services or tasks fulfilled by drones to enhance the overall societal situation.

However, all this indicates a lower perceived societal added value, especially in older generations. In consequence, only specific societal parts that utilise such services beneficially, experience added value from respective operations. Nevertheless, this application category is on an international level always third best, so that the same is also assumable in Austria. In line with this, it can be expected that on average 58% of Austrians accept commercial drone applications, although the detailed value is strictly dependent to the exact commercial application.

- **Recreational applications – Outweighing scepticism**

Recreational drone operations are predominantly conducted by the general public in their leisure time for entertainment purposes excluding any societal added value. Due to this, especially older generations (Chapter 6.2.2) are increasingly sceptical towards this use case, especially due to striking associated threats concerning personal rights like privacy, safety or security.

In an international comparison, this application category, also including recreational drones, is less accepted by society, experiencing in Europe on average only 35% societal acceptance. Complementary to this international similarity, it is estimable that also the situation in Austria is not distinctively different. Therefore, and based on the European numbers, Austrian citizens accept civil drones for recreational purposes by approximately 35%.

- **European comparison – The same order**

With respect to this similarity, also in a European comparison involving acceptance values of all examined European countries (SUI, GER, UK, FRA) the established acceptance order is unchanged (EMS/GOV/COM/Private).

Based on the this, it is also concludable on an Austrian level, that ‘Emergency applications’ are most supported, followed by ‘Governmental applications’, ‘Commercial applications’ and lastly ‘Recreational applications’. All this signifies an order, wherein applications without societal added value achieve less societal acceptance (e.g. ‘Recreational applications’). Therein, especially the increased gradient between ‘Commercial applications’ and ‘Recreational application’ must be emphasized, indicating that professional drone usages are always more supported than deployments by the general public, consequently also in Austria.

- **Emergency & security applications – Slight gender correlations**

During the investigation of several studies a few application domains have been pointed out, displaying only marginal acceptance differences between both genders. As described in Chapter 4.2.2., men and women reveal significant differences in individual risk perception and consequently also risk acceptance. Backed on this, the lowest acceptance differences emerge in applications that affect the total society beneficially and not only individual persons.

In line with all findings stated above and according to Figure 37, in an international comparison especially emergency (gender-correlation: 3%), surveillance (gender-correlation: 4%) and environmental conservation (gender-correlation: 5%) applications are entailing only slight gender correlations, so that even in the Austrian society the same effect is expectable. In accordance with that, several respective application types do not display significant gender differences, so that these applications are almost equally supported by both genders in Austria.

- **Infrastructure & for-profit applications – Moderate gender correlations**

Beyond several less gender influenced applications mentioned above, the international comparison revealed also specific domains that implicate marked gender differences, but not at an excessive level. In line with several examined gender differences regarding risk perception, these are primarily applications that do not affect the total society beneficially and thus cause only reduced societally added value.

In correspondence with that, especially applications like infrastructural management (gender-correlation: 8%), military usages (gender-correlation: 9%), commercial drones (gender-correlation: 11%) and air taxis (gender-correlation: 11%) must be mentioned here. Based on this international similarity, it is expectable that similar gender differences are also prevalent in Austria.

- **Recreational & agricultural applications – Highest gender correlations**

Besides applications that implicate low or medium gender differences, in an international comparison also application domains have been determined, which display high gender differences. Therein especially applications that generate exclusively personal added value like recreational flights (gender-correlation: 11%), logistics drones (gender-correlation: 13%), agricultural drones or photography drones (gender-correlation: 14%) are to mention, causing that men are significantly more supportive than women.

With respect to several results and similarities regarding age-influenced drone applications, it is assumable, that the situation in Austria is quite similar. Backed on this, Austrian men accept recreational flights, air taxi operations or photography drones significantly more than women.

- **Men-dominated private drone society**

Another detected international similarity confirms an international trend, signifying that men are in general more disposed to purchase drones than women. In total, 38% more men as female are internationally owners of private drones, which addresses a circumstance that is also applicable to Austria. In line with this, it is assumable, that the Austrian private drone community is strongly men-dominated with a gender-correlation of about 38%.

- **Different information & knowledge levels**

Based on the quote 'Knowledge is a precondition for responsibility', women reveal in comparison to men significant lacks in individual information level, common technology affinity and overall awareness towards civil drones. All this causes ultimately increased uncertainties and thus also less acceptance by women.

Regarding Figure 40, the obtained gender-correlation is especially salient in the level of information. In line with this, men are up to 36% better informed about drones than women (or think so). Besides that, 33% accounts the gender-correlation in common technology affinity and lastly 9% in general awareness towards drones, probably reasoning detected gender-correlations in specific applications. Based on this international similarity, it is also in Austria estimable, that men are proper informed about drones and entail more personal interest towards common technologies.

- **Diverging perception & interpretation of concerns**

An ultimate similarity with respect to gender-correlations has been observed in prevalent societal concerns. Therein, women are coherently more concerned about drones than men, thus especially concerns like security (gender-correlation: 7%), commercial sensitivity (gender-correlation: 6%), privacy (gender-correlation: 5%), safety (gender-correlation: 5%) and noise (gender-correlation: 4%) are most gender-influenced and also causing severe acceptance differences in related application domains.

Based on this, also in Austrian society women are more concerned about drones, especially in their concerns about security, privacy and safety. In contrast, hardly gender-influenced is the concern identifiability (1%), because the identification of drone operators is also for men of upmost importance, since personal data are required in case of an accident or damaged goods to handle any liability issues.

- **High-tech & leisure – Playground of younger generations**

Besides several conducted examinations on gender-correlations, also similarities in connection to different age groups have been determined. Backed on this, futuristic, high-tech or recreational drone applications are internationally more supported by younger age groups. In this context, especially applications like 'Logistic drones' (age-correlation: 29%), 'Recreational drones' (age-correlation: 27%) and 'Air taxis' (age-correlation: 26%) must be mentioned, displaying striking age-correlations.

Due to the fact, that these age-correlations are observable in all international drone studies, independently from culture or surveyed region, it is assumable, that also in Austria several beforementioned applications are consistently better accepted by younger generations.

- **Infrastructure & agriculture – Unaffected by age**

Besides applications entailing high age-correlations, some applications do not display significant age-correlations and are similarly accepted by all age-groups. In line with Figure 43, public acceptance is predominantly at commercial (age-correlation: 5%), agricultural (age-correlation: 4%) or disaster relief (age-correlation: 9%) applications hardly influenced by age. All this is primarily caused by the perceived societal added value of these applications by all age groups.

Analogously to all prior international similarities, these applications are also in Austria almost similarly accepted by all ages.

- **Surveillance & security – Favourites of older generations**

Older generations have a more sensitive risk perception and thus a higher security need than younger generations. In line with this, in an international comparison some drone applications are coherently more supported by older people. Exemplary for that (Figure 44), especially security-enhancing application domains like 'Surveillance-Public areas' (age-correlation:

13%), ‘Police surveillance-Borders’ (age-correlation: 22%) and ‘Military usage’ (age-correlation: 29%) must be highlighted.

Backed on this, the societal situation is also in Austria not severely divergent to the international trend. Therefore, predominantly drones utilised in the context of surveillance or military applications are significantly better accepted by older generations in Austria.

- **Young people are typical private drone users**

The calculated age-correlation concerning private drone owners accounts on an international level approximately 17%, signifying that predominantly the age group ’18-24’ is purchasing and using private drones, especially for recreational purposes.

Backed on this insight from more than 100 international drone evaluations, it is concludable that in Austria especially the age-group ’18-24’ (or even younger) is purchasing personal drones.

- **Different information & knowledge levels**

In addition to variances in risk perception, different age groups display also diverging interests, which influences personal awareness levels and attitudes. In correspondence with Figure 45, especially younger age groups are increasingly interested in common technologies (age-correlation: 10%), are better informed about drones (age-correlation: 27%) and support drones on average more than older generations (age-correlation: 16%).

Owing to this, also on an Austrian level it is estimable that older generations are less interested in common technologies so that in consequence also personal information and knowledge levels concerning civil drones are not comparable to younger generations.

- **The age shapes concerns**

Human risk perception is strongly influenced by age and thus, also risk sensitivity increases with gained lifetime experiences. Older people are more supportive towards security-enhancing drone applications and are also coherently more concerned than younger people. Therein especially concerns like ‘Security’ (age-correlation: 20%) and ‘Safety’ (age-correlation: 8%) are significantly age-influenced, signifying that older generations apprehend predominantly topics like personal security and safety.

Premising on this, it is also assertible in Austria that older generations are more concerned about civil drones, wherein especially individual security and safety concerns are more striking than in younger generations.

- **Increased acceptance for rural and remote operations**

In correspondence with Figure 47, applications involving civil drones are publicly always the more accepted the more rural and uninhabited the respective location of operation is. Therefore, on an international level, a rural drone application (78%) can be more as twice as much accepted by society as the similar application in urban environment (36%). All this signifies an acceptance increase, which is primarily reasonable by an increased uninhabited space and overall enlarged safety and privacy distances on the landside (lower concern levels).

Backed on that, and especially by considering the pronounced rural space in Austria, it is expectable that the same effect is also prevalent among the Austrian population.

- **Rural population more sceptical towards drones**

Rural societal groups are predominantly living in accordance with traditional values and thus they are distinctively less interested in state-of-the-art technologies compared to urban society. In line with this, in an international comparison rural societal groups are always more sceptical towards drones, but especially highly innovative usage scenarios like ‘Air taxis’ (venue-correlation: 7%) and ‘Delivery drones’ (venue-correlation: 14%) are markedly less supported.

To recapitulate, Austria features the largest rural society in this research involving many traditional values, signifying that rural applications are also more supported by Austrians than any city centre operations. Besides that, international rural society itself displays less interest towards common technologies so that especially innovative drone applications are also less supported by Austrian rural society.

7.3.3. International Distinctions and Their Implications for Austria

Based on several determined distinctions during the examination and investigation of all international studies, subsequently all detected distinctions are listed and evaluated concerning potential relevance for Austria.

- **Europe has a remarkably higher acceptance as America**

In comparison with America, Europe displays in all application categories the highest societal acceptance. Therefore, and by considering Austria as a country in the centre of Europe, also Austrian society arguably reveals highest societal acceptance towards ‘Emergency applications’ (87%), ‘Governmental applications’ (72%), ‘Commercial applications’ (58%), but not so much for ‘Recreational applications’ (35%).

- **Recreational drones are most accepted in ‘Other regions’ (Africa)**

The increased societal acceptance towards ‘Recreational applications’ (43%) in ‘Other regions’ is mainly attributable to the strongly diverging societal structure in comparison to Europe. In specific, especially African regions display a quite young and male-dominated society, so that in this region, especially recreational drones are significantly better accepted than in European societies, which are more dominated by older generations.

In line with this, the prevalent distinction is not conveyable to Austria, so that ‘Recreational applications’ seem to remain the least accepted use case in Austria.

- **Canadians are more sceptical towards drones in common**

In an American comparison, Canadian citizens are coherently most sceptical towards drones, independent of the application category. The Canadian societal structure, shaped by older generations (55+: 33.06%), features a large urban population of about 81.6% and the topography displays both mountains and plains.

In correspondence to that, Austrian society is similarly shaped by older generations (55+ 34.28%), displays a distinctively smaller urban population of about 58.7% and is topographically shaped by mountains. In line with this, it is assumable that Austrians are more sceptical towards several application categories, but especially towards recreational drones (older society). All in all, this distinction is also valid for Austria, although this only signifies that Austria is not reaching highest acceptance values in a worldwide comparison and that Austrian society is more cautious, due to its sociodemographic specifics.

- **French are European acceptance leaders**

Aeronautical industry is of uppermost importance to France. The drone sector of France is the economically largest in Europe, incorporates leading aircraft manufacturers and key players on the drone market. Therefore, independent of the exact drone application category, France is featuring highest acceptance values, with least differences in ‘Emergency applications’ and strongest differences in ‘Commercial applications’ in comparison with other European countries.

Correspondingly, the Austrian aeronautical sector is significantly smaller and primarily characterised by ‘Niche-players’, which specialised on the production of special aircraft parts or components. In consequence, Austrian aviation industry experiences on a societal as well as economical level not the same relevance as in France, so that it is not expectable that Austrians accept civil drones similarly.

- **Switzerland and UK are the most sceptical European nations**

In a European comparison, Switzerland and UK display the lowest acceptance towards drones, independent of the application domain. In specific, Swiss (55+: 32.21%) and UK (55+: 31.21%) societies are predominantly shaped by older generations and males. Regarding urban population, Switzerland has in total 73.9% and the UK 83.9% urban citizens. In terms of topographical specifics Switzerland is mostly dominated by mountains (Alps) and the UK by rolling hills and plains.

Austrian society is also dominated by older generations (55+: 34.28%), has an urban population of about 58.7% and is, comparable to Switzerland, also shaped by mountains (Alps). Therefore, Austrian society is more dominated by older generations as both societies of UK and Switzerland and reveals also a significantly larger rural population, which consequently facilitates the statement, that in Austria ‘Emergency applications’ are upmost and ‘Recreational applications’ least accepted.

- **'Other regions' have a significantly different public perception**

The 'Other regions' include also African countries that display in various application domains a diverging societal acceptance, which is mainly caused by a different societal structure, less public knowledge and a more rural topography. Consequently, especially drone applications like 'Film/Photo', 'Agriculture' or 'Infrastructural management' are societally properly accepted in comparison to all other regions (Europe, America).

Based on several societal and cultural differences, the prevalent distinction is not of significance for Austria, which is as central European country societally and culturally incomparable with these regions. In line with this, it is to expect that also public acceptances between Austrian and African citizens towards civil drones deviate strongly.

- **'Parcel delivery' – More accepted in USA as in Europe**

The concept of parcel deliveries with drones has been developed by leading American logistic companies, like Amazon or UPS. Therefore, American and especially US-citizens had already more contact with this concept and thus they are probably more aware and less concerned. In line with this, especially the US-society is strongly shaped by young generations (55+: 29.91%), which also reinforces societal acceptance towards delivery drones.

In contrast to this, the overall of Austrian society had to date hardly contact with this concept and, in opposite to the USA, is societally mostly shaped by older generations (55+: 34.28%) and displays a more rural topography. Therefore, it is expectable that Austrian society accepts delivery drones according to the calculated European mean value (33%) or slightly below.

- **Germans and Swiss are accepting drones for research purposes**

In comparison to several remaining European countries, especially German and Swiss societies accept civil drones for research purposes. In specific, both national drone industries can take recourse to prevalent know-how of remarked universities and research institutes, focussing on specific drone research and sometimes also conducting field experiments in cooperation with companies or governmental entities, which perhaps also enhances public acceptance of research drones in societies of Germany and Switzerland.

In Austria, many universities and research institutes specialised on miscellaneous aspects of civil drones. Furthermore, also in Austria sometimes field experiments take place, which enhance overall awareness and consequently also public acceptance. In combination with several societal, topographical and cultural similarities between Germany, Switzerland and Austria, drones deployed for research purposes are also properly accepted by the Austrian society (80-90%).

- **Swiss are most sceptical towards parcel deliveries and air taxis**

Based on achieved insights from Figure 52, Swiss society are not supportive towards any futuristic concepts involving civil drones, like air taxis or parcel delivery drones. In common, Swiss society is dominated by older generations (55+: 32.21%), has an urban population of 73.9% and is topographically shaped by high mountains (Western Alps).

Complementary, Austria is societally also dominated by older ages (55+: 34.28%), has a strongly decreased urban population of about 58.7% and is also topographically shaped by mountains, significantly lower than in Switzerland (Central and Eastern Alps). In summary, although Austria displays an older and more rural society, it is assumable, that especially due to the increased topographical availability of drones in Austria (e.g. more plains, less high mountains), combined with the overall sceptical mentality of Swiss citizens, the acceptance of Austrian citizens towards air taxi (~30%) or parcel delivery (~33%) drones is somewhere in-between Germany and Switzerland.

- **Swiss are supportive towards official surveillance applications**

As observable in Figure 52, Swiss citizens are predominantly supportive towards security-enhancing drone applications like ‘Police surveillance (Borders)’. As mentioned above, Switzerland is societally predominantly dominated by males, aged above 55 years (55+: 32.21%).

In correspondence with that, the Austrian society is stronger dominated by ages above 55 years (55+: 34.28%) than the Swiss and German. Especially Germany features the largest age group ‘55+’ of about 38.73%, but due to cultural differences the German society is by nature less supportive towards surveillance applications than Swiss citizens. Therefore, predominantly Swiss mentality is responsible for the excessive acceptance towards official, surveillance applications, so that Austrian acceptance towards this use case can be expected to be slightly below the German value (~65%).

- **French and Swiss are more supportive towards agricultural usages**

Especially French and Swiss citizens are proper accepting agricultural drone applications. In the French case, this circumstance is mainly attributable to the significance of the aeronautical sector to citizens as well as the national economic significance of the agricultural sector. Besides that, especially the increased Swiss acceptance is of importance for Austria and mainly caused by the mountainous topography, leading to aggravated agricultural conditions, less efficiency and compatibility. In line with this, especially rural societal groups are anticipating significant benefits from agricultural drones, predominantly in hardly farmable or inhabitable topographies (accessibility, elevation).

In line with several statements for Switzerland, also Austria features an increased rural population and mountainous topography, so that, especially due to the significantly increased rural population (58.7%), Austrian society displays even higher acceptance towards agricultural use (~80%).

7.3.4. Derived Implications for Austria

Compared to other examined countries, Austria features the smallest urban population (58.7%), besides Germany the oldest population and is topographically characterised by mountainous landscapes. All of this has various effects on the public acceptance of drone applications.

Based on the topographical, socio-demographic and economic characteristics, some specific drone applications are in Austria more relevant than others. Accordingly, primarily due to the mountainous landscape drone applications are of societal relevance, which increase the accessibility of rural or remote areas, like air taxis, cargo flights or delivery drones. In addition, 48% of the Austrian landscape consists of agricultural land, so that in total 2% of the overall economic performance of Austria results from the agricultural sector, which reasons the relevance and acceptance of drones in this sector. All in all, it is estimable that currently approximately by 30% of Austrians support air taxis.

In total, 30% of the total Austrian gross domestic product results from the secondary sector (manufacturing industry), which also includes energy production or crude oil processing. Several actors in this sector require intact infrastructure, which is prospectively improvable with drones (e.g. inspection flights). Due to the similar sectoral magnitudes of Germany and

Austria, it is assumable that especially the use case 'Infrastructural Management' experiences comparable public acceptance in Austria (~80%).

The tertiary sector corresponds to 68% of the total gross domestic product in Austria, wherein approximately 10% account to the tourism sector. Accordingly, it is concludable that also various commercial drone applications and services experience significant potential in Austria, which is particularly noticeable from an increased acceptance and societal relevance towards professional photography or transport services with drones. Regarding tourism, it is worth mentioning that in Austria also 'Recreational flights' have considerable potential for touristic purposes.

7.3.5. Derived Implications from Austrian Surveys

Referencing to Chapter 7.2., in 2016 in total 6% of all Austrians indicated to own a private drone and about 17% evaluated the recreational use of drones relevant, which corresponds to the lowest value in an international context.

In 2017, the opinion research institute SPECTRA evaluated the attitude of Austrians towards delivery drones, and about 26% indicated to support this use case. All this corresponds with the assessment made in Chapter 7.3.3. in which the acceptance of Austrians towards delivery drones was estimated with approximately 33%.

In 2019, the opinion research institute 'Marketagent' conducted a survey on delivery drones in which exclusively people below the age of 30 years were interviewed, causing a remarkable acceptance of 50.6%. In this context, it is statable that the use case ‘Delivery drone’ is also in Austria strongly age-influenced (age-correlation: 23.4%), although this corresponds to a lower age-correlation as already observed internationally in Chapter 6.2.2. (age-correlation: 29%). Another result from this survey examines the national gender-correlation of the use case ‘Delivery drone’ in Austria. Accordingly, men are about 21.8% more supportive towards delivery drones as women, signified by an increased age-correlation in an international comparison (13%) (Chapter 6.2.1.).

Lastly, the Austrian Road Safety Board (KFV) conducted in 2019 another evaluation, in which a total of 6% indicated to own a drone, 57% are supportive towards drones and 62% are in favour of strict regulations by Austrian authorities.

7.4. Recommendations – Ways to Enhance Drone Acceptance in Austria

Regarding already mentioned influencing factors for the acceptance of civil drones (Chapter 4.2.), this chapter develops recommendations and possibilities to improve societal drone acceptance in relation to several identified Austrian specifics.

Individuals form an attitude towards a new technology by the individual evaluation of inner values with external information, so that an attitude is only changeable over a longer period by new external information or gained experiences. Furthermore, perceived values like ‘credibility', 'responsibility' and 'accountability' influence the ultimate formation of acceptance or non-acceptance, so that in particular factors like 'visibility', 'social norm', 'knowledge', 'trust' and 'relevance' are of crucial importance for the formation and individual evaluation of hazards, restrictions and consequences. Nonetheless, attitudes and acceptance are also improvable in the aftermath of a completed evaluation process. Backed on this, targeted information measures are always useful to mitigate societal concerns concerning privacy, safety, security, liability and economic issues of drones.

- **Privacy**

A major societal concern regarding civil drones relates to the invasion of one’s privacy by unidentifiable drones with a camera. In this context, the mandatory use of privacy-enhancing (PET) or privacy-by-design (PbD) technologies can provide a remedy, because through the emission of light or noise potential privacy violations are noticeable more quickly. In addition, a defined colour or shape scheme, in combination with a mandatory identification obligation, can enhance the differentiation of professional from private drones since professional drones cause lower privacy concerns than private drones. Complementary, many privacy violations are caused unintentionally by private individuals, so that mandatory in-depth training and information measures when purchasing a drone, accompanied with official societal communication, can mitigate societal privacy concerns. Besides that, also the regulation of drones can mitigate privacy concerns. Accordingly, the restriction of non-approved overflights or recordings of foreign property can, accompanied with appropriate societal communication, also enhance the acceptance of recreational drones. Beyond that, also e-identification of drones can mitigate potential privacy or accompanied identifiability concerns. Therein, cooperative drones broadcast unique identifiers that contain information on current position and operator.

Recapitulatory, several beforementioned measures can mitigate societal privacy concerns, although the most important aspect concerns always the public information regarding personal legal rights, consequences and preventive measures in a clear, transparent and official manner.

- **Safety**

Regarding the mitigation of societal safety concerns, attention must be drawn to technological improvements, which improve the safety for other airspace users and people on the ground by an increased system reliability. In addition, also improvements in areas like drone rescue systems (e.g. parachute), UTM or detect & avoid systems can distinctively minimize the safety risks of uninvolved third and thus also increase public acceptance.

Besides technological safety improvements, especially regulatory opportunities must be highlighted. In this regard, in areas where drone operations by certain groups (e.g. hobbyists) are simply too dangerous for the societal environment, so-called 'no-drone zones' could be defined, enabling considerable safety improvements. Complementary to that, also the introduction of a 'drone pilot license', including compulsory pilot training and the definition of minimum age could mitigate social safety concerns and improve public acceptance.

- **Security**

Security concerns are caused by the hazard of intentionally misused drones for criminal or terrorist purposes. Accordingly, to mitigate prevalent societal security concerns especially in older societal groups, it is required to protect critical infrastructures like airports, nuclear power plants or prisons, but also crowds against improperly used drones. In line with this, officially purchased and deployed drone defence (counter UAV) systems could enhance societal security concerns and thus also improve the public acceptance.

- **Liability**

Since many people especially fear damages against their own person or property, another striking societal concern relates to potential liability issues in the event of drone crashes causing injuries or property damages to third parties.

In accordance with that, a comprehensive and mandatory drone registration and identification obligation, also presupposing an adequate liability insurance, can minimize societal liability concerns regarding drones. In this context, also the real-time traceability of drones by UTM-systems could be beneficial, although this concept is rather difficult to implement.

Nonetheless, with respect to societal concerns caused by liability issues involving drones, it is of significant importance that prevalent regulations and existing possibilities of impaired third parties are adequately communicated from official side, since otherwise any positive effects on public acceptance remain absent.

- **Economy**

Since many people are primarily interested in securing themselves economically, drones implicate also economic concerns, which are predominantly triggered by fears of an increasing automation that causes job substitutions.

Accordingly, the continuous and clear communication from official side safeguards the public acceptance also in these societal groups during entire implementation process, finally enabling a supported incremental implementation of drones in companies.

- **Environment**

Civil drones provoke also environmental concerns in society. In this context, attention must be primarily drawn to noise or exhaust gas emissions, wildlife threats and environmental risks of dangerous payloads.

Backed on this, especially technological improvements can prospectively mitigate noise and exhaust gas emissions of drones by improving overall system efficiency. Besides that, another way to mitigate environmental concerns and consequently to enhance public acceptance are regulatory measures. In this regard, attention must be drawn to officially conducted noise and exhaust gas measurements, defined noise requirements, established no-drone-zones above nature reserves, time as well as weight and payload restrictions (e.g. dangerous goods).

- **Common recommendations – Information campaigns**

With respect to the circumstance that acceptance is equivalent to a trust relationship, it must be pointed out that especially an adequate societal process-involvement, including also the barrier-free and comprehensible provision of required information, is of crucial importance for the establishment of public acceptance for drones in Austria.

In Austria predominantly young men below 30 years are already well informed about civil drones and thus display also highest acceptance values. In contrast to that, many societal groups, affecting predominantly women and older generations, evaluate civil drones rather ambiguous, which is mainly caused by insufficient knowledge levels and thus also increased concerns. However, all this is in accordance to a quote of Dipl-Ing. Erwin Lauschner, Special Advisor from the Bavarian Aviation Cluster bavAIRia:

> *Societal concerns should be eliminated by active and official knowledge exchange, since knowledge always mitigates societal barriers.* – Dipl.-Ing. Erwin V. Lauschner, bavAIRia

Therefore, focussed and official information and education campaigns are prospectively useful methods to provide new insights, knowledge and benefits arising from drones to insufficiently informed, sceptical societal groups.

Furthermore, it must be safeguarded that already established public acceptance is not reduced again by official misconduct like inadequate regulations or a lack of societal communication or level of involvement. In addition, it is also of key importance that operational safety is always ensured, especially during the integration phase of civil drones, because accidents that cause personal injuries always trigger an immense media response and thus have a lasting effect on public acceptance.

8. Results for The Three Main Research Questions

In accordance with the scientific methodology established in Chapter 2, all research questions postulated in Chapter 2.1. are answered.

Q1: What is the current global situation regarding the public acceptance of civil drones?
Several observed similarities, distinctions and trends are utilised to answer the research questions Q1.1. and Q1.2.:

Q1.1.: What are noteworthy similarities and distinctions on a global level?

On an international level, the scrutinised evaluation of a magnitude of qualitative and quantitative research enabled the detection of many global similarities. Therefore, like explained more detailed in Chapter 6.1, especially emergency applications are experiencing globally the highest acceptance values, followed by official governmental applications, commercial applications and recreational applications. Besides that, referencing to Chapters 6.2.1., 6.2.2. and 6.2.3. especially women, older people or rural society are momentarily less informed and more sceptical towards civil drones, leading to increased concerns and an inadequate public acceptance.

In the course of the examination of several international studies, significant distinctions have been determined. Exemplary, Europeans reveal a remarkably higher acceptance towards drones as Americans and in specific, French citizens are global acceptance leaders, arguable by the status of the aviation sector in France. Referencing to Chapters 6.3.1. and 6.3.3., citizens of the 'Other regions' accept especially recreational drones more as citizens of remaining regions, signifying a completely different topography and public awareness level.

Q1.2.: What are noteworthy trends on a global level?

Regarding Chapter 6.1., a significant international trend is observable by analysing the revealed acceptance order in various application categories. Therefore, in a global comparison, 'Emergency applications' and 'Governmental applications' are always the most supported use cases independently from society or culture, which is primarily arguable by the societal added value of these applications. Besides that, further determined international trends are primarily addressing topographical, socio-demographic and other factors, as outlined in Chapters 6.2.1, 6.2.2. and 6.2.3.

Q2: What factors are influencing the societal acceptance of civil drones?

This research question is primarily addressing several examined socio-demographic, topographic and other influences on the public acceptance.

Q2.1.: How pronounced are topographic and geographic influences?

With respect to Chapter 6.2.3., drone applications are the more accepted the more rural or remote the respective place of operation is, which is easily arguable with mitigated societal concerns, like safety or privacy. Therefore, the relocation of an application can almost double the societal acceptance of an application. Nevertheless, especially rural population groups are less interested towards common technologies and live in accordance with traditional values, which leads especially in societies with large rural populations to less acceptance towards high-tech use cases of drones (e.g. air taxis, delivery drones).

Q2.2.: How pronounced are socio-demographic influences?

The societal acceptance towards civil drones is strongly influenced by socio-demographic specifics, but especially by the age of the respondents. In line with this, predominantly young generations are increasingly supportive towards recreational drones or futuristic, high-tech drone applications (e.g. air taxis), as especially young people are less risk sensitive and more influenced by their peers. In contrast, older generations are predominantly supporting security-enhancing drone applications like police surveillance to satisfy their personal security needs. For more detailed explanations, see Chapter 6.2.2.

Furthermore, referencing to Chapter 6.2.1., also the gender of the acceptance subject influences the magnitude and relevance of perceived risks and thus also the acceptance towards specific applications. Backed on this, men are significantly more supportive towards recreational, logistics or film/photo drones, signifying that women are predominantly accepting applications causing distinctively societal added value like emergency applications at an equal level than men. Besides that, women and older people are less informed about drones, leading to an overall increased level of concern and consequently less acceptance.

Q2.3.: Are there any other influencing factors obtainable?

As demonstrated in Chapters 6.4.3. and Chapter 6.4.4., especially the prevalent regulatory regime as well as the strength and size of the national drone community are influential to the public acceptance of civil drones. Regarding regulatory regime, it is worth mentioning that societal concerns are predominantly mitigable by an adequate regulation in areas like property overflights, identification and much more. In general, most societal members always support a strict state regulation of civil drones.

Beyond that, also the relevance of the domestic drone market is influencing the societal acceptance of civil drones. Exemplary, in Chapter 6.3.1. it has been observed that French citizens are European acceptance leaders, independently of application domain, signifying that French are blessing civil drones with additional acceptance. However, the French drone market is one of the most relevant in a European comparison.

Lastly, also the national economical structure influences public perception. Exemplary, the increased acceptance of German citizens towards infrastructural drones signifies, see Chapter 7.3.4., that the secondary sector in Germany accounts 27.6% and thus, Germans are more supportive towards this use case.

Q3: What are verified implications for civil drones in Austria?

This research question highlights and summarises all relevant elaborated implications for Austria and finally an outlook is provided.

Q3.1.: What are valid estimations regarding the public acceptance in Austria?

Referencing to Chapter 9.2., it is assumable for Austria, especially by comparison with neighbouring states, that Emergency applications (89%) and Governmental applications (70%) are societally highest accepted. Besides that, especially commercial (58%) and recreational (35%) drones are least accepted by Austrians, due to the lack of societal added value.

Complementary to that, the Austrian drone society is arguably shaped by males (gender-correlation: 38%) and younger generations (age-correlation: 17%). Nevertheless, currently 6% of Austrians own a personal, private drone (Saturn, 2016, p.9).

Regarding societal information and knowledge levels, it must be estimated, that in Austria especially men below 30 years are properly informed about drones. Besides that, predominantly women and older people are normally less informed, causing concerns and less acceptance.

Addressing societal concerns, especially older age groups and women in the Austrian society consider security concerns posed by drones. In specific, the age group ‘55+’ reveals 20% higher security concerns than the age group ‘0-24’.

Lastly, by considering topographical, demographic and other key Austrian characteristics, in Chapter 9.2. acceptance values for specific application domains have been established for Austria. Therein, it is assumed, that Austrians accept research drones by 80-90%, agricultural drones by 80%, infrastructural drones by 80%, police surveillance applications by 60-65%, delivery drones by 33% and air taxis by 30%.

Q3.2.: Way forward – Are there ways to improve drone acceptance in Austria?

Referencing to Chapter 7.4., also Austrian citizens are coherently supporting strict state regulations to enhance safety, security and privacy of drone operations. All these measures mitigate societal concerns and enhance public acceptance towards specific drone applications, although not only regulation is a potential way to enhance drone acceptance in Austria.

As stated above, distinctive acceptance differences between genders and age groups are evident and predominantly caused by different information and knowledge levels, facilitating the emergence of individual concerns. Referencing to Chapter 7.4., ‘knowledge is a precondition for responsibility’, so that profound and targeted information campaigns focussing on inadequately informed societal groups could facilitate the enhancement of individual knowledge levels and thus mitigate societal barriers. Therefore, a crucial factor in all this process is also further technological progress towards a more redundant drone technology, e-identification, the development and governmental deployment of effective drone protection (counter UAV) devices, the establishment of ‘No-drone-zones’ or operational restrictions in terms of flight time or flights in inhabited areas. All this, in combination with a sufficient societal involvement, facilitates the promotion of public acceptance towards various drone applications, finally enabling an incremental integration of drones into our everyday life and facilitating a sustainable domestic drone market in Austria.

9. Conclusions and Outlook

In accordance with the applicated mixed-methods approach in this scientific work, the subsequent concluding chapter summarises several elaborated statements on an international and Austrian level by utilisation of elaborated statements of Chapters 6 and 7.

9.1. Conclusions Related to International Drone Acceptance

The most important international findings resulting from several examined studies on drone acceptance are presented in the following sequences.

9.1.1. Conclusions from Various Application Categories

The following findings can be reasonably highlighted for various application categories of drones:

- **Emergency and governmental applications are most accepted**

Emergency and governmental drone applications are coherently most accepted by the society, independently to the exact country. In specific, emergency applications experience in Europe public acceptance of about 86%, followed by America with 79%, which is arguable with the enormous societal added value while preserving human lives. In general, European citizens accept several application categories significantly more than American citizens.

In regard to several obtained differences between America and Europe, predominantly differences in the health and welfare system between American and European countries, lead to diverging acceptances. Therein, striking is the difference in 'Governmental applications', which indicates less governmental trust of Americans.

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- **Commercial and recreational applications are less accepted**

Commercial and recreational applications are the least accepted categories on an international level. In specific, commercial applications are predominantly utilised by companies to enhance processes or offered as service to specific customers, signifying a decreased societal added value and thus less public acceptance, which accounts in Europe 58% and in America 39%.

Besides that, recreational drones are operated by general public and thus exclusively creating personal added value and in consequence barely societal relevance. In this context, especially the uncontrolled manner of such operations reinforces concerns and thus decreases acceptance markedly, which accounts in Europe 35% and in America 30%. The lower acceptance in America is probably caused by the fact, that Americans have already been more exposed to recreational drones as Europeans.

In correspondence to that, the citizens of the ‘Other regions’ display the highest acceptance towards recreational drones (44%). All this is predominantly caused by less knowledge and awareness levels.

- **The same order in an intra-American comparison (EMS/GOV/COM/Private)**

In an intra-American comparison, no country deviates from the postulated acceptance order. In specific, USA is coherently featuring highest acceptance values for emergency (80%), governmental (52%) and commercial (41%) applications, so that the USA is the American acceptance leader, also strengthened by the young societal structure of this country.

In contrast to that, Canada features distinctively lower acceptance values in each application category. In specific, especially significant is the obtained acceptance difference for recreational drones.

Citizens of Latin America are exclusively more supportive towards recreational drones (41%) than commercial drones (39%), which signifies prevalent cultural differences between citizens of North and South America.

- **The same order in an intra-European comparison (EMS/GOV/COM/Private)**

No European country deviates from the established acceptance order. In specific, French citizens are revealing in several application categories the highest acceptance values, which is primarily arguable by the status of the French aviation industry, which displays for emergency applications 92%, for governmental applications 88%, for commercial applications 79% and recreational applications 49% of public support. All this transforms France to the European as well as worldwide acceptance leader, also reinforced by the middle-aged French society.

Contrary to that, German citizens reveal in several application domains acceptance values in-between of France and Switzerland. Therefore, German society reveals moderate acceptance towards civil drones in a European comparison.

Beyond that, citizens of Switzerland and UK are most ambivalent, revealing least acceptance in each application category, which is arguable by mentality differences, mid-aged populations and the increased rurality of the Swiss society. Regarding UK, all this is probably reinforced by recently gained, bad societal experiences involving recreational drones (e.g. Gatwick Airport).

9.1.2. Conclusions from Various Application Domains

With respect to various application domains, the ‘Other regions’, also including African regions, are displaying significantly diverging acceptance values in comparison to western, industrialised countries. Exemplary for that, emergency rescue services (69%) receive lower acceptance than infrastructural management (99%) with drones, signifying a completely different socio-demographical and topographical structure, which is in Africa strongly shaped by young ages and rural or remote landscapes.

Commercial services and parcel deliveries with drones are more accepted by American citizens compared to European citizens. All this is mainly caused by the fact, that leading American companies initiated this concept, so that American citizens already had more contact with such services, enabling an increased public awareness and acceptance.

In Europe, the attitude of German (90%) and Swiss (81%) society is most supportive towards research drones, which signifies a remarkable acceptance difference of 61% to the UK.

Switzerland is topographically shaped by mountains, entails a smaller urban population as well as a mid-aged society. Furthermore, on the 9^{th} May 2019 crashed a 10kg drone used for postal deliveries in Zürichberg and triggered respective negative media reports. Backed on this, and in combination with the strongly risk sensitive Swiss society, especially highly futuristic drone applications like air taxis (13%) or delivery drones (19%) feature in Switzerland lowest acceptance values in a European comparison.

9.1.3. Socio-demographic Conclusions

The following socio-demographic specifics in terms of gender and age are strongly influential to the public acceptance of drones:

- **Obtained gender-correlations**

In total three different categories have been specified, which reveal different levels of gender influences and differences:

1. Applications implicating distinctive societal added value like ‘Emergency & Disaster Response’ or ‘Police surveillance’ are hardly influenced by gender, so that both men and women support respective applications similarly.

2. Applications displaying medium gender influences, like ‘Infrastructural management’, ‘Military usages’, ‘Commercial drones’ or ‘Air taxis’, signifying that the more unknown, futuristic and specific an application, the lower is the acceptance of females.

3. Applications with the highest gender-correlations and least female acceptance are ‘Recreational usage’, ‘Delivery drones’ or ‘Film/Photo’, implicating that females are predominantly considering societal added value as key criterion for acceptance.

- **Obtained age-correlations**

Besides the obtained gender-correlations, also different ages are influential to the public acceptance. Therefore, three categories have been introduced, summarising all determined age-correlations:

1. Younger generations are predominantly supporting applications, that enable exclusively personal added value (e.g. Recreational drones) or are strongly innovative (e.g. Air taxis, delivery drones).

2. Some applications reveal only marginal age influences, so that these are similarly accepted by all generations. In line with this, especially commercial, agricultural or emergency applications are less gender-influenced examples.

3. Specific application domains are more supported by older generations. Accordingly, and by considering the increased security need of older people, especially security-enhancing applications are attributable to this category (e.g. Police surveillance, Military usage).

With respect to several obtained facts regarding international private drone communities, it is concludable, that the typical private drone owner is male (gender-correlation: 38%) and between 18-30 years of age (age-correlation: 17%).

- **Information and knowledge levels**

Complementary to that, conclusions regarding examined socio-demographic influences on information and knowledge levels regarding drones can be drawn:

1. Men are displaying a markedly increased information level (gender-correlation: 36%), common technological affinity (gender-correlation: 33%) and awareness level (gender-correlation: 9%) towards civil drones.

2. Younger ages are better informed about drones (age-correlation: 27%) and have an increased interest towards common technologies (age-correlation: 10%).

3. Predominantly young men are proper informed about drones, enabling also increased acceptance in these societal groups.

- **Societal concerns**

Backed on several statements regarding age and gender correlations, it is important to complete these with conclusions regarding sociodemographic influences on societal concerns.

1. Women are coherently more concerned about drones than men, displaying highest gender-differences in security (7%), commercial sensitivity (6%), privacy (5%) and safety (5%) concerns.

2. Women are predominantly more concerned about security, economic as well as safety and privacy issues.

3. Age shapes the relevance of perceived concerns. Therein, especially age differences in common risk perception, causing greater concerns in older generations. Backed on this, especially security (age-correlation: 20%), safety (age-correlation: 8%) and privacy (age-correlation: 4%) concerns are especially age-influenced.

9.1.4. Topographical Conclusions

The location of a drone operation shapes the societal perception. Therefore, it is possible that an application in urban environment is accepted by 36% of society, signifying a value that is increasable by relocation to a more remote place, enabling an acceptance of 78%. In conclusion, drone applications are the more accepted the more rural or remote the place of operation is.

Besides that, rural society displays on average a lower common technological affinity and is living in accordance to traditional values. All this signifies that a more rural society leads to less public acceptance of drone applications, especially affecting the acceptance of innovative concepts like parcel deliveries or air taxis (AIRBUS, 2019, p.15).

9.2. Conclusions Regarding Drone Acceptance in Austria

Based on several conducted examinations and investigations in Chapter 7, subsequently the following conclusions for public drone acceptance in Austria are derivable:

- **Acceptance of Austrians towards various application categories**

In Austria 'Emergency applications' are most supported and experience an acceptance of about 90%. All remaining applications categories are less accepted due to a decreasing societal benefit, which means expressed in numbers: 'Governmental' (~70%), 'Commercial' (~58%) and 'Recreational' (~35%).

- **Gender influences drone acceptance in Austria**

Regarding influences of the Austrian gender distribution on the drone acceptance in Austria, the following conclusions can be drawn:

1. Men evaluate several drone applications more supportive than women.

2. Especially gender-influenced are applications that generate significant societal added value, causing that emergency, surveillance and nature conservation tasks are almost similarly accepted by both sexes.

3. Some applications are in Austria subject to moderate gender influences. Therein, especially infrastructural, military and commercial tasks must be highlighted, generating moderate added societal value.

4. Applications that do not generate added societal value are evaluated highly ambivalent by Austrian men and women (e.g. recreational drones, parcel deliveries, film/photo).

5. Generated societal added value is predominantly for women a key criterion for the individual acceptance building process.

- **Age influences drone acceptance in Austria**

The societal age is influential to the perception and assessment of drones in Austrian society:

1. Older people have an increased risk perception and thus an enlarged security need, which influences public acceptance, especially in the older Austrian society. In specific, applications primarily serving to improve security standards (e.g. border protection), are more supported by older generations to meet increased personal security needs.

2. High-tech and recreational applications are more supported by younger people, as they place less importance on social benefits and potential dangers (e.g. delivery drones, recreational drones, air taxis).

3. Some applications are hardly age-influenced in Austrian society, as these generate neutral societal added value (e.g. infrastructure monitoring, emergency services).

- **Private drone community in Austria**

In total 6% of all Austrians own a private drone, whereby approximately 38% more men as women and 17% more people below the age of 30. Therefore, the Austrian private drone community is dominated by young men below 30 years of age.

- **Information and knowledge level of Austrians**

The Austrian society displays the following sociodemographic specifics:

1. In the Austrian population men below 30 years are properly informed about drones.

2. Especially women are inadequately informed about drones, which is reflected in pronounced gender-correlations (information: 36%, technology affinity: 33%, awareness: 9%) and lower acceptances.

3. The age influences the public perception of drones in Austria, since older people are less informed about drones (27%) and entail less pronounced technological affinities (10%).

- **Relevant concerns of Austrians**

The following examined societal concerns are in Austria shaped by sociodemographic specifics:

1. Women are generally more concerned about drones, displaying striking gender-correlations in concerns like security (7%), economic (6%), privacy (5%) and safety (4%).

2. Identifiability (1%) is almost equivalent relevant to both genders.

3. Older age groups tend to be more concerned than younger age groups in the areas of security (20%), safety (8%) and privacy (4%).

- **Topographical influences on drone acceptance in Austria**

Another investigated aspect addresses topographical influences on the acceptance of drones in Austria.

1. Public drone acceptance depends in Austria strongly on the place of operation. Drone applications are the more accepted the more rural or remote the place of operation is.

2. In rural surroundings privacy or security concerns are not that relevant as in the city centres. Exemplary, an urban application accepted by 36% is in rural environment accepted by 76%, which is more than twice as high.

3. Austria is featuring an enlarged rural society, which must be considered as these societal parts display not the same magnitude of common technological affinity as the urban population and live accordance with traditional values.
4. Rural society assesses especially futuristic or general high-tech drone applications like air taxis (7%) or delivery drones (14%) more critical, signifying an effect that must be considered especially in Austria.

- **Austria vs. Switzerland**

Austrian society is shaped by older generations (55+: 34%) so that, due to the absence of a Swiss risk prevention mentality and the older German population (55+: 39%), security applications are in Austria supported by 60-65%, but less than in Switzerland (73%) or Germany (68%).

Considering the enlarged rural society of Austria, the similar topography and the absence of a Swiss risk prevention mentality, agricultural drones are even better accepted in Austria than in Switzerland (76%), so that an acceptance of about 80% is estimable. Therein, the high acceptance values are caused by the additional operational value of drones when deployed in inaccessible or hardly to access Alpine regions.

- **Austria vs. Germany**

German citizens support infrastructural applications by 78%, whereby the secondary sector in Germany accounts for about 27.6% of the total gross domestic product. Based on this statement, also in Austria infrastructural applications are societally well supported, since the domestic secondary sector accounts for around 30% of the gross domestic product. Therefore, infrastructural applications are in Austria even more relevant and therefore accepted by approximately 80%.

- **Austria vs. USA**

Highlighting the international public acceptance of delivery drones, some conclusions for Austria are derivable. The US-society displays highest acceptance values for this use case, which is primarily explainable by the younger socio-demographic structure (55+: 29.91%) and a marked societal urbanisation (82.7%). In addition, the concept of delivering parcels with drones has been initiated by US-companies, so that the American population probably had already more contact with this concept than Europeans, causing an increased public acceptance

(39%). Accordingly, due to the enlarged rural and older society, Austrian citizens feature a lower acceptance than US-residents and the European average towards delivery drones (~33%).

- **Research drones in Austria**

Research drones are highly supported by societies in Switzerland (81%) and Germany (89%). Consequently, due to the cultural and linguistic similarities to Austria, as well as the comparable density of research institutions specialising in drones, it is concludable that research drones are also proper accepted in Austria (~80-90%).

- **Taxi drones in Austria**

Swiss society reveals the least acceptance towards taxi (13%) and delivery drones (19%), which is mainly reasoned by the Swiss mentality, accidents with cargo drones in the past, the societal age (55+: 32.21%) and the decreased urban population (73.9%).

Nevertheless, mainly due to implications from the conducted D-A-CH approach (Chapter 7.3.1.) and the absence of the risk-prevention culture of Swiss citizens lead to the conclusion that Austrians evaluate high-tech applications more supportive than Swiss, although the estimated Austrian acceptance is, due to the socio-demographic specifics, still below the European average. Consequently, delivery drones are accepted by about 30-33% and air taxis by approximately 30% of Austrians.

9.3. Outlook and Recommendations for Drone Acceptance in Austria

In summary, drones are currently ambiguously evaluated by various societal groups, primarily caused by concerns owing to insufficient knowledge and information levels. Nevertheless, many ways to promote public acceptance are available:

1. Technological enhancements can help to mitigate safety, privacy, environmental and security concerns.

2. The official deployment of drone (counter UAV) protection systems at critical infrastructures can minimize security concerns.

3. Targeted societal campaigns (e.g. folders, demonstration flights) by official entities can enhance public awareness, especially in currently less informed societal groups (generation 50+, women).

4. Introduction of strict regulatory measures to prevent misuse (e.g. mandatory registration, 'drone pilot license').

5. Establishment of a mandatory liability insurance obligation to all drone categories will mitigate any liability concerns.

6. The governmental establishment of 'no-drone-zones' and geographically or timely restricted areas.

7. Funding of national research on drone technologies to enhance capabilities and thus societally anticipated benefits from drones.

8. Profound societal dialogue regarding several enacted regulations and prevalent rights of individuals (e.g. in case of privacy intrusion).

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