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Urban air mobility in Europe and US: A comparative analysis of the governance of European Union Aviation Safety Agency and the Federal Aviation Administration for the growth of eVTOL aircraft

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MA Programme Euroculture Declaration

I, Radhitya Diva Putra, hereby declare that this thesis, entitled "Urban air mobility in Europe and US: A comparative analysis of the governance of European Union Aviation Safety Agency and the Federal Aviation Administration for the growth of eVTOL aircraft", submitted as partial requirement for the MA Programme Euroculture, is my own original work and expressed in my own words. Any use made within this text of works of other authors in any form (e.g., ideas, figures, texts, tables, etc.) are properly acknowledged in the text as well as in the bibliography.

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ABSTRACT

With the aim to understand how novel technologies are being governed for sustainable environment and enhance urban air mobility, this thesis investigates the governance of two civil aviation bodies, the European Union Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA), in governing electric Vertical Takeoff and Landing (eVTOL) aircraft in their respective jurisdictions. The key research question is “How is the governance of EASA and FAA to facilitate the growth of eVTOL aircraft for urban air mobility in Europe and United States from 2019 to 2022?”. The study draws on four theoretical frameworks—sociotechnical transitions, technology governance, rational choice institutionalism, and effective governance—to analyze and compare the governance of these institutions. Furthermore, the question is answered specifically through the lens of elements of effective governance, which are accountability, performance, and participation. From these elements, several sub-questions are created to allow detailed analyses based on structured, focused comparison as the main methodology. The findings reveal that EASA excels in performance and citizen outreach, while both institutions demonstrate relatively similar legal accountability and industry participation. Nevertheless, insights can be drawn from each body's approach, offering essential learnings to enhance the governance of emerging technologies like eVTOL.

Keywords: EASA, FAA, eVTOL aircraft, urban air mobility, governance

Word count: 24981

LIST OF ABBREVIATIONS

1. **CRT**: Comment Response Tool - A platform used by EASA for industry stakeholders to review and provide feedback on proposed regulations.
2. **EASA**: European Union Aviation Safety Agency - The European regulatory body responsible for aviation safety and regulations.
3. **EB #105**: Engineering Brief #105 - An engineering brief issued by the FAA providing guidelines and standards for vertiports
4. **eVTOL**: Electric Vertical Takeoff and Landing - A type of aircraft that can take off and land vertically using electric propulsion systems.
5. **FAA**: Federal Aviation Administration - The United States regulatory body responsible for aviation safety and regulations.
6. **MOC SC-VTOL**: Means of Compliance for Special Conditions VTOL
7. **PTS-VPT-DSN**: Prototype technical specifications for the design of VFR vertiports for operation with manned VTOL-capable aircraft certified in the enhanced category
8. **SC-VTOL**: Specific Conditions - Vertical Takeoff and Landing Aircraft
9. **SC-Joby**: Special Class Airworthiness Criteria for the Joby Aero, Inc. Model JAS4-1 Powered-Lift
10. **SC-Archer**: Special Class Airworthiness Criteria for the Archer Aviation Inc. Model M001 Powered-Lift
11. **VTOL**: Vertical Takeoff and Landing - A type of aircraft that can take off and land vertically.
12. **UAM**: Urban Air Mobility - A transportation concept that involves the use of eVTOL aircraft for urban transportation.

LIST OF TABLES

LIST OF PICTURES

TABLE OF CONTENTS

Chapter 1: Introduction

Ever since the inception of the European Union (EU), mobility has been one of its best virtues — citizens of its member states and travelers are able to travel within the EU area with less restriction, allowing for greater political cooperation and economic impact. This also means that transportation remains among the sectors that consume the most energy in Europe, accounting for 18.8 percent of the total final energy consumption in EU member states in 2020[1]. The percentage is only slightly lower than energy transformation (24.2 percent) and higher than households (18.5 percent), industry (17.2 percent), and services (9.1 percent)[2].

The European Commission has laid out the plan to making the EU climate neutral by 2050 through the European Green Deal, which targets reduction in emissions for road, air, and maritime transport; however, there is still a long road ahead as the share of energy from renewable sources in transport drops in 2021 compared to the previous year: only Croatia, Denmark, Finland, and Lithuania were able to increase their proportion[3].

In recent years, improvements in fuel efficiency resulting from policy actions and industry efforts have been observed. This led to a reduction of 24 percent in fuel consumption per passenger between 2005 and 2017, contributing to environmental benefits. However, the continuous growth of air traffic has offset these improvements, as the average distance travelled by passengers increased by 60 percent in 2017 compared to 2005[4]. Direct emissions from aviation accounted for 3.8 percent of the total CO2 emissions in the European Union in 2017. Among transport sectors, aviation was the second-largest contributor to greenhouse gas (GHG) emissions, accounting for 13.9% of the total, following road transport[5].

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[1] "Energy Statistics - an Overview," accessed March 20, 2023, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview.
[2] "Energy Statistics - an Overview."
[3] Sean Goulding Carroll, "EU Sees Brutal Drop in Renewable Energy Used in Transport," www.euractiv.com, February 14, 2023, https://www.euractiv.com/section/agriculture-food/news/eu-sees-brutal-drop-in-renewable-energy-used-in-transport/.
[4] "Reducing Emissions from Aviation," accessed March 20, 2023, https://climate.ec.europa.eu/eu-action/transport-emissions/reducing-emissions-aviation_en.
[5] "Reducing Emissions from Aviation."

One of the key areas of focus under the Green Deal is sustainable mobility, and as such, the Commission has set out to reduce greenhouse gas emissions from the transportation sector, including aviation[6]. The EU's commitment in ensuring safe and environmentally sustainable aviation is demonstrated by the EU Regulation 2018/1139 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency (EASA) — a regulation which includes provisions on the facilitation of novel technologies in aviation, aiming to "promote, as appropriate, the development of new technologies, taking into account the social and economic impact of these technologies, as well as their impact on the environment."[7].

The regulation has paved way for EASA to facilitate the rise of vertical take-off and landing (VTOL) aircrafts—capable of taking off and landing vertically as opposed to the conventional one which requires a runway of a certain size—powered by electric motors and that uses distributed propulsion with lift generated by rotors or ducted fans. The use of electric propulsion systems in aircraft are considered to be more environmentally sustainable as they produce zero emissions and less noise pollution during flight, particularly for short-haul flights and in urban areas[8].

eVTOL aircraft is expected to be used for air transportation and mobility in urban areas, which, in recent years, has been popularly called urban air mobility (UAM). The technology is anticipated to deliver advantages for both the environment and the public and private sectors, especially in terms of commercial and emergency/medical applications[9].

In addition to EASA, several other aviation agencies have taken steps to facilitate the integration of eVTOL aircraft for urban air mobility. Take, for example, the US' Federal Aviation Administration has been working on developing regulations and guidelines

[6] "Mobility Strategy," accessed March 21, 2023, https://transport.ec.europa.eu/transport-themes/mobility-strategy_en.

[7] "Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on Common Rules in the Field of Civil Aviation and Establishing a European Union Aviation Safety Agency," § Article 57 (2018).

[8] "Targeting Zero-Emission Aviation," World Economic Forum, July 29, 2021, https://www.weforum.org/agenda/2021/07/targeting-true-net-zero-aviation/.

[9] "Study on the Societal Acceptance of Urban Air Mobility in Europe" (Cologne: European Union Aviation Safety Agency, May 2021).

specifically for eVTOL aircraft to ensure they can operate safely in urban environments. In addition, Civil Aviation Authority of Singapore (CAAS) has established a regulatory sandbox to enable the safe testing and development of new urban air mobility solutions, including eVTOL aircraft, while the Japan Civil Aviation Bureau (JCAB) has established a working group to study the feasibility of integrating eVTOL aircraft into Japan's airspace, and is collaborating with industry stakeholders to develop a regulatory framework for eVTOL operations.

These regulatory efforts are timely as many industry players are competing to launch the commercial operation of their eVTOL aircrafts: European players like Lilium and Volocopter go hand in hand with their American counterpart, Joby, to enable an ecosystem where urban air mobility becomes the next solution for a sustainable air transportation. However, the eVTOL industry as a whole is still in its infancy as aviation authorities around the world are still working to increase its resources, personnel, and systems to better facilitate eVTOL aircrafts.

From the European perspective, that adds to the lack of supranational regulation that allows for a commercial operation from happening: to create a regulatory framework for aviation, EASA takes a risk-based approach, prioritizing their resources based on the level of risk associated with different types of operations or technologies. For eVTOL aircraft, the agency is focusing on developing new regulations and guidelines that address the unique safety concerns and operational challenges associated with this new type of aircraft.

Although there has been a growing interest in the development and deployment of eVTOL aircraft for urban air mobility in recent years, there is still a gap in academic research that seeks to understand the governance of civil aviation regulatory bodies in supporting the growth of eVTOL aircraft. While several studies have investigated the regulatory frameworks for traditional aviation[10][11], there is a lack of research that analyzes the differences and similarities between EASA and FAA's approaches to facilitating the

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[10] Steven Truxal, *Competition and Regulation in the Airline Industry* (London: Routledge, 2012), https://doi.org/10.4324/9780203119464.
[11] Ruwantissa Abeyratne, *Competition and Investment in Air Transport* (Cham: Springer, 2016), https://doi.org/10.1007/978-3-319-24372-6.

development and implementation of eVTOL aircraft. Additionally, while some studies have explored the challenges and opportunities of eVTOL aircraft for urban air mobility[12], no study has investigated the specific institutional factors that influence EASA and FAA's ability to regulate and promote the use of these new aircraft technologies. Therefore, this research aims to contribute to filling this gap by providing a comprehensive analysis of EASA and FAA's governance of eVTOL aircraft, examining the policies, regulations, and guidelines that shape their approaches to promoting the growth of eVTOL aircraft for urban air mobility in Europe and the United States. The use of EASA in comparison with FAA in this thesis is given the latter's prominence in the aviation industry and their influence on global aviation regulations[13]. Aiming to dissect the differences in their approaches to facilitate the growth of eVTOL aircraft for urban air mobility, this research is conducted within the realm of technology governance, highlighting how institutions with authoritative capacity govern the development and use of technology through policies, regulations, and guidelines.

This research is timely given the significant advancements and growing interest in the eVTOL industry and the urgent need to develop regulatory frameworks that promote safety, security, and sustainability. A key aspect of this analysis is a comparative study of EASA and FAA, which will clarify on the differences and similarities in their institutional capacity to support eVTOL development and implementation. Elements of effective governance which are accountability, performance, and participation will be examined to identify the key drivers of institutional capacity and their influence on the regulatory process. By analyzing the governance of EASA and FAA within the context of technology governance, this study will provide insights into how regulatory bodies govern the development and use of technology.

This research aims to provide a comprehensive analysis of the governance of EASA and FAA with regards to the development and implementation of eVTOL aircraft, specifically by examining their institutional capacity and regulatory frameworks. A key aspect of this

[12] "How Do Consumers View Advanced Air Mobility? | McKinsey," accessed April 30, 2023, https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/up-in-the-air-how-do-consumers-view-advanced-air-mobility.
[13] Nadine Zumsteg and Andreas Wittmer, "The Role of Public Policy," in *Sustainable Aviation: A Management Perspective* (Cham: Springer, 2022).

analysis is a comparative study of the two regulatory bodies, which will highlight the differences and similarities in their approaches to promoting safety, security, and sustainability in the eVTOL industry. The comparative analysis will be carried out by examining elements of effective governance such as accountability, performance, participation from relevant stakeholders, and legal frameworks, with the aim of identifying key drivers of institutional capacity and their influence on the regulatory process. By analyzing the governance of EASA and FAA within the context of technology governance, this study will provide insights into how regulatory bodies govern the development and use of technology, with a specific focus on eVTOL aircraft

1.1 Literature Review

Evidently, technology governance has been studied from various perspectives before. A first strand of research focuses at the interplay of regulation and technological innovation: for example, Shawn Donnelly has examined that regulation can either promote or hinder economic and technological innovation by creating a business environment for innovation which affects a company's ability to attract investment and innovate. It is argued that the task for regulators is diversifying regulatory instruments to fit different needs, capturing diverse forms of technological innovation, and balancing the portfolio of innovation between unproven and proven technological bases[14]. In addition, it is found that businesses benefit from regulation, which improves their chances of translating good ideas and products into advanced technologies that generate profits and employment. Consequently, this avoids "technological suffocation"—less innovation from other competitors—which could happen by a business dominating the market[15]. Another study within this line of research has examined the importance of a mix of policy interventions in addressing environmental externalities and encouraging the development and diffusion of green technologies. Policy measures such as emission taxes, cap-and-trade schemes, top-down regulations, R&D incentive schemes, and subsidies, can provide incentives for the development and diffusion

[14] Shawn Donnelly, "Regulation, Innovation, and Competitiveness," in *Regulating Technological Innovation: A Multidisciplinary Approach* (Palgrave Macmillan, 2011).
[15] Donnelly.

of green technologies and address the environmental externality directly while also indirectly addressing the knowledge spillover externality.[16]

A second strand of research focuses on regulators and their particular challenges in managing innovations in the industry. EASA as a policymaker constitutes one of five key actors in sustainable aviation system in Europe; the other being technology, consumers, airports, and airlines. Müller et all argues that state sovereignty makes policymaker "the most powerful and therefore central actor" in aviation; through regulations, policymakers greatly influence airlines and airports while steering demand and behavior of consumers. However, it is argued that the internationality of aviation makes the sector difficult to regulate, and that policymakers need to understand the interdependencies in the industry and all the relevant actors in the aviation system to implement coordinated measures that can have a significantly positive effect on the climate impact of aviation.[17]

Lourdes Q. Maurice and Carl E. Burleson from the FAA have analyzed the unique challenges faced by the institution in regulating the global aviation industry, which consists of diverse and varying markets. A notable example highlights the differences between the European and US markets, despite their relative maturity. In the United States, the majority of the aviation industry is domestic, characterized by minimal growth in recent times and a globally unparalleled general aviation sector. On the other hand, Europe faces the challenge of border-crossing flights and has experienced double-digit growth in the commercial aviation industry due to the introduction of low-cost carriers. These agency-specific studies provide valuable insights into the distinct challenges faced by regulators in managing different markets within the aviation context.[18]

It has been examined that the FAA lacks of organizational independence and regulations, preventing the agency from using resources efficiently. The US Congress, for example, has

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[16] Bronwyn H. Hall and Christian Helmers, "The Role of Patent Protection in (Clean/Green) Technology Transfer," *Santa Clara High Technology Law Journal* 26, no. 4 (September 2010), https://doi.org/10.3386/w16323.
[17] Adrian Müller et al., "Towards Sustainable Aviation: Implications for Practice," in *Sustainable Aviation: A Management Perspective* (Cham: Springer, 2022).
[18] Lourdes Q. Maurice and Carl E. Burleson, "Aviation Policy & Governance," in *Energy, Transport, & the Environment: Addressing the Sustainable Mobility Paradigm* (London: Springer, 2012).

prevented the FAA to a significant extent from using its resources more efficiently. It is also observed that the internal decision-making process is inflexible, making it difficult for technological advances to be implemented, leading to reduced productivity in the air transportation sector. In addition, there is a political pressure from special interest groups, such as the National Business Aviation Association and the National Air Traffic Controllers Association, that thwart the efforts to reform aviation infrastructure policy.[19]

The third line of research focuses in particular on eVTOL and its integration into urban air mobility systems. The EASA for its part has conducted a study analyzing public attitudes and concerns towards urban air mobility and provides recommendations for promoting its acceptance in Europe. The study categorizes urban air mobility into drones and air taxis. The main difference between them is that the former is typically used for non-passenger purposes, while the latter is designed to carry passengers. is It is found that the surveyed public considers the technology to be faster, cleaner and provide extended connectivity. However, concerns are on safety, environment/noise, and security.[20]

Still within the third strand of research, EASA has also investigated public trust in regulatory bodies and their role in governing urban air mobility, in which it was found that there are variations in levels of trust towards different types of authorities. Respondents from Budapest, Rome, and Barcelona indicated greater confidence in European authorities, whereas those from Hamburg and Oresund had more trust in national and local authorities. Notably, participants from Paris were the most doubtful, with trust levels below 50 percent for all types of authorities. In addition, according to qualitative interviews with local authorities, the majority of them, except those in cities with pilot projects or demonstrators, had uncertainties regarding UAM and lacked adequate information to make informed decisions at the local decision-making level. They expressed concern about the insufficient involvement of local authorities in the deployment of UAM and were uncertain about how

[19] Steven A. Morrison and Clifford Winston, "Delayed! U.S. Aviation Infrastructure Policy at a Crossroads," in *Aviation Infrastructure Performance: A Study in Comparative Political Economy* (Washington, D.C.: Brookings Institution press, 2008).
[20] "Study on the Societal Acceptance of Urban Air Mobility in Europe," May 2021.

the role of local authorities would be coordinated with that of national and European authorities.[21]

While there is an increasing number of studies on the FAA, the EASA, and eVTOL aircrafts as a technological innovation, there is still a gap in a research that compares how these institutions are facilitating the eVTOL technology. Consequently, the thesis is built upon the existing literature and studies, giving specific concerns on EASA and FAA's facilitation of eVTOL aircrafts in Europe and the US, respectively. As EASA has noted, public acceptance will "most likely increase if authorities on all levels work together. This will also allow to link the UAM operations to the different local conditions."[22] Indeed, it is one of the areas this thesis is aimed for, to close the gap in the knowledge of governance to facilitate the growth of eVTOL aircraft.

1.2 Research Question

The primary research question which will be the guidance for this thesis is: "How is the governance of EASA and FAA to facilitate the growth of eVTOL aircraft for urban air mobility in Europe and United States from 2019 to 2022?" To gain a deeper understanding of this, a specific question will be addressed: "What are the differences of governance between EASA and FAA to facilitate the growth of eVTOL aircraft for urban air mobility from 2019 to 2022?"

"Governance instruments" in this context is the three elements of effective governance as put forward by Kathe Callahan: accountability, performance, and participation — each carries different indicators which will be explained in more detail in Chapter 3: Methodology.

The research subject will be limited to FAA and EASA, specifically their institutional capacities to facilitate the growth of eVTOL aircraft in their respective jurisdictions. This limitation is important as both of them are also involved in rulemaking activities worldwide; for example, EASA collaborates with Civil Aviation Authority of Singapore for eVTOL aircraft operation in Singapore, while the FAA is also present with various rulemaking

[21] "Study on the Societal Acceptance of Urban Air Mobility in Europe."
[22] "Study on the Societal Acceptance of Urban Air Mobility in Europe."

activities in some Central American states. However, the primary focus of the thesis remains on analyzing the regulatory capacities of EASA and FAA within their respective regions, and research studies dealing with other aviation authorities will not be directly addressed.

The timeline of the research for EASA will be limited from the issuance of the European Union Delegated Regulation 2019/945 and 2019/947, which expanded EASA’s scope to cover unmanned aerial vehicles and drones and subsequently allowed the institution to move forward with various regulatory activities on eVTOL aircraft. The regulations also updated EASA’s jurisdiction after United Kingdom’s withdrawal from the EU.

On the other hand, the timeline of the research for FAA will be limited to from the issuance of UAM Concept of Operations (ConOps) version 1.0 in June 2020 until present time. The ConOps lay the foundation for UAM operations in the US, along with roles and responsibilities of FAA, operational concept, and notional architecture. Some additional documents that will be analyzed under FAA are developing as the thesis goes, but so far include Vertiport Engineering Brief, SC- Joby, NPRM and SFAR.

Chapter 2: Theoretical and Conceptual Framework

Establishing a shared understanding of key concepts utilized in this thesis is essential for a comprehensible analysis, even though offering all-encompassing and precise definitions can be challenging due to varying interpretations among scholars. In this thesis, I use theories and concepts of sociotechnical transitions, technology governance, new institutionalism, and effective governance. They are interconnected in their relevance to understanding the process of eVTOL aircraft regulatory development by EASA and the FAA.

The first theory, sociotechnical transitions, helps us explore the dynamics of sustainable innovation, system interactions, and the co-evolution of technology and society, which is crucial in understanding the development and integration of eVTOL aircraft into existing air transportation systems. Technology governance theory emphasizes the importance of managing technological innovations by considering their potential societal, economic, and environmental impacts, which is relevant for understanding how EASA and the FAA address the challenges and opportunities associated with eVTOL aircraft. Rational choice institutionalism highlights the role of institutions in shaping policy outcomes and the impact of history, culture, and strategic decision-making, which is pertinent for examining the institutional factors influencing eVTOL aircraft regulations. Lastly, effective governance theory underlines the elements necessary for successful governance, including performance, accountability, and participation, which is relevant for assessing the effectiveness of EASA and the FAA in regulating eVTOL aircraft and involving stakeholders in the decision-making process.

This chapter aims to lay the groundwork for specific definitions that will underpin the subsequent research, briefly explaining the origin and relevance of each term in relation to the primary research question..

2.1 Socio-technical transitions to sustainable new technology

In order to effectively integrate eVTOLs and other emerging technologies, acknowledging the wider social, economic, and technological factors that propel socio-technical transitions toward sustainable innovations is essential. We will begin by examining the concept and role of socio-technical transitions in the context of governing technological innovations such as eVTOL aircraft. The origin of the term ‘socio-technical’ can be traced back to the work of Tavistock Institute's founders, Eric Trist and Fred Emery. In essence, it is an approach to the intricate design of organizational work, which acknowledges the interplay between technology and people in the workplace. Moreover, the term also encompasses the relationship between complex infrastructures in society and human conduct. This concept recognizes society itself and most of its substructures as complex sociotechnical systems. Sociotechnical systems theory strives to achieve four closely interrelated objectives in system design and management: user satisfaction, system efficiency, successful system implementation, and effective change management. The approach is commonly applied in managing organizational change or projects that involve business process re-engineering.[23]

The use of socio-technical systems in transition to sustainability has been researched by various scholars. This particular field first appeared in the early 2000s within innovation studies. It was initially tested and refined through numerous historical case studies of transitions, including those in mobility, heating, power, agro-food, water, sanitation, and music. Since then, it has been widely applied to the analysis of unfolding and future sustainability transitions.[24] Frank W. Geels has examined the use of multi-level perspective (MLP) as a specific method within the larger scholarly discussion on sustainability-driven social transformations. It centers on transitions within systems that offer societal functions or end-use services, such as energy, transportation, housing, and agro-food systems.[25] Geels noted in his research:

This unit of analysis is important because mobility (especially automobile and air transport), nutrition (especially meat and dairy), and domestic energy consumption (heating/cooling, lighting, washing, showering, appliances) account for 70–80% of environmental impacts in industrialized countries. Addressing persistent and worsening environmental problems (such as climate change, biodiversity loss, resource depletion) therefore requires fundamental

[23] Jeremy Stranks, “The Relevance of Human Factors within the Sociotechnical System,” in *Human Factors and Behavioural Safety*, First edition (Oxford: Elsevier Ltd, 2007), 100.
[24] Frank W. Geels, “Socio-Technical Transitions to Sustainability: A Review of Criticisms and Elaborations of the Multi-Level Perspective,” *Current Opinion in Environmental Sustainability* 39 (August 2019): 187–201, https://doi.org/10.1093/acrefore/9780199389414.013.587.
[25] Geels.

changes in these systems, which are conceptualized in shorthand as 'socio-technical' since the fulfilment of societal functions involves not only technologies, but also situated consumer practices, cultural meanings, public policies, business models, markets, and infrastructures.[26]

The MLP places a strong emphasis on the significance of "radical innovations". At the same time, it recognizes that socio-technical transitions are brought about by several social groups, such as firms, consumers, social movements, policymakers, researchers, media, and investors, who are involved in various activities, such as exploration, learning, debate, negotiation, power struggle, conflict, investment, coalition building, and goal-setting. The MLP recognizes the actions of these actors as *regimes*, and the transition subjects, such as mobility, energy, and agro-food as *systems*. Various "lock-in mechanisms"—techno-economic, social and cognitive, as well as institutional and political—create incremental and path-dependent innovations in existing systems and regimes, making it challenging to achieve radical innovations that are necessary for sustainability transitions. Techno-economic lock-in mechanisms are created by sunk investments in competencies, factories, and infrastructures that create vested interests against transitional change. Additionally, the low cost and high performance characteristics of existing technologies due to economies of scale and decades of learning-by-doing improvements also hinder radical innovation. Social and cognitive lock-in mechanisms result from routines and shared mindsets that "blind" actors to developments outside their focus. Social capital resulting from alignments between social groups and user practices and lifestyles organized around particular technologies (e.g., car-dependent mobility practices) also contribute to social and cognitive lock-in. Institutional and political lock-in mechanisms also play a crucial role in hindering radical innovation. Existing regulations, standards, and policy networks favor incumbents and create an uneven playing field, while vested interests use their access to policy networks to water down regulatory change and hinder radical innovation.[27]

Geels gives an example of a radical innovation in the area of mobility:

[26] Geels.
[27] Geels.

Table 1: Geels' example of radical niche-innovations in mobility[28]

	Mobility
Radical technical innovation	Battery-electric vehicles, (plug-in) hybrid electric vehicles, biofuel cars; hydrogen cars
Grassroots and social innovation	Car sharing, bike clubs, modal shift to bicycles and buses, tele-working, tele-conferencing
Business model innovation	Mobility services, car sharing, bike sharing
Infra-structural innovation	Intermodal transport systems, compact cities, revamped urban transport systems (tram, light-rail, metro)

The table illustrates a number of radical niche innovations, with differing degrees of maturity and radicality, that could act as starting points for transitioning to sustainable practices in different fields. It is examined that more radical innovations often originate in small, peripheral niches within existing systems, driven by the pioneering efforts of individuals such as entrepreneurs, start-ups, activists, or other relatively unknown outsiders.

2.1.1 The public sector perspective

Early researchers studying socio-technical transitions highlighted that policymakers cannot direct sustainability transformations from an external position due to their reliance on other actors for knowledge, resources, innovation, legitimacy, and consent, along with the fact that transitions are uncertain, open-ended, and challenged[29]. Therefore, it was proposed that policymakers should facilitate social interactions, discussions, learning processes, foresight, and information exchange rather than orchestrating change. One example of such facilitation is the Strategic Niche Management (SNM) approach, which proposed that policymakers should stimulate radical innovation through real-world experiments, projects that encourage multidimensional learning, and transformative coalitions. Subsequent research has elaborated on these ideas by investigating various types and roles of experiments, the activities of intermediary actors and policy implementation agencies, and the importance of long-term policy visions, missions, and foresight in sustainability transitions.

The emergence of eVTOL aircraft is a prime example of a niche-innovation that could potentially transform the transportation industry and contribute to sustainability transitions.

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[28] Geels.

[29] Adrian Smith, Andy Stirling, and Frans Berkhout, "The Governance of Sustainable Socio-Technical Transitions," *Research Policy* 34 (2005): 1491–1510, https://doi.org/10.1016/j.respol.2005.07.005.

While regulatory support is integral, as highlighted by socio-technical transition scholars, policymakers need to facilitate social interactions, learning processes, and transformative coalitions that can accelerate sustainability transitions. They must also be aware of the synergies and inconsistencies between policies and aim for a policy mix that combines multiple instruments to encourage diffusion and pressure incumbent regimes. Transition scholars have investigated the conditions that facilitate the introduction of stronger policies that may accelerate sustainability transitions. These include external shocks or crises, coalitions that exert pressure on policymakers, shifts in public opinion and pervasive narratives, the maturation of niche-innovations, and regime destabilization.[30]

2.2 Technology governance

Drawing upon the insights from socio-technical transitions and its public sector perspective, technology governance emerges as a crucial framework for managing the multifaceted aspects of technological advancements. Having technology governed to maximize its benefits is becoming increasingly important as technological advancements continue to transform various aspects of our lives, from transportation and communication to healthcare and commerce. While its definitions vary from one scholarship to another, the Organization of Economic Co-operation and Development (OECD) explains technology governance more comprehensively:

Technology governance can be defined as the process of exercising political, economic and administrative authority in the development, diffusion and operation of technology in societies. It can consist of norms (e.g. regulations, standards and customs), but can also be operationalised through physical and virtual architectures that manage risks and benefits. Technology governance pertains to formal government activities, but also to the activities of firms, civil society organisations and communities of practice. In its broadest sense, it represents the sum of the many ways in which individuals and organisations shape technology and how, conversely, technology shapes social order.[31]

[30] Geels, "Socio-Technical Transitions to Sustainability."
[31] "Technology Governance - OECD," accessed April 10, 2023, https://www.oecd.org/sti/science-technology-innovation-outlook/technology-governance/.

Public sector's role in regulating technology business is a topic of intense debate in public policy: while there is an argument that reducing regulation leads to better innovation and that businesses should have the freedom to comply with regulatory standards voluntarily, there is no clear link between minimal regulation and economic success through technology. In fact, businesses often profit from regulation that enhances their ability to transform innovative ideas and products into cutting-edge technologies, generating substantial profits and creating employment opportunities.[32] Donnelly has examined that there are at least five different means by which regulation can increase the likelihood of technological advancements and facilitate their transformation into economically viable products:

1. Attracting factors of production
2. Ensuring monopolistic competition
3. Removing restrictions to market entry
4. Reducing transaction costs
5. Preventing technological suffocation[33]

Attracting factors of production. Technological innovation is often a vital component of regional development projects for impoverished areas. However, policy makers and businesses also recognize that securing access to financial capital and skilled labor is critical, both of which are notoriously mobile and selective. Reducing regulatory transaction costs for investors bringing their capital into an enterprise (including tax rates) and enhancing legal certainty for investors that their investment returns are secure are the primary means of addressing the investment side. In this case, reducing the risk of politically motivated regulatory changes after an investment has been made is crucial. These two factors play a role in an investor's political and regulatory risk analysis before investing in a location.[34]

Ensuring monopolistic competition. If a company's product is highly innovative, its technology can protect the company's market share, and the issue of IP (intellectual property) rights takes care of itself. However, as competitors successfully imitate the product, the

[32] Donnelly, "Regulation, Innovation, and Competitiveness."
[33] Donnelly.
[34] Donnelly.

company's market position erodes, and they must either move on to other products or rely on regulatory protection of their innovative processes and products through patents. In this case, regulation ensures monopolistic competition despite the introduction of variable prices for the same product, known as perfect pricing. Companies sell to prosperous consumers at higher prices than they do to less prosperous consumers, and they rely on regulatory prohibitions on the sale and import of so-called grey-market goods to prevent the import and sale of the same product from a low-price area to a high-price area.[35]

Preventing technological suffocation. Contrary to the previous point, it is also examined that "too little competition is bad for other companies, and by extension, the economy as a whole". When a single company becomes dominant in a market, it can limit innovation by other companies that wish to develop products in a different way. Donnelly noted that, for example, Microsoft's dominance was subject to regulatory action because the company's position in the market made it difficult for software developers to create products that were not specifically designed to work with Windows. Microsoft also used its connections with computer manufacturers to bundle its own products with the factory-delivered Windows operating system, which competed with other products available to end users. These practices were curtailed through regulatory action to prevent the suffocation of technological innovation through dominant market positions.[36]

Removing restrictions to market entry. There are two types of restrictions, or barriers, in this context: the private and the public ones. Private barriers are created by companies themselves, and examples include cartel agreements, predatory pricing, and access conditions to network industries such as telecommunications, energy grids, and operating systems. Public barriers, on the other hand, are created by government regulations, such as licensing requirements or tariffs on imports. Regulation can be used to foster innovation and avoid 'rent-seeking', which is the act of seeking to gain economic benefits through political influence rather than through productive activity.[37]

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[35] Donnelly.
[36] Donnelly.
[37] Donnelly.

Reducing transaction costs. Regulation can also be used to promote lower transaction costs for industry by encouraging product standardization and providing exemptions for high-tech firms that cooperate in research and development for mutual benefit. However, there is a history of resistance from competing companies seeking monopolistic profits. There are also questions about whether regulators should promote standardization through regulations, particularly as regulators lack the knowledge to participate in the creative process. Nevertheless, in cases where standardization has occurred for product components produced widely for a national economy, it has positively impacted the economic competitiveness of companies and their products. This has been documented in the automobile industry in Germany, which has been able to keep and build on a common store of knowledge, technology and skill as a result of standardisation.[38]

2.3 Rational choice institutionalism in EU

The concept of institutions experienced a significant revival in 1977 with the influential paper "Institutionalized Organizations: Formal Structure as Myth and Ceremony" by John W. Meyer and Brian Rowan. This study is later known as the "new institutionalism", where the authors argue that formal structures in organizations are not necessarily efficient or practical, but are instead symbolic and ritualistic. Organizations become institutionalized through "isomorphism"—a process where they adopt similar structures and practices to other organizations in their field. This phenomenon is driven by a desire for legitimacy and that formal structures, including hierarchies, rules, and procedures, are used by organizations to create rationality and control. Meyer and Rowan describes this as a "myth" of rationality to maintain legitimacy and ensure that organizations are seen as legitimate by external stakeholders.[39]

The growth of rationalized institutional structures in society makes formal organizations more common and more elaborate. Such institutions are myths which make formal organizations both easier to create and more necessary. After all, the building blocks for organizations come to be littered around the societal landscape; it takes only a little

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[38] Donnelly.
[39] John W. Meyer and Brian Rowan, "Institutionalized Organizations: Formal Structure as Myth and Ceremony," *American Journal of Sociology* 83, no. 2 (1977): 340–63.

entrepreneurial energy to assemble them into a structure. And because these building blocks are considered proper, adequate, rational, and necessary, organizations must incorporate them to avoid illegitimacy. Thus, the myths built into rationalized institutional elements create the necessity, the opportunity, and the impulse to organize rationally, over and above pressures in this direction created by the need to manage proximate relational networks.[40]

In the context of this research, Meyer and Rowan's argument suggests that the regulatory efforts of EASA and FAA in governing eVTOL aircraft could potentially be influenced by existing regulatory instruments and practices, rather than being innovative or specifically tailored to the unique challenges posed by the eVTOL sector. As rationalized institutional structures become more prevalent in society, organizations, including EASA and FAA, may feel compelled to adopt these established practices to maintain legitimacy and gain acceptance from external stakeholders. Thus, when examining the governance instruments employed by EASA and FAA to facilitate the growth of eVTOL aircraft for urban air mobility, it is crucial to consider the potential influence of institutional pressures and the desire for legitimacy on their regulatory approaches. By doing so, this thesis will provide a more nuanced understanding of the factors shaping the governance of eVTOL aircraft in Europe and the US.

Further research down the years have found it difficult to pinpoint new institutionalism into a single definition. For example, Hall and Taylor (1996) examined that the approach does not "constitute a unified body of thought", instead categorizing it into three different analytical approaches, each of which can be labeled "new institutionalism": historical institutionalism, sociological institutionalism, and rational choice institutionalism. Scholars of the first approach, historical institutionalism, seek to identify the "critical junctures" in history where institutions were established or altered and trace the effects of these events on subsequent institutional development. Scholars of sociological institutionalism, on the other hand, argue that institutions are not only shaped by formal rules and incentives but also by social norms and values that guide the behavior of actors within institutions. Actors within

[40] Meyer and Rowan.

institutions are seen as socialized into particular institutional norms and values that guide their behavior and decision-making[41].

The third approach, which is particularly relevant to this thesis, is rational choice institutionalism: an approach that views institutions as rules and organizations that shape individual behavior by providing incentives and constraints. This theory suggests that individuals are rational actors who make decisions based on the expected costs and benefits of their actions. Institutions are seen as structures that facilitate or hinder rational decision-making and can be designed to promote efficient outcomes. One of the main characteristics of this approach is the emphasis of the role of strategic interaction in determining political outcomes, where institutions structure such interactions by "affecting the range and sequence of alternatives on the choice-agenda", or by "providing information and enforcement mechanisms that reduce uncertainty about the corresponding behavior of others". In Hall and Taylor's words, rational choice institutionalists take a "calculus approach" to explaining how institutions affect individual action.[42]

In the context of EASA and FAA governance, applying rational choice institutionalism allows for an examination of how these agencies develop regulations and policies based on rational benefit calculations, taking into account the anticipated costs and benefits associated with their decisions. This approach underscores the significance of strategic interactions in shaping policy outcomes, acknowledging that institutions can influence these interactions by setting the parameters for decision-making, offering essential information, and establishing enforcement mechanisms that minimize uncertainty about others' behavior. Rational choice institutionalism enables a comprehensive examination of not only the formal structures and policies implemented by these institutions but also how they engage with stakeholders and adapt to incentives and constraints within their respective domains.

It is worth noting that this approach has also been employed in other contexts, such as EU politics. This broader applicability underscores the value of rational choice institutionalism as an analytical tool for examining decision-making processes across a range of domains. For

[41] Peter A. Hall and Rosemary C.R. Taylor, "Political Science and the Three New Institutionalisms," *Political Studies* XLIV (1996): 936—957.
[42] A. Hall and C.R. Taylor.

her research on EU politics, Mastenbroek (2006) examines that rational choice approach assumes individuals are the basic units of social analysis, with personal rankings of alternatives and a consequentialist logic. Institutions are equally crucial in decision-making, as they structure the process, designate players, and determine feasible strategies. Players' preferences and institutions are important to understand decision-making process[43].

Rational choice theory has been utilized as a model to research the governance of political institutions in the EU. According to Pollack (2006), however, it is important to underline that this theory follows a "positive heuristic" which guides the analyst's focus towards specific types of inquiries. As a result, the impact of rational choice theory has not been consistent across all questions or issue-areas. While the use of rational choice theories is not confined to the examination of formal EU institutions—as it has been extended to other areas such as the Europeanization of domestic politics and public attitudes towards the EU[44]—the realms of legislative, executive, and judicial politics, has seen the most significant advancement in the application of rational choice approaches.

In the1980s and early 1990s, a considerable amount of theoretical modelling and empirical research has been conducted on the European Parliament (EP), with an increasing number of scholars investigating the legislative organization of the EP and the voting behavior of its members (MEPs). To accomplish this, they have modified models of legislative politics that were largely derived from the study of the US Congress. Despite the multinational nature of the EP, MEPs' voting behavior is predicted more by their party group than their nationality. Studies show that. the EP's legislative organization, including the powerful committees, plays a crucial role in setting the agenda for parliamentary debates. The EP can be studied as a "normal parliament" where members vote predictably and cohesively in a "two-dimensional" issue space that includes both nationalism/supranationalism and the left-right political spectrum.[45] EP's decision-making process, thus, is rooted in the rational choice theory, as

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[43] Ellen Mastenbroek and Michael Kaeding, "Europeanization Beyond the Goodness of Fit: Domestic Politics in the Forefront," *Comparative European Politics* 4 (November 2006): 331–54, http://dx.doi.org/10.1057/palgrave.cep.6110078.
[44] Mark A. Pollack, "Rational Choice and EU Politics," in *ARENA Working Paper No. 12*, 2006, https://dx.doi.org/10.2139/ssrn.1011326.
[45] Pollack.

rational decisions are made based on their preferences and available information, and that institutions are shaped by the strategic behavior of their members.

Moving to the European Commission as the EU's executive branch, Tallberg (2000, 2003) pointed out that examination of EU executive politics is not solely the domain of rational choice scholars; for instance, the Commission's causal influence has been studied by both neofunctionalists and intergovernmentalists, while the Commission itself as an institution has also been studied by sociological institutionalists, students of political entrepreneurship, and normative democratic theorists[46]. However, Tallberg points out that rational choice institutionalism has emerged as the popular approach to studying the Commission and other executive actors, such as the European Central Bank and EU agencies. The studies mainly address two questions:

1. Why and under what conditions a group of (member state) principals might delegate powers to (supranational) agents, such as the Commission?
2. What if the supranational agents behave in ways that diverge from the preferences of the principals?

In regard to the first question, rational member-state principals delegate powers to supranational organizations mainly to reduce the costs of policymaking by enabling governments to commit credibly to international agreements and benefit from the policy-relevant expertise of supranational actors. Through a range of quantitative and qualitative methods, the collective empirical work of these scholars has demonstrated that delegation of powers to the Commission is primarily to reduce the transaction costs of policymaking, such as monitoring member-state compliance, filling-in of 'incomplete contracts', and swift adoption of implementing regulations.[47] The answer to the second question is primarily found in the administrative procedures that principals establish to define agency activities beforehand, as well as the oversight procedures that enable subsequent oversight and punishment of agents who act improperly. When applied to the EU, principal-agent analysis suggests that agency autonomy is likely to vary across issue areas and time, based on member

[46] Pollack.
[47] Pollack.

governments' preferences, information distribution between principals and agents, and decision rules regarding sanctions or new legislation. Empirical studies of executive politics in the EU have generally supported these hypotheses, highlighting the importance of decision rules as a key factor determining executive autonomy.[48]

In the United States, rational choice institutionalism has also been applied to the study of various political institutions. One notable example is the work of Terry M. Moe (1984), which applies the new economics of organization—a framework heavily influenced by rational choice theory—to understand the behavior and structure of public bureaucracies. The study highlights the importance of understanding the principal-agent dynamics that exist within public bureaucracies. According to the rational choice perspective, political principals (e.g., elected officials) seek to control bureaucratic agents to ensure that their policy preferences are implemented. However, bureaucratic agents have their own preferences and may use their discretion to pursue their own interests. This creates a tension between political control and bureaucratic discretion, which shapes the organizational structure and functioning of public bureaucracies.[49]

The concept has also been used to analyze the committee system in the US Congress, explaining why committees are formed, their jurisdictional boundaries, and the allocation of seats on committees. For instance, Shepsle and Weingast (1987) argue that the committee systems in US Congress play a crucial role in shaping legislative decision-making by providing specialized committees with the authority to set the legislative agenda. They develop a model of legislative organization based on the premise that legislators create and maintain committee systems to advance their policy preferences and enhance their electoral prospects. In this model, the key driver of the committee system's structure and power is the legislators' strategic behavior. The study explains that the power of congressional committees is derived from their ability to control the legislative process through agenda-setting. Committees can shape policy outcomes by determining which proposals are considered and

[48] Pollack.
[49] Terry M. Moe, "The New Economics of Organization," *American Journal of Political Science* 28, no. 4 (1984): 739–77, https://doi.org/10.2307/2110997.

by modifying the content of the legislation. This gatekeeping authority allows committee members to advance their policy preferences and, in turn, benefit their constituencies.[50]

The insights from rational choice institutionalism applied to political institutions offer a valuable framework for understanding the governance of eVTOL aircraft by civil aviation regulatory bodies like EASA and FAA. Comparing their approaches in the context of technology governance, the research will contribute to the understanding of how regulatory bodies govern the development and use of emerging technologies and foster innovation and growth in the rapidly evolving eVTOL sector for urban air mobility.

2.4 Determining the effective governance in EU

Rational choice institutionalism has been a dominant theory in the study of governance and public policy that emphasizes the role of self-interested actors who strategically design and implement policies to maximize their own interests and achieve desired outcomes. While this perspective offers valuable insights into the decision-making processes of policy actors, it does not account for the importance of effective governance in achieving policy goals. As eVTOL aircraft continue to take shape and space, effective governance becomes critical in ensuring their safe and efficient integration into existing air transportation systems.

2.4.1 The concept of multi-level governance

The EU is not a traditional federation, but rather a unique system of governance that involves multiple levels of authority, including supranational, national, and subnational actors. This complex structure encompasses both exclusive and shared competences, where certain policy areas are under the sole jurisdiction of the EU, while others involve collaboration between the EU and its member states in decision-making and implementation processes. Liesbet Hooghe and Gary Marks developed the concept of multi-level governance model in early 1990s to explain the European integration. Contrary to state-centric model—where national governments are the primary decision makers and only delegate limited authority to supranational institutions for specific policy objectives—the multi-level governance model

[50] Kenneth A. Shepsle and Barry R. Weingast, "The Institutional Foundations of Committee Power," *American Political Science Review* 81, no. 1 (March 1987): 85–104, https://doi.org/10.2307/1960780.

acknowledges the importance of national governments and domestic politics in the European Union, but also recognizes that decision-making is shared among actors at different levels.[51]

In the context of this thesis, the focus on EASA as the primary institution responsible for eVTOL regulations in Europe is justified by its direct regulatory authority over aviation safety and certification. However, it is important to acknowledge that EASA operates within the multi-level governance framework of the EU. This means that the agency's decisions are influenced not only by its internal processes but also by interactions with other European-level actors, national governments, and industry stakeholders. Therefore, while the analysis will center on EASA's governance instruments, the broader context of multi-level governance will be considered in understanding how the agency's policies and regulations on eVTOL aircraft are shaped and implemented. This approach will help illuminate the complexities of eVTOL regulatory development within the EU and provide a better understanding of EASA's role in it.

European Commission's authority to propose new legislation and implement decisions extends to the aviation sector: the Commission has delegated some of its powers to EASA, especially in the area of aviation safety. In the context of multi-level governance, EASA acts as an independent actor in policymaking with delegation from the Commission. EASA then works closely with aviation authorities of EU member states to develop and implement common safety standards and rules, in addition to issuing certifications and approvals for aircraft, personnel, and organizations involved in aviation. The relationship between the Commission and EASA illustrates how actors across different levels interact and share decision-making responsibilities. The Commission can ensure the successful implementation of its aviation safety policies by establishing this connection, while EASA can provide valuable expertise and knowledge to policy-making processes at the EU level.

2.4.2 Effective governance

Many scholars in public administration focus on "governance" as a crucial concept for the future. Bingham, Nabatchi, and O'Leary distinguish government from governance:

[51] Liesbet Hooghe and Gary Marks, *Multi-Level Governance and European Integration*, Governance in Europe (Lanham, MD: Rowman & Littlefield Publishers, 2001).

"Government occurs when those with legally and formally derived authority and policing power execute and implement activities; governance refers to the creation, execution, and implementation of activities backed by the shared goals of citizens and organizations, who may or may not have formal authority and policing power", and that "as an activity, governance seeks to share power in decision making, encourage citizen autonomy and independence, and provide a process for developing the common good through civic engagement"[52]. Pertaining to this thesis, the question in mind would be which theoretical framework to assess the effectiveness of governance of EASA on eVTOL aircraft and compare it with the US' FAA. Kathe Callahan has outlined three elements to assess in order to measure effective governance: performance, accountability and participation. She noted that there are assumed relationships between the three:

Greater accountability leads to better performance and the more the public is involved in the governance process, and in particular the measurement of government performance, the more they can hold government accountable for its results.[53]

2.4.2.1 Public sector accountability

There are various definitions of accountability in the public sector, including the idea that it involves answerability to a legitimate source of control[54] and adherence to legal mandates and moral standards. However, the traditional bureaucratic model of accountability, which assumes a clear chain of command and unambiguous rules and procedures, is not always applicable in today's complex and networked models of service in public sector, which result in an overlapping relationships with state and local level. This has resulted in a need to redefine accountability relationships and determine who is accountable to whom and for what in a decentralized and non-hierarchical environment. The prevailing notion of accountability revolves around command and control and focuses on imposing regulations and rules to restrict bureaucratic discretion. Typically, two approaches are employed to limit this

[52] Lisa Blomgren Amsler, Tina Nabatchi, and Rosemary O'Leary, "The New Governance: Practices and Processes for Stakeholder and Citizen Participation in the Work of Government," *Public Administration Review* 65, no. 5 (September 2005): 547–58, https://doi.org/10.1111/j.1540-6210.2005.00482.x.
[53] Kathe Callahan, *Elements of Effective Governance: Measurement, Accountability and Participation* (Boca Raton: Auerbach Publications, 2007).
[54] Melvin J. Dubnick, "Accountability and Ethics: Reconsidering the Relationships," in *Encyclopedia of Public Administration and Public Policy: Second Edition* (New York: Taylor & Francis, 2008).

discretion: external accountability, which involves legislative controls through mechanisms such as legislative oversight, mandates and administrative law by the courts, and active participation and elections by citizens; and internal accountability, which entails adhering to organizational procedures, administrative regulations and rules, as well as professional standards and ethics.[55]

Romzek and Dubnick proposed a complex framework for public sector accountability that goes beyond formal and legalistic approaches. They argue that accountability is a strategy for managing competing expectations from different sources. They identified four alternative systems of accountability: bureaucratic, legal, professional, and political. These systems are based on variations in two critical factors: the source of control (internal or external) and the degree of control (high or low) over defining organizational expectations. The interplay of these two dimensions generates the four types of accountability systems.[56]

	Internal	External
High	Bureaucratic	Legal
Low	Professional	Political

Table 2: Romzek and Dubnick’s type of accountability systems

The most commonly used and recognized form of accountability is bureaucratic accountability, also known as hierarchical or organizational accountability. This type of accountability requires a clear chain of command, regulations and procedures that guide administrative behavior, and emphasizes compliance with rules and directives. It reflects individuals' obligations and responsibilities to the organization and prioritizes those at the top of the organization. Managers or supervisors obtain control through stated rules and regulations, and accountability is maintained through the use of rewards or punishments. Bureaucratic accountability is characterized by internal mechanisms, supervisory relationships, rules and procedures, and a high level of control.[57]

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[55] Callahan, *Elements of Effective Governance: Measurement, Accountability and Participation*.
[56] Barbara S. Romzek and Melvin J. Dubnick, “Accountability in the Public Sector: Lessons from the Challenger Tragedy,” *Public Administration Review* 47, no. 3 (May 1987): 227, https://doi.org/10.2307/975901.
[57] Romzek and Dubnick.

Legal accountability is similar to bureaucratic accountability, only that it refers to an organization's obligation to follow established mandates set by external authorities. The managers of an organization are subject to external oversight, such as reviews of policies and procedures, fiscal audits, and legislative oversight hearings[58]. In the context of this thesis, for example, the EASA is legally accountable to the Commission for ensuring that aviation safety regulations are implemented in the European Union. An example for this is EASA's responsibility for ensuring that its regulations, policies, and procedures align with the relevant EU laws and directives, such as the Basic Regulation (Regulation (EU) 2018/1139), which establishes the framework for civil aviation safety in the EU. In comparison, the FAA operates under the oversight of the U.S. Department of Transportation (DOT) and is subject to U.S. laws and regulations, such as the Federal Aviation Act.

2.4.2.2 Theoretical foundations of performance measurement

The concept of performance measurement is rooted in organizational theory and public administration literature. It is a tool to provide accurate, unbiased, significant, and prompt data on the performance of an organization or program. This tool is utilized to enhance management techniques and assist in making informed managerial decisions, resulting in better performance. When implementing performance measurement, it is crucial to keep in mind two important factors: it should be designed with a specific purpose in mind, and it should be tailored to the capacity of the organization and its personnel.[59]

An effective performance measurement system should encompass a range of measures, including input (quantity), output (number), outcome (quality), and efficiency (cost). The system should focus on a select few indicators that relate to the overall objectives and goals of the organization or program, rather than numerous scattered indicators.[60]

It is important to think of performance measurement as a process or system of measures and procedures, whereby organizations assess how well they are performing compared to previous performance and to other organizations. The system should clearly articulate service

[58] Romzek and Dubnick.
[59] Callahan, *Elements of Effective Governance: Measurement, Accountability and Participation*.
[60] Callahan.

goals and objectives, define service outputs and outcomes, and specify expected quality levels for these outputs and outcomes within a specified time frame.[61]

Callahan has outlined eight performance indicators to that can be used to measure performance:

1. Input indicators: Indicator to measure the resources used in a program, such as money or employee hours. Input measures should reflect the actual resources used, not just those allocated.
2. Workload or process indicators: Reflect the effort needed to provide a service or create a product. These measures may be referred to as inputs, workload, or process measures.
3. Output indicators: The amount of service provided to a population within a given time. They include examples like meals delivered, number of students taking the high-school proficiency test, or number of regulations issued. Output indicators reflect the quantity of something produced or delivered, rather than its quality or effectiveness.
4. Outcome indicators: Measurement of the quality or results of programs and services, indicating progress towards achieving the mission and objectives. These indicators have both quantitative and qualitative aspects to show how well something was done.
5. Efficiency and cost-effectiveness indicators: Focus on how a goal is achieved, rather than what was achieved. Efficiency indicators measure the ratio of input, such as the cost and labor needed to provide a service to the level of service actually provided, and they calculate the cost per unit of output or outcome.
6. Productivity indicators: Measure the output or outcome achieved for a given input or resource used. It is the opposite of efficiency indicators, which measures the cost of providing a service. Productivity indicators combine efficiency and effectiveness to measure the amount of output or outcome achieved per unit of input or resource used.

[61] Callahan.

7. Service quality indicators: Assess how well services are provided and include factors such as wait time, accuracy, convenience, safety, accessibility, and courtesy. They can be measured through surveys or standards set for specific services.
8. Customer satisfaction indicators: Measures the satisfaction of customers and are often obtained through surveys. While these indicators are subjective, they provide a complementary perspective to capture the level of satisfaction and inspire managerial thinking.

It is understood that some performance indicators are more relevant to this research than others. For instance, input, output, outcome, and efficiency indicators can be applied to assess the effectiveness and efficiency of the agencies' regulatory processes for eVTOL aircraft. On the other hand, service quality and customer satisfaction indicators may be less relevant due to the nature of the regulatory institutions and their objectives. Therefore, this thesis will primarily focus on the performance indicators that are most applicable to the research question, namely input, output, outcome, and efficiency indicators, to evaluate the performance of EASA and the FAA in their governance of eVTOL aircraft for urban air mobility.

2.4.2.3 Citizen and industry participation

In the study of public sector, many scholars define citizen participation as "the role of the public in the process of administrative decision-making".[62] Citizen participation in government decision-making is a cornerstone of democracy, but it often generates controversy due to conflicting perspectives. On one hand, some argue that citizens must have an active role in the decision-making process to ensure that government acts in the best interest of the public. On the other hand, proponents of representative democracy support indirect participation, where citizens elect representatives to act on their behalf and trust professionals to implement public policy fairly and efficiently. How much can the government involve citizens in decision making is a critical question.[63] In the context of

[62] Cheryl Simrell King, Kathryn M. Feltey, and Bridget O'Neill Susel, "The Question of Participation: Toward Authentic Public Participation in Public Administration," *Public Administration Review* 58, no. 4 (1998): 317–26, https://doi.org/10.2307/977561.
[63] Callahan, *Elements of Effective Governance: Measurement, Accountability and Participation*.

EASA/FAA governance, citizen participation can impact regulatory processes and decisions through various channels as will be explained in the second paragraph.

Callahan identifies collaborative participation as the new form of governance in a deliberative democracy, which can be applied to EASA/FAA governance. Deliberative democracy in this case is as opposed to the traditional participation which is characterized by the rigid structure and authoritarian nature of public administration that limit the potential of meaningful citizen participation. In collaborative participation, the involvement of the general public presents a chance to impact both the course of action and end result. Callahan gives an example of collaborative participation in the US: every two years, around 3000 residents participate in large town meetings called Citizen Summits where they work together with the District's administration to determine the city's key priorities. These priorities shape the strategic plan and budget. This collective information is then used to develop a two-year management initiative known as Neighborhood Action, which integrates strategic planning, budgeting, performance measurement, and public scorecards to evaluate how well the city is meeting its objectives.[64] In regard to aviation, the FAA often holds public hearings or consultative sessions, where citizens, industry stakeholders, and other interested parties can provide input on proposed regulations or policies. Similarly, EASA conducts consultations and workshops with stakeholders, including the general public, to gather feedback and insights. These participatory processes can help ensure that the perspectives of the public and those directly affected by aviation regulations are considered in decision-making.

A popular measurement to identify citizen participation was created by Sherry Arnstein in 1969:

8. Citizen control
7. Delegated power
6. Partnership
5. Placation

[64] Callahan.

4. Consultation
3. Informing
2. Therapy
1. Manipulation

Figure 1: Arnstein's ladder of citizen participation.[65]

Arnstein categorizes number 1 and 2 as "non-participation", which real objective is not to involve citizens but rather to "educate" or "cure" participants. These participations are schemed for citizens into thinking they have real influence in the decision-making process, or to believe their behavior is the source of the problem. Number 3, 4 and 5 is categorized as a progress to "tokenism" that allow citizens to hear and have a voice. In these forms of participation, citizens are given a consultative role where they are informed of decisions that have already been made, and are asked to attend meetings and fill out surveys that are designed by public managers. At the highest rung of the ladder, citizens and public managers work together in a partnership where citizens are delegated decision-making authority, leading to complete citizen governance.[66]

Equally important for this thesis is private sector participation, which bears the same characteristic as citizen participation, but targets the involvement of private sector particularly those which line of business is directly affected by the regulations and the decision-making processes. Private sector participation can take various forms, including public-private partnerships, stakeholder engagement, and corporate social responsibility initiatives. Proneos GmbH, in collaboration with three institutions in Budapest, Bratislava, and Paris, conducted a study for the European Commission to understand the involvement of industry in public research policy decision making. It is examined that, while it is widely accepted that decision making is the responsibility of policy makers, the private sector, as the main beneficiary of commercially relevant research, has an interest in being involved in all phases of research policy decisions. This includes contributing to the identification of research priorities and policy needs, expressing perceptions and needs during the design

[65] Sherry R. Arnstein, "A Ladder of Citizen Participation," *Journal of the American Planning Association* 35, no. 4 (July 1969): 216–24.
[66] Callahan, *Elements of Effective Governance: Measurement, Accountability and Participation*.

phase, advising on policy measures, and providing feedback during the implementation phase. Private sector interaction is also important during assessment and review phases to ensure that its needs are considered in future research policy measures.[67]

One example noted by Proneos is research with high commercial relevance. There is a consensus that private sector participation adds value to public sector's research policy making. In this context, private sector can contribute considerably to the policy making process by providing knowledge, alternative ideas, and feedback. In turn, public sector research has become increasingly important for the private sector as a source of advanced technological knowledge and innovation. However, there is a trade-off between getting the private sector more involved and finding a fair balance between economically important research areas and those which are of less interest for the private sector. Therefore, finding the right measure and form of involvement is essential.[68]

Building upon the concepts that have been discussed on citizen and private sector participation, this thesis will further investigate how their involvement is integrated into the eVTOL rulemaking processes of both EASA and the FAA. By examining case studies and real-world examples, we will explore the mechanisms used by these agencies to engage the public and private sector in the development of eVTOL regulations.

[67] Michael Braun et al., "Private Sector Interaction in the Decision Making Processes of Public Research Policies" (Bad Camberg: Proneos GmbH, August 2006).
[68] Braun et al.

Chapter 3: Structured, focused comparison as the method for the three elements of governance

The utilization of structure, focused comparison as the key methodology of the thesis provides the most suitable approach to examine and compare the governance of EASA and FAA on eVTOL for UAM. Developed by Alexander L. George and Andrew Bennett as a means to overcome the limitations of traditional case study research, this type of comparison involes asking standardized, general questions to each case under study, focusing on specific aspects relevant to the research objective. This method allows for systematic comparison and cumulation of findings across cases, and operates on a straightforward principle: it begins by establishing general research questions that reflect the study's objectives, ensuring a *structured* approach. Standardized data collection procedures, involving the same set of questions for each case, enable systematic cross-case comparison and the accumulation of findings. The method maintains *focus* by solely addressing specific aspects of the examined cases as determined by theoretical considerations.[69]

The implementation process, which is applied in the subsequent subchapters, involves five phases: I) specification of the problem and the research objective; II) developing a research strategy; III) case selection; IV) describing the variance in variables; and V) formulation of data requirements[70].

As the *first phase* (specification of the problem and the research objective) has been established with a central research question, the *second phase* (research strategy) is carried out by defining the variables across each case. This phase emphasizes the importance of properly defining the problem and the dependent variable to avoid losing important differences among cases. In the context of this thesis, differentiation is made through establishing different guiding question for each element of governance—legal accountability, performance, and citizen and private sector participation—thereby generating different answers that contribute to the overall research objective. The *third phase* (case selection) is conducted through tables that display relevant elements for each question as well as the

[69] Alexander L. George and Andrew Bennett, "The Method of Structured, Focused Comparison," in *Case Studies and Theory Development in the Social Sciences* (Cambridge, Massachusetts: MIT Press, 2005).
[70] George and Bennett.

variance in variables based on ‘Yes’ or ‘No’ answer. The *fourth phase* (describing the variance in variables) is conducted in Chapter 4: Discussion and Analysis. The *fifth phase* (formulation of data requirements) is determined by the research objectives and integrated with the other tasks. Standardizing data requirements through general questions ensures comparability and systematic analysis across cases. This phase is reflected in the different sources used to analyze the elements of governance. The next subsection will explain the operationalization of structured, focused comparison for the analysis of the elements of governance, as well as the variance in variables.

The subchapters that follow are categorized in such a manner: *3.1* explains in tabular format the elements of eVTOL aircraft and infrastructure for UAM that are necessary as a basis for the analyses. The next subchapters of 3*.2, 3.3, and 3.4* are operationalizations of structured, focused comparison on legal accountability, performance, and citizen participation, respectively, while the private sector participation is analyzed in a descriptive manner in *Chapter 4: Discussion and Analysis*. The analyses in each subchapter is presented in a tabular format, tailored based on the specific question for each element of governance.

3.1 Elements of eVTOL aircraft and infrastructure for UAM

To pursue safe and sustainable urban air mobility (UAM) and analyze EASA and FAA’s governance, a clear understanding of the fundamental elements that constitute eVTOL aircraft and the supporting infrastructure is needed. It is important to note that this section does not aim to define an exhaustive set of ideal characteristics for eVTOL aircraft and infrastructure from a quantitative perspective, as these aspects are subject to ongoing advancements and are best determined by engineers, regulators, and manufacturers in the field. Instead, the focus is on identifying the key qualitative elements that contribute to the development of eVTOL operations specifically tailored for UAM.

The basic elements of eVTOL aircraft and infrastructure for UAM can establish a framework for evaluating the governance of EASA and FAA in facilitating the growth and development of the industry. Several studies have addressed these aspects, including a notable study on VTOL conducted by Uber in collaboration with NASA, MIT International Center for Air Transportation, Georgia Tech School of Aerospace Engineering, American Helicopter

Society, and other industry experts. While the study, conducted in 2016, predates the specific focus on eVTOL for UAM, it serves as a foundational resource that identifies "vehicle" and "infrastructure and operations" as two key aspects of VTOL aircraft[71]. The study highlights that the key elements of the aircraft include safety, noise, emissions, performance, and certification. These elements provide crucial considerations in ensuring the viability and sustainability of eVTOL operations. Additionally, the infrastructure elements encompass vertiports, maintenance hubs, charging stations, and operational frameworks, all of which play integral roles in supporting the seamless integration and reliable functioning of eVTOL aircraft within urban environments.

These elements will be explained further in the subsections below and guide our analysis in subsequent chapters as we assess the extent to which these regulatory bodies address the key aspects and contribute to the realization of eVTOL for UAM.

[71] "Fast-Forwarding to a Future of On-Demand Urban Air Transportation" (Uber Elevate, October 27, 2016).

3.1.1 Aircraft elements

Table 3: eVTOL aircraft elements

No	Elements	Sub-elements	Description
1	Safety	Airworthiness	This involves demonstrating that the eVTOL aircraft meets the necessary safety standards for design, construction, and performance
2		Structural integrity	Ensuring the aircraft's structural components are designed and manufactured to withstand operational loads and stresses, preventing failure or structural degradation.
3		Flight control systems	Reliable and redundant flight control systems to maintain stable and predictable aircraft behavior, allowing for precise control and maneuverability.[72]
4		Collision avoidance systems	Equipping the aircraft with advanced sensors with appropriate software algorithms to detect and avoid potential collisions with other aircraft, obstacles, or buildings.[73]
5		Emergency systems	Incorporating safety mechanisms, such as emergency landing systems[74], fire suppression, parachutes, to mitigate the consequences of critical failures during flight and protect occupants and bystanders.
6		Redundancy and fail-safe mechanisms	Designing the aircraft with redundant systems and fail-safe mechanisms to handle failures or malfunctions, ensuring the continued safe operation of the aircraft.
7	Noise	Design for noise reduction	Refers to the specific design features and technologies implemented in eVTOL aircraft to mitigate and reduce noise emissions during operation.[75]

[72] "Flight Controls | SKYbrary Aviation Safety," accessed May 25, 2023, https://www.skybrary.aero/articles/flight-controls.
[73] Matheus Pedroso Sanches, "Visual Flight Rules-Based Collision Avoidance System for VTOL UAV" (Porto, Universidade do Porto, 2020).
[74] Hanneke Weitering and 2022 December 29, "NASA Crash Tests EVTOL Concept Cabin to Study Passenger Safety," FutureFlight, accessed May 30, 2023, https://www.futureflight.aero/news-article/2022-12-22/nasa-crash-tests-evtol-concept-cabin-study-passenger-safety.
[75] "A Focus on Noise Reduction for EVTOL Success," *Vertical Mag* (blog), accessed May 25, 2023, https://verticalmag.com/features/focus-noise-reduction-evtol-success/.

8		Standards and limitations	The levels of noise emissions from eVTOL aircraft during their operation in urban environments. The noise standards and limits take into consideration the unique noise characteristics of eVTOL propulsion systems, rotor blades, and overall aircraft design.[76]
9		Mitigation measures	These are strategies and techniques implemented to mitigate and reduce the noise generated by eVTOL aircraft during their operation. Various mitigation measures can be employed, including acoustic treatments, active noise control, rotor noise reduction, and optimization of propulsion systems.
10	Emission	Power and energy source	The choice of power source plays a critical role in determining the emissions profile of an eVTOL aircraft. Electric battery-powered systems, for example, produce zero direct emissions during flight operations[77]. Other potential power sources, such as hydrogen fuel cells or hybrid-electric configurations, offer the potential for reduced emissions compared to conventional internal combustion engines.
11		Battery technology	The selection and optimization of battery technology for eVTOL aircraft play a crucial role in determining the energy storage capacity, weight, and efficiency. Advanced battery technologies that offer higher energy density and longer flight ranges contribute to reducing emissions by enabling longer electric flight operations[78].
12		Environmental compliance	Involves the assessment of environmental impact of the aircraft. This includes evaluating emissions levels, noise characteristics, and compliance with environmental regulations and standards.
13		Propulsion systems	The propulsion system of an eVTOL aircraft determines how the power generated by the power source is converted into thrust. Efficient and optimized propulsion systems can enhance energy conversion efficiency and reduce emissions.

[76] "A Focus on Noise Reduction for EVTOL Success."
[77] "Urban Air Transportation."
[78] Martin Talke, Nicolas Brieger, and Martin Talke, "Certification and Time-to-Market: The EVTOL Battery Balancing Act" (Aachen: Umlaut, July 2021).

14	Flight performance	Vertical take-off and landing capability	eVTOL aircraft should have the ability to take off and land vertically, allowing them to operate in urban areas without the need for traditional runways or extensive ground infrastructure.
15		Payload capacity	Refers to the maximum weight that an eVTOL aircraft can carry, including passengers, cargo, or other equipment. It is essential for eVTOLs to have sufficient payload capacity to support various UAM applications, such as transporting passengers or delivering goods.
16		Flight testing and demonstration	Rigorous flight testing programs to validate the eVTOL aircraft's performance.
17		Maneuverability and agility	eVTOL aircraft should possess good maneuverability and agility to navigate through urban environments with precision and safety. This includes the ability to perform controlled hovering, vertical and horizontal maneuvering, and obstacle avoidance.
18		Cruise speed and range	Refers to the sustained speed at which the eVTOL aircraft can fly during the main phase of its flight, while range refers to the maximum distance an eVTOL aircraft can travel on a single charge or with a full fuel load
19		Human-machine interface	Involves the design and functionality of the cockpit or control interface that allows pilots or operators to interact with the aircraft's systems.

3.1.2 Infrastructure and operations elements

Table 4: eVTOL infrastructure and operations elements

No	Elements	Sub-elements	Description
1	Vertiport	Vertiport Set-Up	The process of creating a dedicated infrastructure facility to facilitate the take-off and landing of the aircraft
2		Landing and Takeoff Infrastructure	Designated areas or landing pads where eVTOL aircraft can safely take off and land.
3		Passenger Facilities	This includes facilities such as waiting areas, ticketing and check-in counters, security checkpoints, and boarding gates.
4		Ground Operations Infrastructure	This includes facilities and equipment necessary for ground operations, such as maintenance areas, charging stations, and storage facilities for eVTOL aircraft
5		Integration with Urban Infrastructure	This refers to the vertiport's connection with the existing urban infrastructure, including road networks, public transportation, and connectivity to support transportation options for passengers
6	Maintenance and maintenance hub	Maintenance hub set-up	The process of creating a dedicated facility or center specifically designed to provide maintenance, repair, and servicing support for eVTOL aircraft[79]
7		Maintenance personnel	Trained and qualified personnel, including certified aircraft technicians and engineers, who have the expertise to carry out maintenance and repairs on eVTOL aircraft.
8		Maintenance equipment and tools	A range of tools, equipment, and diagnostic systems necessary for performing maintenance, repairs, and inspections on eVTOL aircraft.
9		Maintenance procedures	Established maintenance procedures and protocols specific to eVTOL aircraft.
10	Charging station	Charging station set-up	The process of creating a network of dedicated facilities or locations where eVTOL aircraft can recharge their electric power systems.[80]
11		Charging infrastructure	Power converters, chargers, and electrical distribution systems capable of providing the necessary voltage and current for efficient and safe charging.

[79] Stephan Baur et al., "Urban Air Mobility: The Rise of a New Mode of Transportation" (Munich: Roland Berger Gmbh, November 2018).
[80] Baur et al.

12	Operations	Air traffic management	Refers to the system and processes in place to safely and efficiently manage air traffic, ensuring the separation and flow of both manned and unmanned aircraft. ATM is crucial for the integration of electric vertical takeoff and landing (eVTOL) aircraft into the urban air mobility (UAM) ecosystem. As eVTOLs aim to operate autonomously, the challenge lies in integrating them into the existing ATM network, which traditionally relies on verbal instructions given to pilots[81].
13		Operational procedures and manuals	The development of comprehensive operational procedures, manuals, and training programs. These cover areas such as maintenance protocols, operational limitations, emergency procedures, pilot training, and operational safety management.
14		Trip reliability	The consistency and dependability of the entire transportation journey, from the moment a user requests a vehicle to the drop-off[82]
15		Weather conditions	Weather considerations for eVTOL aircraft in urban air mobility (UAM) are significant due to their potential impact on aircraft operations. Thunderstorms, low visibility, icing, and gusty winds pose challenges and affect the safety and reliability of eVTOL flights. Weather conditions can disrupt takeoff, landing, and vehicle control, requiring additional technologies and strategies for safe operations.[83]
16		Security considerations	It is essential to incorporate security measures into the systems of eVTOLs right from the beginning to proactively mitigate potential cybersecurity risks.[84]

[81] Nick Klenske and Download Print Version, “Air Traffic Management,” FutureFlight, accessed May 30, 2023, https://www.futureflight.aero/report/2019-11-14/air-traffic-management.
[82] “Urban Air Transportation.”
[83] “Urban Air Transportation.”
[84] “Delivering Reliability, Safety, and Security to Electric Vertical Takeoff and Landing Vehicles: Meeting the Challenges of the Next Generation of Advanced Air Mobility” (Wind River Systems, Inc., July 2020).

3.2 Operationalization of structured, focused comparison for legal accountability

The main question for this element is: "*Does the regulation authorizing the EASA and the FAA to conduct general aviation activities put by the European Union and the US Congress, respectively, allow the regulatory bodies to regulate, set, and/or handle the defined aspects of eVTOL?*" By using the defined elements in 3.1.1 and 3.1.2, the assessment will be able to determine whether in fact both institutions have the sufficient competences and powers to facilitate the growth of eVTOL for UAM. The criteria for document selection, therefore, is that the regulations must be issued by authorities above the EASA and the FAA, and that the regulations are intended to provide the agencies with competences and power to conduct aviation activities. In regard to the question, the regulations that will be looked at and analyzed are:

1. EASA:
    a) Regulation (EU) 2018/1139 of the European Parliament and the European Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency
    b) Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems
    c) Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures of the operation of unmanned aircraft
2. FAA:
    d) FAA Reauthorization Act of 2018, signed into law on 5 October 2018

The number of regulations differs between the EU and the FAA, as in the case of the EU, there is one legislative act (EU 2018/1139), along with two non-legislative acts which are EU 2019/945 and EU 2019/947. On the other hand, the FAA is governed by the FAA Reauthorization Act of 2018, which is a comprehensive legislative act. That being said, the difference in the number of regulations does not necessarily indicate a disparity in regulatory effectiveness. It rather reflects the distinct legislative approaches and regulatory structures employed by the EU and the US in governing aviation activities: In the EU, the regulatory framework for civil aviation is established through a combination of European Parliament, Council of the EU, and European Commission regulations. This approach necessitates multiple regulations to cover various aspects of civil aviation. According to Enhesa, a global consulting firm specializing in regulatory compliance, the US regulatory system differs from the EU's. In the US, regulations are predominantly based on overarching legislation that grants the FAA the authority to develop detailed regulations through its rulemaking process. This system involves the adoption of laws, which further elaborate on implementation, bridge any existing gaps, and interpret the provisions of the laws[85]. Conversely, EU regulations are comprehensive legislative acts that may be supplemented and detailed through Commission delegated and implementing acts, as well as further implemented by national administrative rules[86]. These distinctions highlight the differing approaches taken by the EU and the US in their regulatory frameworks for civil aviation.

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[85] Beatriz Garcia Fernandez-Viagas, "What Is the Difference between a US Regulation and a EU Directive or Regulation," *Enhesa* (blog), accessed June 30, 2023, https://www.enhesa.com/resources/fundamentals/what-is-the-difference-between-a-us-regulation-and-a-eu-directive-or-regulation/.

[86] Fernandez-Viagas.

Table 5: Operationalization of structured, focused comparison for legal acccountability

No.	Topic	Regulation coverage	For EASA	For FAA	Which regulation? *only EASA as FAA only has one regulation*
1.	Safety	Airworthiness	*Yes*	*Yes*	EASA: a, b, c
2.		Structural integrity	No	No	
3.		Flight control systems	No	No	
4.		Collision avoidance systems	*Yes*	*Yes*	EASA: a, c
5.		Emergency systems	*Yes*	*Yes*	EASA: a
6.		Redundancy and fail-safe mechanisms	*Yes*	*Yes*	EASA: a
7.	Noise	Design for noise reduction	*Yes*	*Yes*	EASA: a, b, c
8.		Standards and limitations for noise	*Yes*	*Yes*	EASA: a, b, c
9.		Mitigation measures for noise	*Yes*	*Yes*	EASA: a, b, c
10.	Emission	Power and energy source	*Yes*	*Yes*	EASA: a
11.		Battery technology	No	*Yes*	
12.		Environmental compliance	*Yes*	*Yes*	EASA: a, b, c
13.		Propulsion systems	*Yes*	No	EASA: a

14.	Flight performance	Vertical take-off and landing capability	No	No	
15.		Payload capacity	*Yes*	No	EASA: b, c
16.		Flight testing and demonstration	No	*Yes*	
17.		Maneuverability and agility	No	No	
18.		Cruise speed and range	*Yes*	No	EASA: a, b
19.		Human-machine interface	*Yes*	*Yes*	EASA: a, b, c
20.	Vertiport	Vertiport set-up	No	No	
21.		Landing and takeoff infrastructure	No	No	
22.		Passenger facilities	No	No	
23.		Ground operations infrastructure	No	No	
24.		Integration with urban infrastructure	No	No	
25.	Maintenance and maintenance hub	Maintenance hub set-up	No	No	
26.		Maintenance personnel	*Yes*	*Yes*	EASA: a
27.		Maintenance equipment and tools	No	*Yes*	

28.		Maintenance procedures	*Yes*	*Yes*	EASA: a, b, c
29.	Charging station	Charging station set-up	No	No	
30.		Charging infrastructure	No	No	
31.	Operations	Air traffic management	*Yes*	*Yes*	EASA: a, c
32.		Operational procedures and manuals	*Yes*	*Yes*	EASA: a, b, c
33.		Trip reliability	No	No	
34.		Weather conditions	*Yes*	*Yes*	EASA: a
35.		Security considerations	*Yes*	*Yes*	EASA: a, c
	Final score		22	21	

Note:

A = EU 2018/1139, B = EU 2019/945, C = EU 2019/947

3.3 Operationalization of structured, focused comparison for performance

In this section, the focus is on assessing the performance of the EASA and the FAA as regulatory bodies responsible for the regulation of eVTOL for UAM. The central question driving this analysis is: *"To what extent do the set of regulations by EASA and FAA reflect the requirements of eVTOL aircraft, infrastructure, and operations?"* In answering the question, I will align between the regulations and the practical requirements of eVTOL as in 3.1.1 and 3.1.2, thus analyzing how the regulatory bodies facilitate the growth and development of eVTOL aircraft for UAM.

In contrast to the legal accountability aspect, which encompasses a broader scope including general aviation regulations, the performance aspect in this analysis will narrow its focus exclusively on regulations specifically related to eVTOL and UAM. To explore this performance aspect, the analysis will delve into the key regulations and guidelines put forth by EASA and FAA exclusively for the industry. It is important to note that as of June 2023, the EASA has not issued guiding regulatory documents on eVTOL regulation[87], while the FAA has not yet finalized its approach to regulatory pathway[88]. In absence of these regulations, both have issued a number of documents as a basic guidance for industry specifically for eVTOL and UAM. In this case, both institutions adopt an approach of "experimentalist governance," a regulatory approach that emphasizes flexibility, adaptability, and iterative learning in response to emerging challenges and uncertainties[89]. The qualities of these final documents, which were issued between 2019 and 2022, will be analyzed whether or not they have covered the aspects as in 3.1.1 and 3.1.2:

1. EASA:
   a. Special Condition VTOL Aircraft (SC-VTOL-01), published on 2 July 2019
   b. Means of Compliance with the Special Condition VTOL (MOC SC-VTOL), published on 12 May 2021

[87] "Vertical Take-Off & Landing - VTOL," EASA, July 8, 2021, https://www.easa.europa.eu/en/domains/rotorcraft-vtol/VTOL.
[88] "Commentary: FAA Changes Course on EVTOL Certification," accessed June 11, 2023, https://evtol.news/news/commentary-faa-changes-course-on-evtol-certification.
[89] Sandra Eckert and Tanja A. Börzel, "Experimentalist Governance: An Introduction," *Regulation & Governance*, September 2012, https://doi.org/10.1111/j.1748-5991.2012.01163.x.

c. Second Publication of Means of Compliance with the Special Condition VTOL (MOC-2 SC-VTOL), published on 22 December 2022
d. Third Publication of Proposed Means of Compliance with the Special Condition VTOL (MOC-3 SC-VTOL), published on 29 June 2022
e. Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category (PTS-VPT-DSN), published in March 2022
2. FAA:
f. Engineering Brief #105 Vertiport Design (2), published on 21 September 2022
g. Special Class Airworthiness Criteria for the Joby Aero, Inc. Model JAS4-1 Powered-Lift (SC-Joby), published on 8 November 2022
h. Special Class Airworthiness Criteria for the Archer Aviation Inc. Model M001 Powered-Lift (SC-Archer), published on 20 December 2022

On EASA side, the SC-VTOL-01 sets specific conditions for VTOL aircraft and carries legal importance as it is the certification basis for VTOL aircrafts as mentioned in the document's statement of issue. All three MOCs of SC-VTOL provide non-binding guidance to "illustrate means to establish compliance with the Basic Regulation and its Implementing Rules"[90]. The PTS-VPT-DSN, as a guidance, provides non-binding technical specifications for vertiport design. On the other hand, FAA's EB #105 is a guidance for vertiport design, thus it is "not legally binding in its own right and will not be relied upon by the FAA as a separate basis for affirmative enforcement action or other administrative penalty", as stated on the document's introduction section. The other documents, SC-Joby and SC-Archer, establish legally binding requirements for certifying specific aircraft models.

Given the highly progressive nature of the eVTOL sector, it is important to confine the study to a specific timeframe. The period from 2019 to 2022 captures a significant span of time during which key regulations and guidelines for the sector were developed and implemented. As can be seen above, EASA has taken a more comprehensive and sequential approach,

[90] "Acceptable Means of Compliance (AMC) and Alternative Means of Compliance (AltMoC)," EASA, accessed June 30, 2023, https://www.easa.europa.eu/en/document-library/acceptable-means-compliance-amcs-and-alternative-means-compliance-altmocs.

issuing a series of documents specifically dedicated to VTOL aircraft, in addition to the technical specifications of vertiports. On the other hand, the FAA has adopted a more modular approach, creating separate documents addressing different aspects such as vertiport design and airworthiness criteria for specific aircraft models.

Table 6: Operationalization of structured, focused comparison for performance

No.	Topic	Subtopic	EASA Regulation	FAA Regulation	Description
1.	Safety	Airworthiness	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
2.		Structural integrity	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
3.		Flight control systems	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
4.		Collision avoidance systems	No	No	Not applicable
5.		Emergency systems	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
6.		Redundancy and fail-safe mechanisms	*Yes*	*Yes*	EASA: b FAA: g, h
7.	Noise	Design for noise reduction	No	No	Not applicable
8.		Standards and limitations for noise	No	No	Not applicable
9.		Mitigation measures for noise	No	No	Not applicable
10.	Emission	Power and energy source	*Yes*	*Yes*	EASA: a, b, c, d FAA: f, g, h

11.		Battery technology	*Yes*	*Yes*	EASA: b, c, d FAA: f
12.		Environmental compliance	No	No	Not applicable
13.		Propulsion systems	*Yes*	*Yes*	EASA: b, c, d FAA: g, h
14.	Flight performance	Vertical take-off and landing capability	*Yes*	*Yes*	EASA: b, c FAA: g, h
15.		Payload capacity	No	No	Not applicable
16.		Flight testing and demonstration	*Yes*	*Yes*	EASA: b, c FAA: g, h
17.		Maneuverability and agility	*Yes*	*Yes*	EASA: b. c FAA: g, h
18.		Cruise speed and range	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
19.		Human-machine interface	*Yes*	*Yes*	EASA: a FAA: g, h
20.	Vertiport	Vertiport set-up	*Yes*	*Yes*	EASA: e FAA: f
21.		Landing and takeoff infrastructure	*Yes*	*Yes*	EASA: e FAA: f
22.		Passenger facilities	No	No	Not applicable
23.		Ground operations infrastructure	*Yes*	*Yes*	EASA: e FAA: f

24.		Integration with urban infrastructure	*Yes*	No	EASA: e
25.	Maintenance and maintenance hub	Maintenance hub set-up	No	No	Not applicable
26.		Maintenance personnel	No	No	Not applicable
27.		Maintenance equipment and tools	*Yes*	No	EASA: c
28.		Maintenance procedures	*Yes*	*Yes*	EASA: a, b, c FAA: g, h
29.	Charging station	Charging station set-up	*Yes*	*Yes*	EASA: e FAA: f
30.		Charging infrastructure	*Yes*	*Yes*	EASA: e FAA: f
31.	Operations	Air traffic management	No	No	Not applicable
32.		Operational procedures and manuals	*Yes*	*Yes*	EASA: a, b, c, e FAA: g, h
33.		Trip reliability	No	No	Not applicable
34.		Weather conditions	*Yes*	No	EASA: b, c
35.		Security considerations	*Yes*	No	EASA: b
	Final score		24	20	

3.4 Operationalization of structured, focused comparison for citizen outreach and industry involvement

This subchapter aims to examine the extent of citizen outreach and industry involvement in the realm of eVTOL aircraft. Specifically, it assesses how the EASA and the FAA familiarize citizens with eVTOL concepts and the level of industry participation in the rulemaking process. Citizen in this context refers to the individuals and non-business communities who are directly impacted by the operation of eVTOL aircraft and vertiports, while industry encompasses business entities with direct relevance to eVTOL aircraft, infrastructure, and operations. This subchapter aims to address two key questions:

1. Citizen outreach: How does the EASA and the FAA cover important aspects of eVTOL and UAM to familiarize citizens on its online touchpoints*?*
2. Industry involvement: How does the regulatory bodies engage industry in the rulemaking process of eVTOL and UAM?

In choosing the specific types of participation for citizens and the industry, consideration is made on the nature of the eVTOL and aviation industry. Given the highly technical and complex nature of this sector, the primary focus for citizen outreach is on information sharing. This approach recognizes that citizens may not possess the technical expertise to actively participate in rulemaking processes, but they should still have access to relevant and understandable information about eVTOL and its implications for urban air mobility. On the other hand, the industry's expertise and insights can contribute to the development of effective regulations that address the specific needs and challenges of the sector. Therefore, the focus for the industry is on rulemaking involvement, recognizing their ability to provide valuable input and shape the regulatory framework.

To answer the first question, an analysis is conducted on EASA and FAA's online touch points for engaging and familiarizing the general public and citizens with eVTOL. The analysis focuses on information available on their websites and draws on references from sections 3.1.1 and 3.1.2. To ensure a comprehensive evaluation of citizen involvement, the analysis utilizes refined criteria that better reflect the nature of citizen engagement. The key question regarding the coverage of various aspects is addressed through a table, which will be presented on the following page. The main criterion for determining a "Yes" or "No" answer is based on the presence of non-regulatory, descriptive information provided on the respective online touchpoints, namely official websites and non-regulatory, publicly accessible documents on eVTOL and UAM published by the institutions, all of which enable citizens to gain a deeper understanding of the specific aspect. The choice of non-regulatory documents for the analysis is justified by the need to capture a broader range of information beyond formal regulations: while regulatory documents establish legal frameworks and requirements, they may not always provide comprehensive information accessible to the general public. Non-regulatory documents, such as informative web pages, fact sheets, and publicly accessible reports, play a vital role in engaging citizens by presenting eVTOL and UAM-related concepts, benefits, and technological advancements in a more user-friendly and informative manner. These documents help bridge the gap between technical regulations and public understanding.

To answer the second question, the analysis is scoped exclusively on the final documents by EASA and the FAA that are used as a basic guidance for industry specifically for eVTOL and UAM, which were also used in the operationalization of structured, focused comparison for performance. The analysis is made against Arnstein's ladder of citizen participation, which offers a systematic way to assess the degree and nature of industry involvement in the rulemaking process. Unlike other structured, focused comparison analyses that utilize tabular formats, this particular analysis will take a descriptive approach that allows for a comprehensive examination of the regulatory landscape and the specific ways in which the industry has been engaged in the rulemaking process. The second question will be discussed in Chapter 4: Discussion and Analysis.

Table 7: Operationalization of structured, focused comparison for citizen outreach

No.	Topic	Are these aspects covered?	EASA	FAA
1.	General	eVTOL aircraft basic concept and purpose	*Yes*[91]	*Yes*[92]
2.		UAM basic concept and purpose	*Yes*[93]	*Yes*[94]
3.		Benefits of eVTOL for UAM	*Yes*[95]	*Yes*[96]
4.	Safety	Passenger safety during flight	*Yes*[97]	*Yes*[98]
5.		Technology for safety	*Yes*[99]	No
6.		Emergency systems	*Yes*[100]	No
7.	Emission	eVTOL aircraft environmental impact	*Yes*[101]	No
8.		Emissions	*Yes*[102]	No
9.		eVTOL aircraft battery and/or hydrogen fuels technology	*Yes*[103]	No
10.	Noise	Noise levels produced by eVTOL aircraft	*Yes*[104]	No
11.		Community impact management for noise of VTOL operations	No	No

[91] "Vertical Take-off and Landing (VTOL)," EASA, accessed June 15, 2023, https://www.easa.europa.eu/en/light/topics/vertical-take-and-landing-vtol.
[92] "Advanced Air Mobility | Air Taxis | Federal Aviation Administration," accessed June 16, 2023, https://www.faa.gov/air-taxis.
[93] "Urban Air Mobility (UAM)," EASA, May 19, 2021, https://www.easa.europa.eu/en/domains/urban-air-mobility-uam.
[94] "Urban Air Mobility (UAM) Concept of Operations v2.0" (Washington, D.C.: Federal Aviation Administration, April 26, 2023).
[95] "Study on the Societal Acceptance of Urban Air Mobility in Europe," May 2021.
[96] "Urban Air Mobility (UAM) Concept of Operations v2.0" (Washington, D.C.: Federal Aviation Administration, April 26, 2023).
[97] "VTOL Designs for Urban Air Mobility," EASA, accessed June 15, 2023, https://www.easa.europa.eu/en/light/topics/vtol-designs-urban-air-mobility.
[98] "Concept of Operations v2.0."
[99] "VTOL Designs for Urban Air Mobility."
[100] "VTOL Designs for Urban Air Mobility."
[101] "Study on the Societal Acceptance of Urban Air Mobility in Europe" (Cologne: European Union Aviation Safety Agency, May 19, 2021).
[102] "Study on the Societal Acceptance of Urban Air Mobility in Europe."
[103] "VTOL Designs for Urban Air Mobility."
[104] "Study on the Societal Acceptance of Urban Air Mobility in Europe," May 2021.

12.	Vertiport	Vertiport basic concept and purpose	*Yes*[105]	*Yes*[106]
13.		Accessibility of vertiports	No	No
14.		Integration with urban areas	*Yes*[107]	*Yes*[108]
15.	Operations	Passenger journey	*Yes*[109]	No
16.		Integration with existing air traffic management	*Yes*[110]	*Yes*[111]
17.	Flight performance	VTOL capabilities	*Yes*[112]	*Yes*[113]
18.		Aircraft capacity	*Yes*[114]	No
19.		Maneuverability and agility	No	No
20.		Speed and range	*Yes*[115]	No
	Final score		**17**	**8**

[105] "Vertiports in the Urban Environment," EASA, March 24, 2022, https://www.easa.europa.eu/en/light/topics/vertiports-urban-environment.
[106] "Concept of Operations v2.0."
[107] "Vertiports in the Urban Environment."
[108] "Concept of Operations v2.0."
[109] "VTOL Designs for Urban Air Mobility."
[110] "Study on the Societal Acceptance of Urban Air Mobility in Europe," May 19, 2021.
[111] "Concept of Operations v2.0."
[112] "Vertical Take-off and Landing (VTOL)."
[113] "UAM Concept of Operations v1.0" (Washington, D.C.: Federal Aviation Administration, June 26, 2020).
[114] "VTOL Designs for Urban Air Mobility."
[115] "Study on the Societal Acceptance of Urban Air Mobility in Europe," May 2021.

Chapter 4: Discussion and Analysis

This chapter discusses and analyzes the comparisons that are shown in the previous chapter, aiming to evaluate the legal accountability, performance, as well as citizen and private sector involvement of both EASA and FAA on UAM. The objective of this analysis is to identify strengths, areas of improvement, and potential opportunities for both institutions in navigating the evolving landscape of these innovative aviation technologies. The structure of this chapter is organized systematically, reflecting the elements of governance pertinent to eVTOL and UAM. Each element forms a subchapter, and within these subchapters, we further examine the identified aspects through the lens of similarities, differences, and a comprehensive summary of the comparison.

4.1 Legal accountability: Similar score for EASA and FAA

The final score for structured, focused comparison for legal accountability between the two institutions are nearly the same, with EASA scoring 22 and FAA 21 out of 35 aspects. In terms of percentage, this is translated into 62.86% aspects covered for EASA and 60% for FAA.

This creates the impression that in general, both regulatory bodies have the similar degree of authorization to regulate, set and/or handle the defined aspects of eVTOL by the European Commission and the US Congress, respectively. Both are fully similar in all aspects within the topics of safety, noise, vertiport, charging station, and operations; which counts as five out of the eight topics presented as the bases of analysis. However, there are many aspects in which the regulations and the act differ. The analysis below will first examine the similarities and afterwards the differences.

4.1.1 Similarities of legal accountability

Based on the aspects, the EU regulations and the FAA act are similar in 28 out of 35. In terms of safety, the EU regulations and the FAA act all cover *airworthiness*, *flight control systems, collision avoidance systems, emergency systems*, as well as *redundancy and fail-safe mechanisms*. However, *structural integrity* and *flight control systems* are not covered in the documents. The regulations also cover all of the noise aspects which are *design for noise* *reduction*, *standards and limitations for noise, and mitigation measures for noise*, while in the operations topic, all aspects are covered except *trip reliability*.

What is interesting, however, is that the regulations do not at all cover vertiport and charging station topics, as all aspects are marked 'No'. It is because all of the regulations were issued between 2018 and 2019, while the development of vertiports and charging stations is still relatively new and evolving. This is evident from the vertiport-specific documents from the EASA and FAA that was only issued three to four years later in 2022; EASA's PTS-VPT-DSN in March 2022 and FAA's EB #105 in September 2022. This indicates that there are ongoing discussions and considerations regarding the appropriate regulatory framework for vertiport; this is further reflected in the fact that PTS-VPT-DSN and EB #105 are not legally binding, instead serving as a general guidance for the industry in respective jurisdictions.

In addition, the absence of vertiport and charging station topics is because they are closely associated: vertiport as a dedicated infrastructure facility to facilitate the take-off and landing of the aircraft also serve as a location where eVTOL aircraft can recharge their electric power systems. This is evident in EASA and FAA vertiport documents which outline the two topics. The PTS-VPT-DSN mentions that charging facility means a "charging station that supplies alternating current (AC) and/or direct current (DC) to an electric aircraft for recharging its batteries, including, if needed, the connection between charging station and electric aircraft (refer to the International Electrotechnical Commission (IEC)", also stating in the document that "when designing VTOL-capable aircraft stands, the location and dimensions of the charging facility should be taken into consideration".[116] The EB #105, on the other hand, has a specific chapter for charging infrastructure, in which it is stated that "charging infrastructure design for vertiports should consider adapting to multiple aircraft specific systems. Additional guidance is currently being developed as the AAM industry continues to evolve."[117] Another aspect in which they differ is on *maintenance hub set-up* — I argue that

[116] "Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category" (Cologne: EASA, March 2022).
[117] "Engineering Brief #105, Vertiport Design" (FAA, September 21, 2022).

this aspect is also closely associated with vertiport and charging station. The PTS-VPT-DSN and the EB #105 indeed cover maintenance hub, attaching maintenance activities to vertiport.

4.1.2 Differences of legal accountability

The differences between the EU regulations and the FAA act on authorizing EASA and FAA, respectively, may reveal contrasting approaches between the two institutions on regulating eVTOL. Overall, there are three topics in which the regulations differ: emission, flight performance, and maintenance hub.

The EU regulations do not at all cover one of emission's aspects, battery technology, while the FAA covers the aspect under the term *removable power source*: "a power source that is separately installed in, and removable from, a zero-emission vehicle and may include a battery, a fuel cell, an ultra-capacitor, or other power source used in a zero-emission vehicle." The act also instructs the Department of Transportation, which FAA is a part of, to conform with the technical requirements developed by the International Civil Aviation Organization on lithium cells and battery requirements for air transportation. Another difference within the emission topic is on propulsion systems which is covered by EU regulations this time. While in the FAA act there is no provision on propulsion systems, the EU 2018/1139 extensively covers the aspect, ranging from the integrity of the propulsion systems, production process and materials, and its link to continued airworthiness, for example.

The second difference is within the maintenance hub topic: unlike the FAA act, the EU regulations do not cover maintenance equipment and tools. However, the FAA act only comprehensively outlines the aspect related to security technology, as evident in the act's 'Sec. 1918: Maintenance of security-related technology'. This means that despite its coverage in the FAA act, maintenance equipment and tools is not the focus of the EU regulations and the FAA act.

Furthermore, the flight performance topic reveals the most significant disparities, indicating contrasting approaches to flight performance between the EU and the US. Both EU regulations and FAA act do not include *VTOL capability*, suggesting that the prevailing industry landscape and technological advancements of VTOL were not the focal point for the regulations' purpose to facilitate general aviation activities between 2018 and 2019. At the same time, both the EU regulations and FAA act incorporate *human-machine interface* which indeed has been a vital instrument in any traditional aircraft. The two institutions firstly differ in *flight testing and demonstration*: the FAA act extensively covers the aspect in 'Sec. 343: Unmanned aircraft test ranges', which—despite its title—addresses both civil and unmanned aircrafts. For example, the section includes provisions about designation of airspace for flight test and coordination of relevant aspect with the Next Generation Air Transportation System. On the other hand, the EU regulations do not address the specific requirements and procedures related to flight testing and demonstration activities. This suggests that the regulatory approach relies more on EASA's know-how on additional guidance, industry standards, or best practices to address these aspects. This is evident in the fact that *flight testing and demonstration* is covered in EASA's MOC SC-VTOL and MOC-2 SC-VTOL, two documents serving as the bases of analysis for the second element of governance, performance.

Another difference within flight performance is on *payload capacity* and *cruise speed and range*. The FAA act does not address these two aspects, while they are extensively covered in the all three EU regulations. The EU 2019/945, for example, includes maximum take-off mass (MTOM) as one of the requirements for various types of aircraft. The EU regulations defined MTOM as "the maximum aircraft mass, including payload and fuel, as defined by the manufacturer or the builder, at which the aircrarft can be operated". Similarly, aircraft speed for various types of aircraft is also covered within the EU regulations, while it is nowhere to be found within the FAA act.

4.1.3 Summary of comparison

In terms of legal accountability, the analysis has shown that the EU regulations and the FAA act score nearly similar, 22 against 21. This suggests that both regulatory bodies have a similar degree or extent of authorization to regulate and oversee the defined aspects of eVTOL by their respective governing bodies, the European Commission and the US Congress. Upon further inspection, however, it becomes evident that there are significant differences between the EU regulations and the FAA act in various topics and aspects. While the overall scores may indicate similar legal accountability, the specific areas where they differ highlight divergent approaches to regulating eVTOL aircraft. Indeed, both institutions cover similar topics in safety, noise, and operations, while omitting the topics of vertiport and charging station, which are still relatively new and evolving in the industry.

Notable differences emerge in three areas: emission, flight performance, and maintenance hub. Specifically, the EU regulations and the FAA act differ in the aspects of *battery technology, propulsion systems, maintenance equipment and tools, payload capacity, flight testing and demonstration, cruise speed and range.* As the final scores are nearly similar, these differences do not imply that one is inherently superior to the other. Instead, they reflect the distinct perspectives and priorities of each regulatory body. The key takeaways of the differences between the two institutions can be seen as follows:

1. The EU regulations adopt a broader environmental focus, while the FAA act places a stronger emphasis on zero-emission vehicles
2. The FAA act takes a comprehensive approach on flight testing and demonstration procedures, while the EU regulation relies more on EASA's additional guidance and industry standards for these aspects
3. The EU regulations prioritize defining and regulating the technical parameters related to payload capacity and aircraft performance, while the FAA act may take a more flexible approach, allowing manufacturers and operators to determine these specifications based on their specific aircraft designs and operational needs
4. The FAA act is particularly concerned on security technology, while the EU regulations do not specifically cover this aspect, indicating a reliance on other mechanisms to address the aspect.

4.2 Performance: EASA outweighs FAA

Before delving into the detailed comparison of the regulations and documents issued by EASA and FAA, it is crucial to consider the scope of these documents. A key distinction between the two regulatory bodies is that the FAA's publications primarily focus on specific aircraft models—evident in SC-Joby and SC-Archer regulations, which are intended for specific aircraft models manufactured by Joby Inc. and Archer Aviation—whereas EASA's documents encompass a broader scope that applies to the entire industry.

This distinction suggests that EASA's regulatory framework encompasses a more comprehensive approach to the regulation of eVTOL aircraft, infrastructure, and operations. By considering the industry as a whole, EASA can address a wider range of aspects and stakeholders, ensuring a robust and cohesive regulatory environment. In contrast, the FAA's narrower focus on specific aircraft models may provide more specific guidance but potentially limits the extent of its regulatory oversight. It is important to highlight here that while the FAA documents in eVTOL sector focus on specific aircraft models, it does not necessarily mean that the institution always adopts a narrow and specific approach across all regulatory areas. In many cases, the FAA establishes regulations and guidance that are applicable to the entire industry with a defined degree of flexibility. One of many examples to this is the Title 14 CFR Part 23 that sets the airworthiness standards for small and medium-sized aircraft used for various purposes. However, in the context of eVTOL and UAM, the FAA consider them new concept and technology[118] which unique nature creates new concerns related to performance and safety, and in response to these the FAA decided to adopt a more focused and specific approach to address the distinct characteristics in each eVTOL aircraft.

In absence of industry-wide documents, the SC-Joby and SC-Archer are considered to hold significant importance for the American industry. They are seen as crucial blueprints for future aircraft certifications and serve as guiding frameworks for manufacturers and operators in the United States[119]. Interestingly, both model-specific regulations carry identical criteria, indicating a consistent approach by the FAA in defining the airworthiness requirements for the whole eVTOL industry in the United States.

In terms of the comparison, the final result has shown that EASA scores higher (24) than FAA (20) out of 35 subtopics, or 68.57% against 57.14%. This result—along with the difference in regulatory approach between EASA and FAA as discussed above—generally indicates that EASA performs better as regulatory bodies, as the regulations encompass a

[118] "Advanced Air Mobility | Air Taxis | Federal Aviation Administration."

[119] "Joby's Airworthiness Criteria: A Blueprint for the Nascent EVTOL Industry," *Vertical Mag* (blog), accessed July 5, 2023, https://verticalmag.com/opinions/jobys-airworthiness-criteria-a-blueprint-for-the-nascent-evtol-industry/.

broader range of topics and subtopics in contrast to FAA's. Further analysis on the similarities and differences are made in the sections that follow.

4.2.1 Similarities of performance

The comparison of EASA and FAA documents reveals that both institutions have extensively covered various topics related to eVTOL aircraft, with their approaches and responses aligning in the areas of safety, noise, emission, flight performance, and charging station. In these areas, both EASA and FAA documents have provisions (displayed by combinations of two 'Yes') for almost every subtopic, indicating a consistent and comprehensive regulatory framework. However, there are certain subtopics where the documents of both regulatory bodies do not provide specific provisions. Notably, noise, emission's *environmental compliance*, flight performance's *payload capacity*, vertiport's *passenger facilities*, maintenance and maintenance hub's *set-up and personnel*, as well as operations' *air traffic management* are not addressed within the documents of either EASA or FAA. Drawing the lines between these and the ones in legal accountability, it is evident that both institutions mostly focus on *safety* as their approaches in this topic are fully aligned, indicated by 100 percent similar answers: results show that in the *safety* topic, there are nine combinations of 'Yes' and only three 'No' across legal accountability and performance. Apart from *safety,* the institutions are also fully aligned in *noise* and *charging station*, indicated by 100 percent similar answers across legal accountability and performance. In contrast to *safety*, it appears that the two topics are not the primary focus of the regulatory frameworks, as indicated by a lower proportion of combinations of 'Yes' for these aspects. Specifically, in the area of *noise*, there are three combinations of 'Yes' and three combinations of 'No.' For the *charging station*, there are two combinations of 'Yes' and two combinations of 'No.'

Moving back to analysis of performance, It is arguable that the decision to not include noise aspects, which are *design for noise reduction, standards and limitations for noise, and mitigation measures*, as well as emission's *environmental compliance*, is due to the inherent nature of eVTOL aircraft, which often utilize electric propulsion systems. These systems have the potential to generate little to no emission and be quieter and than traditional combustion engines, as they do not generate the same level of noise and emission[120] as traditional aircraft. Therefore, the need for specific design standards and mitigation measures for noise and environmental compliance may be relatively less pronounced in the context of eVTOL aircraft. However, the eVTOL industry in the US has demanded that the noise requirements for eVTOL aircraft be more stringent, arguing that more regulations on noise will allow the public to accept the nascent concept of eVTOL[121]. On the other hand, EASA on 4 May 2023 issued a consultation paper for regulatory amendment addressing eVTOL noise and emission[122], acknowledging the institution's lack of regulatory framework on noise in the previous documents. The document is not part of the analysis as it is not yet officially agreed as of 5 July 2023, pending comments and feedback from the public and eVTOL manufacturers and stakeholders.

Another aspect that is not included is *payload capacity*, referring to the maximum weight that an eVTOL aircraft can carry, including passengers, cargo, or other equipment. Provision on this aspect will provide guidance and standards for manufacturers, as well as clear parameters and requirements to ensure that manufacturers adhere to standardized testing procedures and certification processes. However, excluding *payload capacity* from the documents indicate the variability across eVTOL designs, configurations, and operational requirements. The payload capacity of an eVTOL aircraft can vary significantly depending on factors such as size, propulsion system, intended use, and regulatory restrictions. Take, for example, the Lilium Jet that can seat six passengers[123], while Joby's aircraft is designed to accommodate four passengers[124]. This variability makes it challenging to establish specific and standardized payload capacity requirements that would be applicable to the entire eVTOL industry.

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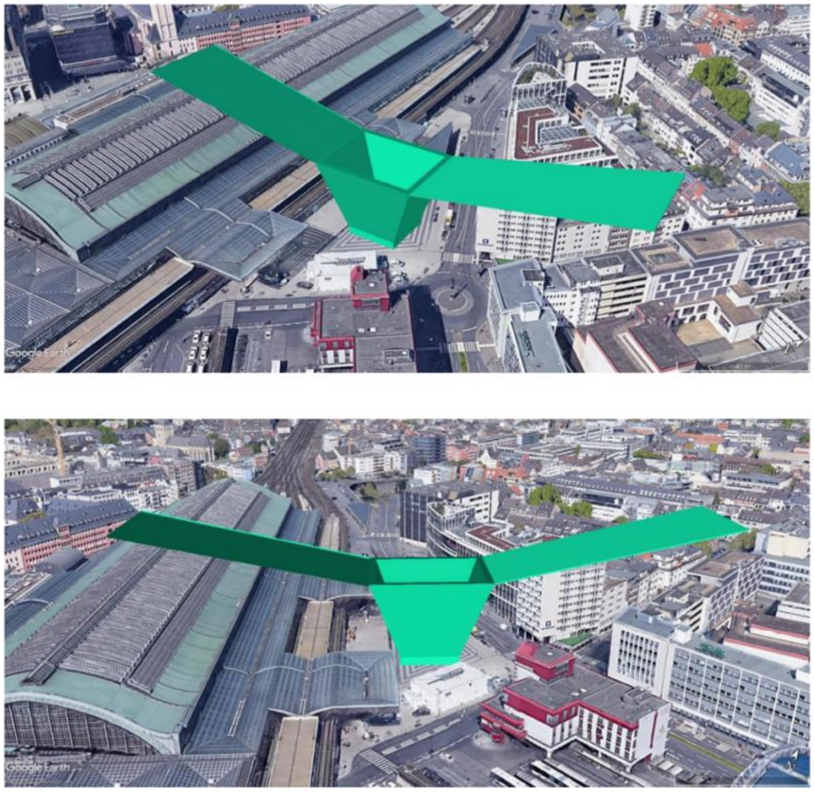
[120] https://newatlas.com/author/loz-blain, "NASA Acoustic Testing Puts Real Numbers on Joby's EVTOL Noise Signature," New Atlas, May 11, 2022, https://newatlas.com/aircraft/nasa-joby-evtol-noise/.
[121] "Lost in the Noise," accessed July 5, 2023, https://evtol.news/news/lost-in-the-noise.
[122] "Consultation Paper: Environmental Protection Technical Specification (EPTS) Applicable to EVTOL Powered by Multiple, Vertical, Non-Tilting, Evenly Distributed Rotors," EASA, May 4, 2023, https://www.easa.europa.eu/en/document-library/product-certification-consultations/consultation-paper-environmental-protection.
[123] "Lilium Jet - The First Electric VTOL (EVTOL) Jet - Lilium," accessed July 5, 2023, https://lilium.com/jet.
[124] "Joby Increases Flight Test Capacity in Support of FAA Certification Goal | Joby," accessed July 5, 2023, https://www.jobyaviation.com/news/joby-adds-second-pre-production-prototype-aircraft/.

Furthermore, the absence of *passenger facilities* of vertiport in the documents of both institutions is identified, despite the fact that both EASA and FAA have issued documents specifically on vertiport (PTS-VPT-DSN and EB#105, respectively). The two documents have outlined other vertiport subtopics, as indicated by 'Yes' on *vertiport set-up, landing and takeoff infrastructure*, and *ground operations infrastructure*. The omission of specific provisions for passenger facilities may suggest that EASA and FAA consider these aspects to fall under the purview of local regulations, industry standards, or best practices. Similar argument can be made on the absence *maintenance hub set-up* and *personnel* on both documents: the comparison of all documents reveals that maintenance hub is seen as a facility within vertiport as the infrastructure that holds together all activities related to eVTOL operations. Add air traffic management

4.2.2 Differences of performance

The differences between the performances of EASA and FAA highlight areas where the FAA is lacking. The analysis reveals that there is no subtopic where EASA lacks provisions that the FAA covers. In other words, there are no instances where EASA is marked as 'No' while the FAA is marked as 'Yes' in the analysis of performance. In contrast, there are four subtopics where EASA documents include provisions while the FAA documents do not: vertiport's *integration with urban infrastructure,* maintenance and maintenance hub's *equipment and tools*, as well as operations' *weather conditions* and *security considerations*.

In the introduction of PTS-VPT-DSN, EASA Director Patrick Ky mentioned that the majority of vertiports "will be built within an urban environment, and the EASA guidance therefore offers new and innovative solutions specifically for congested urban environments." — on the other hand, provisions on urban environment is nowhere to be found in FAA's EB #105.



Picture 1: Illustration of vertiport integration with urban infrastructure in PTS-VPT-DSN

Another discrepancy is visible in *maintenance equipment and tool*. EASA's MOC-2 SC-VTOL repeatedly underlines the importance of every type of aircraft having Aircraft Maintenance Manual, which naturally contains equipment and tool. This requirement is nowhere to be found within FAA documents. Furthermore, w*eather conditions* and *security considerations* are included in EASA documents of MOC SC-VTOL and MOC-2 SC-VTOL, with the following provisions as example:

1. *Weather conditions*: "The design should allow for sufficient external field of view free of obstruction. Account can be taken of aircraft specific features (as "chin bubbles") that provide the crew with sufficient visible external cues, in all day/night and weather conditions expected in operation." — MOC-2 SC-VTOL
2. *Security considerations*: "The equipment, systems and networks of Category Enhanced VTOL aircraft, considered separately and in relation to other systems, should be protected from intentional unauthorised electronic interactions that may result in catastrophic or hazardous effects on the safety of the aircraft. Protection

should be ensured by showing that the security risks have been identified, assessed and mitigated as necessary." — MOC SC-VTOL

4.2.3 Summary of comparison

In contrast to their relatively similar scores in legal accountability (62.86% for EASA and 60% for FAA), the analysis of performance highlights a notable disparity between the two institutions. EASA achieves a higher score of 24 'Yes' (68.57%), while FAA scores 20 'Yes' (57.14%) out of the 35 subtopics. It is also worth noting that there is no instance of EASA 'No' and FAA 'Yes', indicating that the FAA documents do not cover any subtopic that is absent in the EASA documents. Conversely, the topics of *integration with urban infrastructure, maintenance equipment and tools*, as well as *weather conditions* and *security considerations* are absent in FAA documents but present in EASA ones.

Furthermore, when considering the scope of the documents, it is evident that EASA's regulations have broader applicability to the entire industry, while FAA's documents are specific to eVTOL aircrafts of Joby and Archer Aviation. Although the FAA's documents are expected to serve as the foundation for future certification bases, their current applicability is limited to these specific aircraft models. Therefore, the extent to which these documents can be applied to other aircraft types and manufacturers remains uncertain.

The concept of rational choice institutionalism provides insights into understanding how EASA and FAA develop documents based on rational benefit calculations, suggesings that established practices and institutional arrangement may shape how the agencies approach their regulatory tasks. In this case, I argue that EASA's broader scope reflects a desire for legitimacy and acceptance from a wide range of stakeholders which consist not only of the industry, but also from national aviation authorities across its member states. In addition, the comprehensive coverage of subtopics suggests that EASA encourage the industry to consider various dimensions of eVTOL and UAM, aligning with rational choice institutionalism's emphasis on creating institutions that provide incentives and constraints to shape individual behavior.

On the other hand, FAA's limited scope can be seen as a result of its pragmatic approach to regulate the immediate concerns posed by specific eVTOL models. The FAA may prioritize addressing immediate safety and operational issues of these models first before expanding their regulations to encompass the entire industry. This approach could also be influenced by the desire to manage regulatory complexities and ensure smooth implementation without overwhelming resources. It can also be understood as a strategic decision by the FAA to address and regulate the introduction of new and innovative aircraft models in a controlled and incremental manner. It appears that the FAA may be seeking to reduce the uncertainty and risks associated with novel technologies, ensuring a gradual integration into the existing aviation ecosystem.

Another perspective to look at is that there are many similarities in the approach of both institutions's performance as regulatory bodies. They are similar in 31 out of 35, or 88.57% of all the subtopics of performance. This indicates a significant level of convergence in their regulatory requirements and standards for eVTOL industry. When the results of comparisons of legal accountability and performance are accumulated, there reveals a harmonized approach between EASA and FAA in certain topics, particularly in safety. In terms of legal accountability, the EU regulations and the FAA act do not have provisions specifically addressing subtopics related to *structural integrity* and *flight control systems*. Similarly, in the performance analysis, there are no provisions related to *collision avoidance systems* for either EASA or FAA.

Another area of harmonization is observed in the topic of noise. In legal accountability, the EU regulations and the FAA act have provisions addressing noise-related aspects, yet those are absent in the EASA and FAA documents. While the impact of this absence is debatable, this displays EASA and FAA's similar approach and consideration towards the nature of eVTOL aircraft which is arguably quieter than traditional aircraft.

Interestingly, and as opposed to noise topic as mentioned above, the topic of charging station also show a harmonized approach yet this time it is the legal accountability that is lacking. In the performance analysis, all institutions include provisions related to charging station, highlighting a shared recognition of the importance of infrastructure for recharging eVTOL aircraft. However, in terms of legal accountability, none of the EU regulations and the FAA act include provisions related to charging station.

4.3 Citizen outreach: Significant disparity as EASA covers majority of the aspects

The comparison of citizen outreach in Chapter 3 reveals highly different scores between EASA and FAA on their efforts in familiarizing citizens about the concepts of eVTOL and UAM. Out of the 20 indicators, EASA covers 17 or 85% of the important aspects, while FAA covers eight or 40%. In addition, there is no combination of EASA 'No' and FAA 'Yes', meaning that there is no aspects of citizen outreach on which the FAA is more superior than the EASA. The following sections discuss the similarities and differences between the two institutions on citizen outreach.

4.3.1 Similarities and differences of citizen outreach

EASA and FAA are similar in 10 out of the 20 identified aspects, with 8 combinations of two 'Yes' and two combinations of two 'No'. The 'Yes' similarities are all three aspects within general, safety's *passenger safety during flight*, vertiport's *basic concept and purpose* and *integration with urban areas,* operations' *integration with existing air traffic management*, and flight performance's *VTOL capabilities*. On the other hand, the 'No' similarities are noise's *community impact management for noise of VTOL operations* and vertiport's *accessibility of vertiports*, as well as flight performance's *maneuverability and agility*.

The 'Yes' similarities as well as the characteristics of the aspects indicate that both regulatory bodies have covered the distinguishable, basic concepts of eVTOL and UAM across their online touchpoints. EASA and FAA all cover general's *eVTOL aircraft basic concept and purpose, UAM basic concept and purpose,* and *benefits of eVTOL for UAM*.

Table 8: EASA and FAA's coverage of general topic across online touchpoints

Aspects	EASA	FAA
eVTOL aircraft basic concept and purpose	*"Although both VTOL and conventional rotorcraft make use of propulsion to lift into the air, VTOLs are using more than two propulsion units, referred to as distributed propulsion. If implemented properly, distributed propulsion can increase aircraft safety by sharing critical functions among several components."*	"*Advanced Air Mobility (AAM) is an umbrella term for aircraft that are likely highly automated and electric. These aircraft are often referred to as air taxis or electric Vertical Takeoff and Landing (eVTOL) aircraft."*

UAM basic concept and purpose	*"New technologies such as electric propulsion and enhanced battery capacity, applied to vertical take-off and landing systems, make this possible. The first commercial operations are expected to be the delivery of goods by drones and the transport of passengers, initially with a pilot on board. Later remote piloting or even autonomous services could follow."*	*"Urban Air Mobility (UAM) enables highly automated, cooperative, passenger or cargo-carrying air transportation services in and around urban areas. […] As a subset of AAM, UAM focuses on operations moving people and cargo in metropolitan and urban areas."*
Benefits of eVTOL for UAM	*"Perceived usefulness of UAM use cases: Drone delivery of medical supplies to hospitals; […] long-distance forwarding of heavy cargo; […] commute from a suburb to the city centre."*	*"[…]aimed at developing an air transportation system that moves people and cargo between local, regional, intraregional, and urban locations not previously served or underserved by aviation using innovative aircraft, technologies, infrastructure, and operations."*

The three 'No' similarities, on the other hand, suggest the areas of improvement for both institutions. The absence of *community impact management for noise of VTOL operations* and *accessibility of vertiports* in the online touchpoints of both EASA and FAA suggests that their approach is primarily focused on familiarizing citizens with the basic concepts and introducing the general idea of eVTOL. This is apparent as EASA covers *noise levels produced by eVTOL aircraft* indicating an acknowledgement that it is necessary for the public to understand the noise aspect. The absence of *maneuverability and agility* may stem from EASA and FAA deeming it more appropriate to address these aspects through regulations rather than including them in the familiarization for citizens. This is evident as EASA and FAA do cover *maneuverability and agility* in their regulatory documents, as apparent in Table 6.

Moving forward, the differences showcase that EASA is particularly better than FAA as there is no instance in which the FAA covers something EASA does not—in other words, there is no combination of EASA 'No' and FAA 'Yes' in the comparison of citizen outreach. On the other hand, there are nine instances of combination of EASA 'Yes' and FAA 'No', indicating that EASA covers a lot of aspects that FAA does not. Most notably, FAA does not cover any aspect within emission and noise, as opposed to EASA which covers everything except *community impact management for noise of VTOL operations*.

4.3.2 Summary of comparison

There are 10 out of 20 aspects in which the EASA and FAA are similar—eight combinations of 'Yes' and two combinations of 'No'—indicating a moderate level of similarity. Both institutions have established online touchpoints that are vital for European and American citizens, respectively, to understand eVTOL and UAM. Arguably the most important topic is general which comprises of the basic concepts and purpose of eVTOL and UAM as well as their benefits. In these areas, both regulatory bodies have captured the essential ideas for citizens to understand—the glimpse of this can be seen in Table 8 above.

However, the highly different overall scores between the two showcase that EASA (85%) have included far more information than FAA (40%) to familiarize citizens. While the FAA covers all the aspects within general, the institution falls behind on the rest: the only aspects covered outside general for FAA are *passenger safety during flight*, *vertiport basic concept and purpose*, *integration with urban areas*, *integration with existing traffic management*, and *VTOL capabilities*.

This is in contrast to EASA, which covers all but three of the 20 aspects: the institution does not cover on its online touchpoints *community impact management for noise of VTOL operations*, *accessibility of vertiports*, and *maneuverability and agility*. It must also be highlighted that these three aspects are also not covered by the FAA, indicating the areas that both regulatory bodies may improve in order for their respective citizens to understand better about eVTOL and UAM.

4.4 Industry involvement

The comparison of industry involvement is the only one that does not utilize tabular format as a descriptive analysis is a better approach to compare how the EASA and FAA engage the industry professionals in the rulemaking process of eVTOL and UAM. The analysis is divided into sections each for EASA and FAA, and then a comparison will be made in the last section of this subchapter. In answering the question of how the regulatory bodies engage industry in the rulemaking process of eVTOL and UAM, I take into account two factors: *first*, I limit the scope of the analysis within the final documents from EASA and FAA for industry specifically for eVTOL and UAM. These documents are also used in the structured, focused comparison for performance: for EASA, the documents are SC-VTOL-01, MOC SC-VTOL, MOC-2 SC-VTOL, MOC-3 SC-VTOL, and PTS-VPT-DSN. For FAA, the documents are EB #105, SC-Joby, and SC-Archer. *Second*, the documents are analyzed against Arnstein's ladder of participation as the fundamentals of analysis, as the approach offers a structured way to evaluating the extent and manner of industry participation in the rulemaking process.

4.4.1 EASA's engagement

EASA attempts to streamline the public feedback through its notice of proposed amendments (NPAs), which serve as a means of seeking input and feedback from stakeholders and the public before finalizing the proposed documents. NPAs outline the proposed amendments, provide supporting information, and allow interested parties to review and provide comments on the proposed changes. EASA gets the industry involved in providing the feedback on these NPAs through its established consultation mechanism, specifically the Comment-Response Tool (CRT) which is used to "collect views from stakeholders for consideration before issuing its Opinions and Decisions"[125].

					Commenting / Reaction period (yyyy-mm-dd)	
Status	Task numbers	Title	Number	Affected rules & codes	Begin	End
CMT	N/A	EASA issue 3 CM-21.A/21.B-00-Certification Memorandum 'Criteria for the determination of the EASA LoI in product certification'	N/A	N/A	2023-07-13	2023-08-03
CMT	N/A	Proposed Deviation Wheel Flange Debris and Fuel Tank Protection, ref. DEV-F25.734-01	N/A	N/A	2023-07-07	2023-07-28
CMT	RMT.0524	Datalink services	NPA 2023-07	CS-ACNS	2023-07-07	2023-09-08
CMT	N/A	Means of Compliance with Light-UAS.2510	N/A	N/A	2023-06-30	2023-08-31
CMT	N/A	Proposed ESF Degraded flight instrument external probe heating system, ref. ESF-F25.1326-01	N/A	N/A	2023-06-27	2023-07-18
CMT	RMT.0180	Turbine-engine endurance and initial maintenance programme testing, and substantiation of piston-engine time between overhauls or replacements	NPA 2023-06	CS-E	2023-06-21	2023-09-21
CMT	N/A	Proposed Certification Memorandum CM-21.A-A-003 on Analysis of occurrence reports and determination of possible unsafe conditions originated by human performance issues on large aeroplanes	N/A	N/A	2023-06-16	2023-07-21
CMT	RMT.0161 RMT.0524	Acceptable means of compliance, guidance material and detailed specifications supporting the new regulatory framework on the conformity assessment of ATM/ANS systems and ATM/ANS constituents	NPA 2023-05	ATM/ANS conformity assessment (AMC/GM) DS-GE DS-SoC Part-ATM/ANS.AR AMC/GM Part-ATM/ANS.OR AMC/GM Part-AUR.COM (AMC/GM) Part-DPO (AMC/GM) Part-SUR.COM (AMC/GM)	2023-06-14	2023-08-02
CMT	RMT.0682	Introduction of ACAS Xa for operations in the single European sky (SES) airspace & PBN specifications for oceanic operations	NPA 2023-04	Part-ACAS Part-ACAS AMC/GM Part-CAT AMC/GM Part-CNS Part-NCC AMC/GM Part-SPO AMC/GM	2023-05-26	2023-08-28
CMT	RMT.0392	Extended diversion time operations (EDTO)	NPA 2023-03	AMC-20-6 CR AIROPS (IR) Part-ARO Part-ARO AMC/GM Part-CAT Part-CAT AMC/GM Part-Definitions Part-Definitions AMC/GM Part-ORO AMC/GM Part-SPA Part-SPA AMC/GM	2023-05-12	2023-08-14

[125] "Notices of Proposed Amendment (NPAs)," EASA, accessed July 14, 2023, https://www.easa.europa.eu/en/document-library/notices-of-proposed-amendment.

Picture 2: Snapshot of the first page of list of documents for feedback on EASA's CRT

The consultation period varies from one NPA to another, however it might be extended upon request from the industry. The period for MOC-3 SC-VTOL, for example, took place from 29 June 2022 to 12 August 2022[126]. When a comment is submitted, it is assigned a unique identification number as confirmation of its successful submission. Throughout the consultation period, users have the flexibility to revise their comments if needed. The documents can be posted in any official language of the European Union. The nature of this CRT is "public", meaning that both citizens and the industry can access the tool upon online registration and provide comments either personally or on behalf of the industry or company they are working at. While the CRT is accessible for citizens and industry, for the purpose of this thesis it is considered a part of the industry involvement as the documents are highly technical, meaning that actual citizens may not possess the technical expertise to actively participate in rulemaking processes. Therefore, the focus is on the industry, specifically how they provide input and shape the documents.

Almost all of EASA's documents for eVTOL and UAM as listed above were open for consultation except the PTS-VPT-DSN, which serves as a guidance for industry as claimed by the institution. In the creation of SC-VTOL-01 and all of its MOCs, EASA first uploaded the NPAs and documents onto the CRT, from which users are allowed to comment on a specific provision. After the comments are provided, EASA may engage with various stakeholders in different ways in response to the comment. For example, the engagement can take a broad approach when involving the public or a more targeted approach when engaging specific stakeholders.[127]

After the consultation period ends, EASA issues a "Comment Response Document" containing all of the comments provided by the public for any given NPA in a tabular format. The table consists of name of author, the comment text, suggested resolution, concerned paragraph and/or provision, as well as EASA's response to the comment. It is found that

[126] "Special Condition for VTOL and Means of Compliance," EASA, December 22, 2022, https://www.easa.europa.eu/en/document-library/product-certification-consultations/special-condition-vtol.
[127] "Notices of Proposed Amendment (NPAs)."

EASA further responds to the public comment into four types of disposition: *Accepted, Partially Accepted, Noted, and Not Accepted*. Each of these dispositions are then followed by a note explaining the response.

EASA SC-VTOL-01 Comment Response Document

Comment				Comment summary	Suggested resolution	Comment is an observation or is a suggestion*	Comment is substantive or is an objection**	EASA comment disposition	EASA response
NR	Author	Paragraph	Page						
38	*GAMA*	N/A	General Comment	One key issue that EASA needs to consider, in light of VTOL, is the way that these aircraft can operate in Europe. It generally takes the better part of a decade to update operational constructs of the magnitude required to formulate an entirely new operating framework and sending VTOL down this kind of dead end, won't be positive for VTOL operations in Europe over the next 10-years.	GAMA believes EASA should pay serious consideration to calling these aircraft either 'aeroplanes' if they fly on wing for portions of flight or 'rotorcraft' if they are always lifted by thrust. It would be appropriate to use the performance based material in the proposed VTOL special condition, but adapted based upon industry comments, for the design criteria but issuing an aeroplane/rotorcraft TC would allow these aircraft to be operated across Europe in the initial small numbers while the European institutions work to create a rule framework which might better allow them to operate at large scale in the future.	Yes	Yes	Not accepted	Work has started in parallel to develop specific VTOL operational aspects to complement the vehicle certification. See also the SC preamble.
39	*GAMA*	N/A	General Comment	GAMA applauds EASA's decision to base the design specifications for VTOL aircraft in the performance-based framework of CS-23 Amd 5. The strength of these rules are based in the flexibility that is necessary as a result of the broad range of characteristics of VTOL aircraft. Some VTOL aircraft utilize thrust for lift for the entire flight while others are more like aeroplanes except for brief periods of time when they might takeoff or land vertically. Having a baseline special condition and eventually a common rule framework based in CS-23 Amd 5 will be extremely helpful in this regard.	GAMA believes that the means of compliance which has been developed to address CS-23 under ASTM F44 remains extremely relevant to much of the VTOL designs and there are activities underway within F44 to create means of compliance which are specific to VTOL designs. GAMA requests that EASA continue working with ASTM F44 to assure these materials can be globally accepted means of compliance for VTOL designs.	Yes	Yes	Noted	ASTM F44 output is one of the possible sources of material that will be considered for the AMC
40	*GAMA*	N/A	General Comment	GAMA is concerned that EASA has made several fundamental changes to the baseline CS-23 material which will limit future applicability. The applicability of CS-23 to aircraft weighing up to 8618 kg with up to 19 passengers while EASA has limited the SC-VTOL to 2000 kg and 5 passengers. Limiting the SC-VTOL in this manner will result in significant issue, especially with respect to a 2000 kg limit. Under the CS-23 framework there are several key differentiators (airworthiness levels 1-4, high-speed/low-speed, etc.) that have been used historically.	It would seem more appropriate for EASA to leverage the concept of airworthiness levels 1-4 that were used to define vehicle risk under CS-23. Perhaps EASA should consider creating a new differentiator for VTOL (such as vertical take-off and landing capable) which would allow VTOL aircraft to fit more neatly into CS-23 or would allow an SC-VTOL to include similar differentiators.	Yes	Yes	Partially accepted	Weight and passenger limits have been reconsidered (see Explanatory Note 9) and existing airworthiness levels used with adaptation to the VTOL specificities
41	Aidan Reilly	Background/scope		Rotorcraft regulations (such as CS-27) may be more appropriate for some of the proposed configurations, especially during VTOL flight. Basing the new regulation on CS-23 alone is perhaps not the best starting point.				Partially accepted	See Explanatory Note 2. Relevant elements from CS-27 will be integrated in the AMC.

Picture 3: Snapshot of EASA's Comment Response Document of SC-VTOL-01

Upon a closer analysis based on Arnstein's ladder of participation, EASA's engagement with the industry in the creation of most documents aligns most closely with *partnership*. It is explained by Arnstein that *partnership* entails the agreement to "share planning and decision-making responsibilities through such structures as joint policy boards, planning committees, and mechanisms for resolving impasses"[128]. In this case, the CRT acts as a mechanism that facilitates the sharing of planning and decision-making responsibilities between EASA and the private sector. The opportunity to allow stakeholders to review and provide comments on proposed amendments through the CRT highlights EASA's acknowledgment the importance of their input in shaping the final documents. However, although EASA's approach aligns predominantly with partnership, the institution does not fully adhere to this approach, as the final decision on the document ultimately rests with EASA after the issuance of the CRD.

[128] Arnstein, "A Ladder of Citizen Participation."

This suggests that the sharing of decision-making responsibilities leans more heavily towards EASA's side.

Another document, PTS-VPT-DSN, does not follow the same procedure within CRT as the others due to its nature and purpose of providing technical specifications for the design of VFR vertiports. The document was formulated in collaboration with prominent vertiport companies and VTOL manufacturers[129], the statement of which is displayed in the document's introduction. In order to realize the document, the EASA Vertiport Task Force (VPTTF), established with the purpose of formulating vertiport design requirements, sent a letter on 18 May 2021 to UAM manufacturers to acquire the necessary data for the development of vertiport design specifications. As stated on the document: "VTOL manufacturers are requested to provide information to better define the requirements for the design of the vertiport infrastructure. The information provided will be used to evaluate the technical specifications for VTP-DSN and operation of VTOL-capable aircraft."[130]

In contrast to the CRT, this approach aligns most closely to *delegated power* within Arnstein's ladder of participation. This level of participation involves granting the industry a certain degree of authority and responsibility in decision-making processes. In the context of the PTS-VPT-DSN provided, it can be observed that the EASA established a collaborative approach by addressing a letter to UAM manufacturers to gather essential data for developing vertiport design specifications. This signifies a level of delegated power, as the manufacturers are entrusted with providing valuable input that directly influences the document. As opposed to the other documents, where the private sector was given opportunity to provide feedback via CRT, in the PTS-VPT-DSN participations were before the document was drafted.

The combination of *partnership* and *delegated power* indicates a high level of private sector participation by EASA as both category are high up the ladder of eight rungs, in which *partnership* is on the sixth rung and *delegated power* on the seventh. The highest rung of the ladder, *citizen control*, is a condition where "participants or residents can govern a program or an institution, be in full charge of policy and managerial aspects". This is not in line with

[129] "PTS-VPT-DSN."
[130] "PTS-VPT-DSN."

EASA's engagement with the industry, as the final authority and responsibility for setting rules and standards still lie with the institution rather than the private sector.

4.4.2 FAA's engagement

All of the three documents that have been issued by EASA were consulted to the public via the FederalRegister.gov prior to the issuance of the final versions[131][132][133]. The website is co-administered by the Office of the Federal Register within the National Archives and Records Administration, along with the US Government Publishing Office. The website's aim is "to make it easier for citizens and communities to understand the regulatory process and to participate in Government decision-making."[134].

To allow participation from the public, the FAA issues notices, such as notice of proposed rulemaking (NPRM) and request for comments. The consultation period's duration is set by the FAA, taking into account the complexity and significance of the proposed regulation. Interested parties can submit their comments, feedback, and suggestions directly through the website, following the provided guidelines and procedures. For EB #105, SC-Joby, and SC-Archer the timelines given range from one to one and a half month. The timeline for the consultation process may be extended by the FAA, either based on requests from industry stakeholders or when deemed necessary to ensure a thorough and inclusive review of the proposed regulations. The FAA typically opens different types of slot for comments: for example, comments for EB #105 could only be submitted exclusively via email

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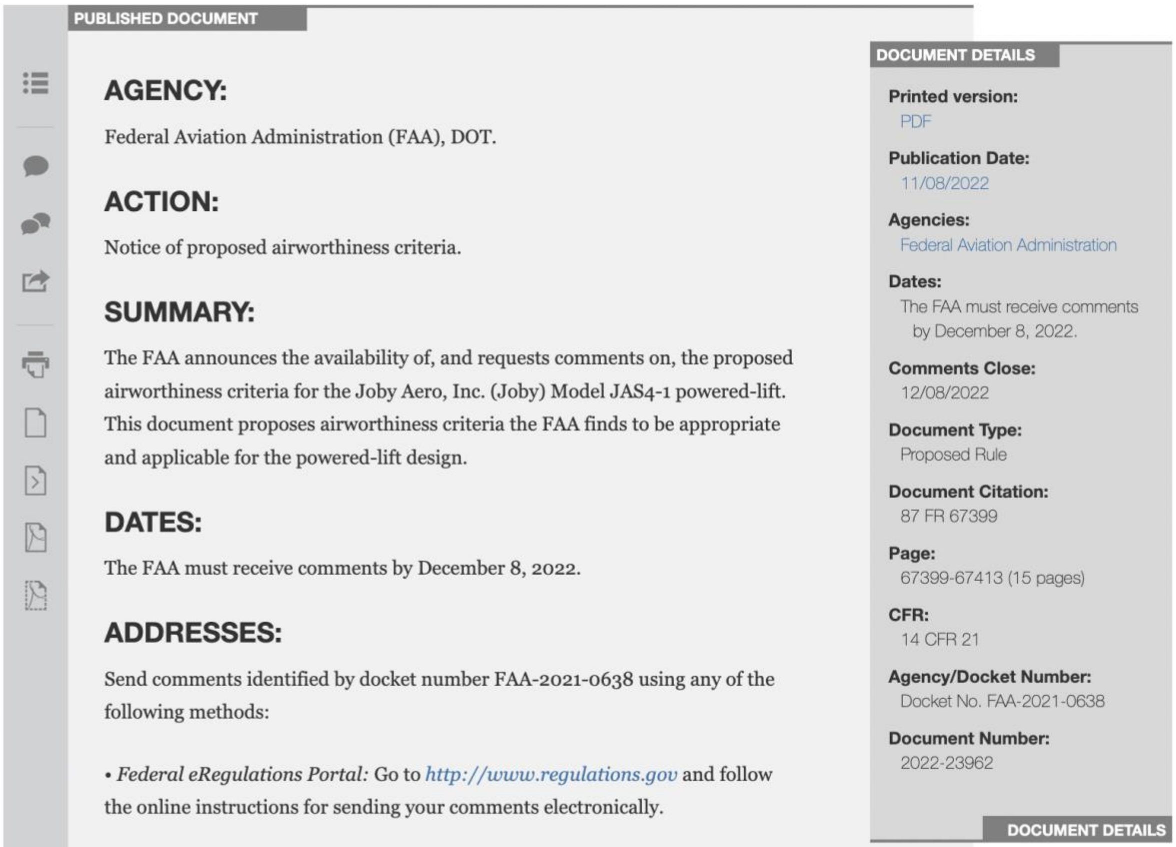
[131] "Airworthiness Criteria: Special Class Airworthiness Criteria for the Joby Aero, Inc. Model JAS4-1 Powered-Lift," Federal Register, November 8, 2022, https://www.federalregister.gov/documents/2022/11/08/2022-23962/airworthiness-criteria-special-class-airworthiness-criteria-for-the-joby-aero-inc-model-jas4-1.

[132] "Notice of Availability, Notice of Industry Day Meeting, and Request for Comment on the Draft Engineering Brief 105 for Vertiport Design," Federal Register, March 2, 2022, https://www.federalregister.gov/documents/2022/03/02/2022-04351/notice-of-availability-notice-of-industry-day-meeting-and-request-for-comment-on-the-draft.

[133] "Notice of Availability, Notice of Industry Day Meeting, and Request for Comment on the Draft Engineering Brief 105 for Vertiport Design," Federal Register, March 2, 2022, https://www.federalregister.gov/documents/2022/03/02/2022-04351/notice-of-availability-notice-of-industry-day-meeting-and-request-for-comment-on-the-draft.

[134] "Reader Aids :: Government Policy and OFR Procedures," Federal Register, accessed July 16, 2023, https://www.federalregister.gov/reader-aids/government-policy-and-ofr-procedures/about-this-site.

vertiports@faa.gov, while comments for both SC-Joby and SC-Archer are allowed within the FederalRegister.gov comments sytem, as well as via mail, hand delivery, and fax[135].


PUBLISHED DOCUMENT

AGENCY:

Federal Aviation Administration (FAA), DOT.

ACTION:

Notice of proposed airworthiness criteria.

SUMMARY:

The FAA announces the availability of, and requests comments on, the proposed airworthiness criteria for the Joby Aero, Inc. (Joby) Model JAS4-1 powered-lift. This document proposes airworthiness criteria the FAA finds to be appropriate and applicable for the powered-lift design.

DATES:

The FAA must receive comments by December 8, 2022.

ADDRESSES:

Send comments identified by docket number FAA-2021-0638 using any of the following methods:

• *Federal eRegulations Portal:* Go to *http://www.regulations.gov* and follow the online instructions for sending your comments electronically.

DOCUMENT DETAILS

Printed version:
PDF

Publication Date:
11/08/2022

Agencies:
Federal Aviation Administration

Dates:
The FAA must receive comments by December 8, 2022.

Comments Close:
12/08/2022

Document Type:
Proposed Rule

Document Citation:
87 FR 67399

Page:
67399-67413 (15 pages)

CFR:
14 CFR 21

Agency/Docket Number:
Docket No. FAA-2021-0638

Document Number:
2022-23962

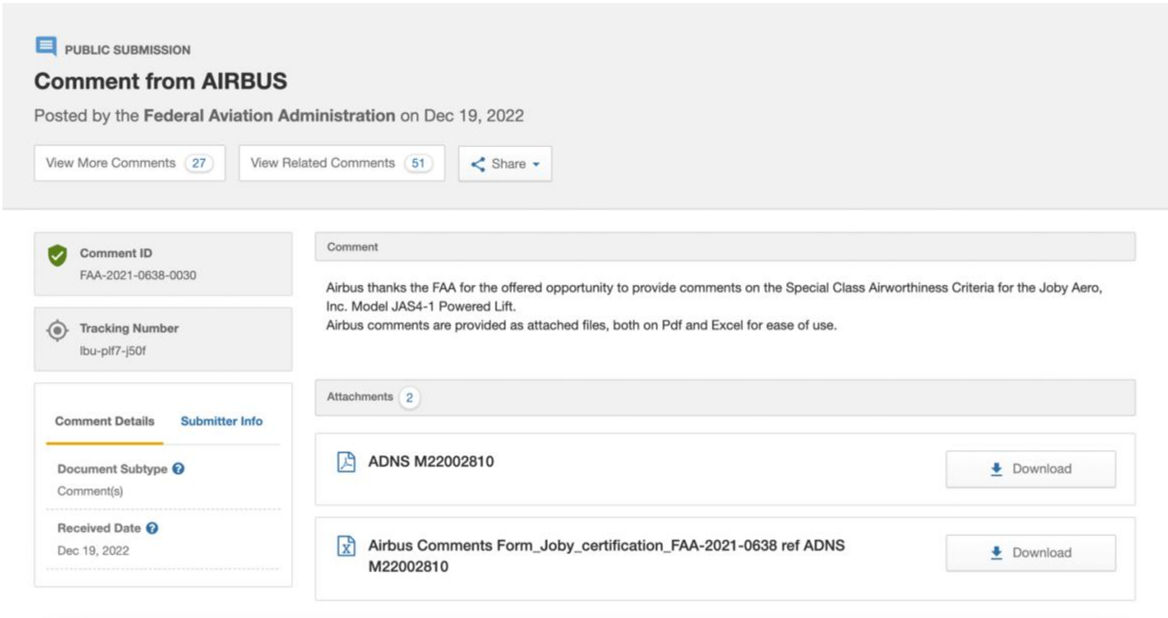
DOCUMENT DETAILS

Picture 4: Snapshot of invitation for comments for SC-Joby on FederalRegister.gov, along with the comment features on the left tab

Parallel to the request for comments, the FAA also invited the industry for a virtual meeting on the draft EB #105. Once the consultation period concludes, the FAA analyzes all the received feedback and comments to inform the finalization of the regulatory document. During this phase, the FAA may engage with stakeholders to address specific concerns and incorporate insights into the final rule. The FAA publishes all received comments exactly as submitted on the http://www.regulations.gov website, which includes the identity of the commenter, which might be citizens, authorized representatives of an association, businesses,

135 "Airworthiness Criteria."

labor unions, and others. However, the research has suggested that the FAA does not publicly issue its responses to each of these documents.



Picture 5: Submission of comments from Airbus for SC-Joby on regulations.gov

The FAA's approach to industry involvement aligns with the "partnership" level, actively involving the public in decision-making by sharing planning and decision-making responsibilities. The FAA recognizes the importance of inclusive governance through soliciting input and feedback from citizens, businesses, associations, labor unions, and other stakeholders. Utilizing FederalRegister.gov as a joint platform for communication and feedback allows interested parties to easily access proposed regulations, submit comments, and actively participate in the decision-making process. Furthermore, the FAA's commitment to transparency is evident in its practice of publishing all received comments, fostering trust between the agency and the public, reinforcing a collaborative "partnership" approach. These approaches indicate a high level of FAA’s engagement to industry.

4.4.3 Summary of comparison

The analyses in the previous sections have shown that both EASA and FAA have a high level of engagement with the industry, displayed through platforms—CRT and FederalRegister.gov— that allow for the solicitation of comments, feedback, and suggestions from industry professionals, businesses, and other stakeholders. Both regulatory bodies actively seek input from the industry for a defined period before finalizing proposed documents, demonstrating a commitment to inclusive decision-making.

In terms of transparency, both institutions also share a similar understanding of showcasing unedited public comments across their respective platforms. In this case, it must be noted that EASA is more structured in their approach as they showcase their responses to the comments, as opposed to FAA which does not do so. This raises questions about whether or not the comments are taken into account into the final documents. In general, however, it must be noted that EASA's CRT and FAA's FederalRegister.gov are similarly on the level of *partnership*, indicating a relatively high level of engagement with the industry

However, there is a difference in their approaches as EASA does not include all of its documents in the CRT. While this exclusion means that EASA's process is a less streamlined than that of FAA's, it is not indicative of a lack of engagement but rather a different approach. The PTS-VPT-DSN was first established by incorporating feedback from the industry, showcasing a higher level of engagement with stakeholders and reflecting a *delegation of power*.

In contrast, the FAA includes all of its documents related to eVTOL and UAM in the FederalRegister.gov platform, indicating a more streamlined process of industry participation than that of EASA. This ensures a centralized and consistent approach for industry to access proposed regulations. However, that also means that the document is established first by the FAA, and only afterward are comments invited, which reflect *partnership* as a lower level of engagement compared to EASA's approach.

Chapter 5: Conclusion

The EU's aims to reduce greenhouse gas emissions in transportation, including aviation, has paved way for the establishment of regulations promoting novel technologies, such as eVTOL aircraft, which hold promise for environmentally sustainable air transportation. For this reason, both EASA and FAA as the regulatory bodies of aviation in two of the most developed regions for aviation, Europe and the US, play crucial roles in facilitating the development and integration of the concept. As key stakeholders in this relatively new industry, EASA and FAA's governance of eVTOL for UAM will significantly impact the development and implementation of the technology, making them integral to the discussions on achieving climate neutrality and promoting sustainable aviation practices. The necessity of this issue is reflected in the research objective of this thesis, which is to analyze and compare the governance of EASA and FAA to facilitate the growth of eVTOL aircraft for urban air mobility in their respective jurisdictions, the Europe and the US. The structured, focused comparison is the central approach of analysis, followed by setting the elements of eVTOL aircraft and infrastructure for UAM which is important for the analysis to move forward.

5.1 Theoretical reflections with the findings

Having put forward the analyses in Chapter 3 and 4, we now move back to the theories that form this thesis and explain how these concepts steer this thesis in the right direction.

At its core, sociotechnical transitions theory recognizes that technological innovations do not occur in isolation but are shaped by social, economic, and political factors. It goes beyond a narrow focus on technology itself and considers the broader sociopolitical context in which innovations emerge and are adopted. The theory highlights the importance of understanding the interactions between technology and society, and how these interactions influence the direction and pace of technological change. In the context of the findings, this aligns with the observed engagement of EASA and FAA with industry stakeholders through platforms like the CRT and FederalRegister.gov, allowing for the solicitation of comments and feedback on proposed regulations. Furthermore, the theory suggests that policymakers should stimulate radical innovation through real-world experiments and projects that encourage multidimensional learning. This approach can be seen in the way EASA and FAA actively seek input from industry professionals and stakeholders during the rulemaking process.

The second theory, technology governance, emphasizes the importance of regulations, norms, and standards in managing technological advancements. The findings reveal that both EASA and FAA have established regulatory frameworks for eVTOL aircraft, covering various aspects such as safety, noise, operations, and more. These regulations act as a guiding framework for the industry, setting the technical parameters and safety requirements for eVTOL operations. In addition, technology governance theory advocates for a holistic approach to technology management, considering not only technical aspects but also broader societal, economic, and environmental implications. The findings highlight that both EASA and FAA have, to a varying degree, address important aspects related to eVTOL aircraft, such as environmental impacts, safety during flight, integration with urban infrastructure, and more.

The third theory, rational choice institutionalism, allows for an examination of how these regulatory bodies engage with industry stakeholders and make decisions based on the anticipated costs and benefits of different regulatory approaches. Both institutions seek to structure the decision-making process through mechanisms like the CRT and FederalRegister.gov, where industry stakeholders are invited to provide feedback and comments on proposed documents. This facilitates a shared planning and decision-making process, allowing both regulatory bodies and stakeholders to align their interests and concerns. Moreover, rational choice institutionalism enables an understanding of how EASA and FAA's histories, organizational cultures, and strategic priorities can influence their approaches to regulating eVTOL aircraft. For example, EASA, being an agency of the European Union, may take into account broader European policies and goals, while FAA's limited scope to the US may lead to a more pragmatic approach focusing on immediate safety and operational issues.

Furthermore, the effective governance theory—which elements include accountability, performance, and participation—provides framework to assess EASA and FAA's governance processes, as well as the benchmark to understand the best practices in each element. Regarding legal accountability, both EASA and FAA possess the necessary authority to regulate eVTOL aircraft based on their respective regulations and acts. While they demonstrate similar legal accountability scores, specific differences in topics such as emission, flight performance, and maintenance hub highlight distinct approaches to regulation. In terms of performance, EASA's higher score suggests more comprehensive regulations covering a broader scope of the industry compared to FAA's more focused approach on specific eVTOL models. However, both institutions share harmonization in certain areas, particularly in safety-related topics, reflecting effective governance principles. Citizen outreach reveals differences in the extent of information provided by EASA and FAA. EASA's higher score indicates a more comprehensive effort to familiarize citizens with eVTOL and UAM. Both regulatory bodies emphasize general aspects, but FAA falls behind in other crucial topics, indicating areas for improvement in citizen engagement. Industry participation displays a high level of engagement from both regulatory bodies, as evidenced by the establishment of platforms like CRT and FederalRegister.gov. While EASA may appear more structured in showcasing responses to comments, FAA's centralized approach ensures consistent access to proposed regulations. Both approaches align with principles of effective governance in stakeholder engagement.

5.2 A learning process

As a total of four comparisons have been showcased, it has been shown that EASA is stronger and more comprehensive than FAA in terms of *performance* and *citizen outreach*, while the two institutions are relatively similar on the scores of *legal accountability* as well as the *industry engagement* with different approaches here and there. With these emerging technologies yet to operate commercially, the regulators can adopt a learning approach that allows for the successful and safe integration of these innovations into the aviation ecosystem. The comparisons can be a starting point from which each institution learn from the points from each other.

Several examples of the comparison can be takeaways for learning for each other. For example, on *performance*, EASA's strength lies in its broader regulatory scope, encompassing the entire eVTOL industry rather than being limited to specific aircraft models, while the FAA's regulations could benefit from adopting a more comprehensive approach. The inclusion of integration of vertiport with urban environment, as done by EASA, could also be a strong point to include in future FAA documents. Furthermore, on *citizen outreach*, FAA can learn from EASA's comprehensive approach and aim to cover a broader range of aspects to provide citizens with a more holistic understanding of these technologies. Conversely, on *industry involvement*, EASA can learn from FAA's centralized approach in requesting for comments to ensure that the industry gets the notice when a feedback on rulemaking is requested. By harnessing these insights both institutions can pave the way for a future of eVTOL and UAM.

It goes unnoticed that both the EASA and FAA, as well as their authorizing bodies which are the European Commission and the US Congress, are well underway in their journey to implementing eVTOL for UAM, as showcased by the analyses, however it must be highlighted that there are rooms for improvement against the elements of aircraft, infrastructure, and operations.

In terms of *legal accountability*, it is necessary for the EU regulations to implement specific requirements for the maintenance equipment and tools necessary for the upkeep of eVTOL vehicles, which will enhance maintenance procedures and support the development of maintenance facilities. On the other hand, the FAA act lacks provisions on VTOL capability, payload capacity, flight testing, and demonstration, as well as cruise speed and range. These aspects are vital for defining the performance characteristics and capabilities of eVTOL aircraft. To support innovation and safety, the FAA should consider incorporating specific requirements and procedures related to these aspects to enable manufacturers to develop and demonstrate the performance capabilities of their aircraft models accurately.

Furthermore, the analysis and comparison of *performance* indicate that EASA—despite its stellar score showing a high performance as the regulatory body for aviation—still lacks in the noise aspect as the institution does not cover relevant provision in the documents. EASA's consultation paper for regulatory amendment addressing eVTOL noise and emission is a step in the right direction, and further efforts in finalizing and implementing these regulations will be crucial. Similar argument can be made on addressing payload capacity as it is essential to provide clear guidance to manufacturers. In regard to FAA's *performance*, the lack of provisions for vertiport integration with urban infrastructure in the FAA's documents indicates a gap in addressing the challenges and opportunities associated with eVTOL operations in congested urban environments. To ensure the successful integration of eVTOL aircraft into urban landscapes, the FAA should develop guidelines and requirements for vertiport planning, design, and integration with urban infrastructure. Similarly, the FAA's documents lack specific provisions on weather conditions and security considerations.

Incorporating guidelines for eVTOL aircraft operations in various weather conditions will enhance the safety and reliability of these aircraft.

In regard to *citizen outreach*, EASA should improve its efforts in familiarizing citizens with the community impact management related to noise from VTOL operations. Noise is an important aspect of eVTOL aircraft, and addressing its impact on communities is essential for public acceptance and support. EASA should provide clear information and guidelines on how the industry plans to manage and mitigate noise concerns, ensuring transparency and proactive engagement with affected communities. FAA, on the other hand, needs to significantly improve its efforts in familiarizing citizens with eVTOL and UAM concepts. Currently, it covers only 40% of the important aspects related to citizen outreach. The FAA should expand the scope of its online touchpoints to include a broader range of topics and subtopics, providing citizens with a comprehensive understanding of eVTOL and UAM and their potential impact on society.

Lastly, within the area of *industry involvement*, EASA should work on streamlining the inclusion of all its documents related to eVTOL and UAM in the CRT. Currently, the PTS-VPT-DSN is not included in the CRT, which may lead to a less streamlined process for stakeholders to provide feedback. Ensuring that all relevant documents are available on the platform would enhance consistency in the public consultation process. On the other hand, FAA should consider publishing its responses to public comments on proposed regulations, similar to EASA's practice. Currently, the FAA publishes all received comments but does not publicly issue responses. This would demonstrate that FAA considers stakeholder input and enhance transparency in the decision-making process.

5.3 Limitation and future research

The research has some limitations that should be considered when interpreting its findings. *Firstly*, comparison of professional accountability—which would have included the analysis of departments of EASA and FAA related to eVTOL and UAM—had to be excluded due to a lack of publicly available data of the role of every department and its correlation to eVTOL for UAM within both institutions. However, it must also be acknowledged that the difference in how responsibilities are distributed does not necessarily mean an institution is better than the others; it rather indicates a different approach which by no means can be compared. That being said, the focus of the research was shifted on both institutions' role as regulators by analyzing the comprehensiveness of documents that they have issued for the eVTOL sector.

Secondly, the rapidly evolving nature of eVTOL for UAM poses another limitation. The study's analysis is based on documents available up to the time of writing, and some significant developments have occurred after the data cutoff date. For instance, EASA issued a "Consultation Paper on Environmental Protection Technical Specifications for eVTOL powered by multiple, vertical, non-tilting, evenly distributed rotors" on 4 May 2023, but it was not included in the research due to its status as a non-finalized document at the time of writing. Similarly, not part of this research is the upcoming US Congress' issuance of a new FAA Act, slated to be issued in October 2023, as it would possibly contain a renewed commitment to eVTOL and UAM.

Having put forward these limitations, future research should consider incorporating these additional documents to provide a more comprehensive and up-to-date analysis. The research can expand upon the current study's limitations and dig into various aspects.

Firstly, investigating professional accountability within EASA and FAA could provide insights into the decision-making process and the impact of different departments on the regulatory framework. Examining the roles and responsibilities of each department in relation to eVTOL and UAM could shed light on potential areas for improvement and collaboration. *Secondly*, the Consultation Paper issued by EASA is a critical document with potential implications for the eVTOL industry. Future research can explore the outcomes of the consultation process, as well as the final version of the document after it is officially agreed upon. Understanding how EASA addresses environmental concerns and incorporates public feedback in the final regulations can have implications for the eVTOL industry's sustainability and acceptance. *Thirdly*, the new FAA Act to be issued in October 2023 is likely to shape the regulatory landscape for eVTOL in the United States. Future research can examine the provisions and updates introduced by the Act, and assess how it aligns with global standards and addresses the unique challenges faced by the eVTOL industry.

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