

Thesis Abstract

No. _____

Registration Number	☒ "KOU" ☐ "OTSU" No. _____ *Office use only	Name	Raquel Garcia Hoffmann de Carvalho
Thesis Title Architecture Definition of Urban Air Mobility Addressing Situation Awareness, Security, Safety Culture, and Sustainability			
Thesis Summary Urban Air Mobility (UAM) is a concept that envisions the integration of electric Vertical Takeoff and Landing (eVTOL) aircraft into the airspace above cities, offering innovative solutions for passenger transport. This doctoral dissertation explores the socio-technical dimensions of UAM, employing an enterprise architecture (EA) methodology and using the Unified Architecture Framework (UAF) to address the complexities and challenges associated with its systematic implementation. The research focuses on four socio-technical concerns: situation awareness, security, safety culture, and sustainability, all examined through a System-of-Systems (SoS) approach. The research begins by exploring the concept of situation awareness (SA) in UAM operations, highlighting the unique demands placed on pilots and air traffic controllers as they navigate dense urban environments. The author investigates SA in the UAM ecosystem and addresses it as a collective competence. Security is another socio-technical concern, and the dissertation assesses both cyber and physical security risks. The research proposes a comprehensive security model tailored to the UAM context, addressing systems, data, and personnel vulnerabilities. Resilient principles applied during security controls and processes are particularly emphasized, showcasing its potential in developing robust security strategies. Safety culture within UAM is investigated with an emphasis on just culture. The research underscores the importance of fostering open communication and accountability to enhance safety performance in the UAM novel operation. It also considers the challenges of building trust and achieving consensus in the highly dynamic and distributed operational environment of UAM, proposing strategies for effective safety oversight. Sustainability is explored through eco-efficiency principles, focusing on the environmental and social impacts of UAM. The author evaluates the potential benefits and drawbacks of eVTOL operations, including their greenhouse gas emissions, resource efficiency, and social equity implications. It highlights the need for a balanced approach incorporating real-world data and community engagement to ensure that UAM contributes positively to sustainable urban development. The dissertation's findings combine the architecture conceptualization process and model visualizations based on the architecture elaboration process. UAF views are evaluated and validated through expert discussions and stakeholder consultations. The study concludes with practical recommendations for policymakers, industry stakeholders, and researchers, advocating for interdisciplinary collaboration and			

adaptive governance to navigate the complexities of UAM. By providing a holistic examination of UAM's socio-technical challenges, this doctoral research contributes insights and frameworks to guide the safe, secure, and sustainable integration of UAM into urban transportation systems.

The dissertation is organized into eight chapters. In Chapter 1, the author introduces the thesis, providing an overview of the research context, problem analysis, research objectives, questions, methods, resources, contributions, limitations, delimitations, and the thesis structure. In Chapter 2 the author conducts a literature review presenting relevant information about UAM, evaluating work related to UAM ConOps, situation awareness, security, safety culture, and sustainability. This chapter identifies gaps in current knowledge and provides theoretical foundations on multiple topics involved in the research. Chapter 3 describes the research methods, including the rationale for the methodology applied, the foundations and principles substantiating the methodology, the standards and processes used during the study, the modeling framework, validation methods, and the model strategy used to develop the research results.

Results are presented in Chapter 4 to Chapter 8. In Chapter 4, Situation Awareness Concern, the author presents the results of the architecture conceptualization and elaboration addressing UAM SoS's concerns regarding situation awareness, including UAM enterprise views, insights, and findings from the analysis. Chapter 5 Security Concern, details the architecture conceptualization and elaboration addressing UAM security concerns, considering UAM cyber and physical security threats and including UAM enterprise views and key findings from the analysis. Chapter 6, Safety Culture Concern, discusses the architecture conceptualization and elaboration addressing UAM safety culture concerns, considering UAM safety management perspectives and including UAM enterprise views and findings from the analysis. Chapter 7, Sustainability Concern, elaborates on the architecture conceptualization and elaboration addressing UAM sustainability concerns, considering UAM's environmental and social impacts and including UAM enterprise views and critical findings from the analysis.

Finally, in Chapter 8, the author discusses the results and stakeholder engagement in each concern, highlights the contribution of EA visualization with different enterprise viewpoints and perspectives, summarizes answers to each research question, and provides recommendations for future work in the field of UAM.

Keywords: Urban Air Mobility (UAM), Situation Awareness, Security, Safety Culture, Sustainability, Unified Architecture Framework (UAF), Enterprise Architecture (EA)