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Insights from Local Authorities for the Assessment of Urban Air Mobility Impacts

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Abstract

Urban Air Mobility (UAM) emerges as an innovative solution driven by technological advancements to address the challenges posed by urbanization and sustainability issues. As a key component of the future mobility sector, its successful integration depends on the perspectives of multiple stakeholders, particularly local authorities and aviation experts, who shape the UAM ecosystem and share responsibility for its implementation. However, while aviation professionals currently play a central role in shaping UAM, the involvement of local authorities remains limited despite their position as the ultimate decision-makers regarding the feasibility and deployment of UAM applications within their jurisdictions. This research explores the perspectives of local authorities on the development of UAM services, focusing on spatial-temporal planning and design. The findings highlight the diverse dimensions of UAM's impact, including environmental and socio-economic aspects, as well as concerns related to urban planning, regulation, safety and operations. Specific indicators identified include emissions, time savings, privacy and connectivity. By centering the perspectives of local authorities—often overlooked in existing UAM research—this study contributes to the literature by bridging the gap between aviation-centric and policy-driven approaches. Practically, the results offer a structured framework for municipalities to assess UAM's viability and inform urban planning strategies. Socially, the study underscores the importance of governance in fostering sustainable and accepted UAM implementations. These insights can guide policymakers, urban planners, and industry stakeholders in designing UAM solutions that align with local needs, regulatory frameworks, and broader sustainability goals.

Keywords: Drones, Urban Air Mobility (UAM), Urban Planning, Transport Planning.

1. Introduction

The growth of urban regions has been an increasing reality all over the world. This rampant urbanization leads to overwhelmed urban systems (Bibri and Krogstie, 2017) and, more specifically, transport systems. In this context, and given the perception of urban mobility as a key component of every city (Bezerra et al., 2020), alternative solutions have been sought.

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Urban Air Mobility (UAM) is an emerging technology that allows the transportation of people and cargo in urban and suburban spaces through the utilization of vertical take-off and landing (eVTOL) aircraft (Sadrani et al., 2025). Given its potential to integrate the mobility sector in the near future, it is essential that all stakeholders are involved in the implementation processes of these services. In line with this, Straubinger et al. (2021, p. 3) state that "local authorities have to carefully monitor UAM introduction in order to ensure a welfare enhancing UAM introduction". Thus, it is vital to gather the perceptions of local authorities regarding UAM, namely concerning its effects and how these effects can be assessed. The current study intends to gather the insights of individuals from a Portuguese local authority regarding the previously mentioned aspects through the development of a panel session. The methodology applied is based on Cognitive Mapping as a Problem Structuring Method (PSM). The results of the session led to the creation of a cognitive map.

The rest of the article is organized in the following way: section 2 presents the literature review, depicting the current state-of-the-art of the topic; in section 3, the methodology used is explained; section 4 encompasses the results of the study; and section 5 contains the conclusion and lines for future research.

2. Literature Review

The potential ability of UAM to overcome some current challenges related to congestion, travel times and sustainability, which are faced by land transportation, has been attracting growing attention to this concept (Kalakou et al., 2023; Straubinger et al., 2021). The multivalence of UAM makes it an interesting option given that it has the potential to transform the mobility sector (Pons-Prats et al., 2022). In this context, UAM may potentially be used for people's transportation, as well as for freight transport purposes. The utilization of delivery drones may be an interesting option in the matter of transport speed, contributing also to the reduction of environmental impacts given their electrical power nature (Borghetti et al., 2022). Nevertheless, there are still many aspects about UAM that are required to be further examined to obtain a broader understanding of the topic.

The relevance of UAM is also perceived by the increasing effort legal entities have been making to create and uniformize regulations concerning these services. In this context, Fehling and Saraceni (2023) addressed the influence of legal and technical critical success factors on the utilization of drones for delivery purposes in Germany, highlighting the fact that the legal restrictions in this country demonstrate the absence of openness to pioneering technologies in air and road transport. Nonetheless, the European Union (EU) has been vital to establish guidelines for the safe utilization of these services in the U-space, which is a geographical zone defined by Member States where these operations are only authorized to occur with the assistance of U-space services (European Commission, 2021). The implementation of UAM is also aligned with: (1) the goals of the European Green Deal that promote the transformation into a green and digital economy (European Commission, 2019); and (2) the EU's objectives to foster sustainable and smart mobility (European Commission, 2022). In addition to the EU, there are other stakeholders involved in UAM and whose perspectives should be considered. In this regard, as stated in the context of development of the Trans-European Transport Network (TEN-T) "the interests of regional and local authorities, as well as those of the public concerned by a project of common interest, should be appropriately taken into account in

the planning and construction phase of projects" (European Commission, 2024, p. 3). The collaboration among local, national and European authorities is necessary to manage UAM's potential impacts, namely environmental and social impacts (European Commission, 2022). Moreover, the co-creation with private and public actors, in which local authorities are included, is one of the key pillars to achieve a socially embraced and sustainable UAM integration (Kalakou et al., 2023; Urban Air Mobility (UAM) Initiative Cities Community (UIC2), 2021). Thus, it is possible to verify that local authorities are one of the stakeholders who have a major role in the implementation and management of UAM services and, as so, their perspectives should be known and taken into account.

The current study is founded on the Stakeholder Theory (Freeman, 1984). During the last couple of decades, this theory has been evolving in accordance with the alterations that have been occurring in business environments. Its application is not limited to businesses, having potential application in other spheres (Barney and Harrison, 2020), namely in public scopes, in which local authorities and other decision-makers are included.

3. Methodology

This study uses Cognitive Mapping as a Problem Structuring Method (PSM) in the context of a constructivist approach. This type of methodology takes into account subjectivity and uncertainty unlike more classical approaches and, as a result, is able to provide a more accurate analysis of the topic.

PSMs have been evolving since 1960, being defined as a wide group of approaches whose objective is to help structure problems rather than solve them directly (Rosenhead, 1996). Their main advantages relate to the fact that they permit to obtain more information and distinct perspectives of the problem, as well as to focus on structuring the problem by promoting the participation of stakeholders, which offers an improved support for processes of decision making (Belton and Stewart, 2010; Daellenbach, 1994; Rosenhead, 1996; Rosenhead, 2006). Nevertheless, PSMs also encompass some disadvantages, such as the volatility of the results. Notwithstanding, these methods have been developing and becoming more sophisticated over time (Rosenhead, 2006).PSMs comprehend a variety of techniques such as, for instance, Soft Systems Methodology (SSM) (Checkland, 1981) and Strategic Options Development and Analysis (SODA) (Eden et al., 1983). In the context of this study, the specific PSM employed is Cognitive Mapping.

Cognitive Mapping is characterized as "a knowledge-intensive interdisciplinary methodology for solving applied-decision problems by means of cognitive maps" (Vaz et al., 2021, p. 919). The cognitive maps consist of models that illustrate the structure of causal relationships, encompassing a group of nodes and arrows. The nodes represent the criteria defined by the experts, as a result of their knowledge and experience, and the arrows represent the potential cause-and-effect relationships between criteria. Thus, the arrows are either associated with a negative signal (-) (if the criterion has a negative effect) or to no signal (if the criterion has a positive effect) (Eden, 2004; Ferreira et al., 2017).

4. Practical Application

For the practical application of the methodology, a group of experts from a Portuguese local authority, *i.e.*, Lisbon Municipality, was gathered. First, for the selection of these

participants, it was ensured that: (1) the experts were familiar with the topics addressed; and (2) heterogeneity was guaranteed in terms of age, gender and professional experience. These panelists were related to diverse areas, such as mobility and transport, urban smart management, and pedestrian accessibility. Then, a panel session was performed to obtain their inputs concerning potential effects of UAM and how these effects may be assessed based on their knowledge and professional experience. The session occurred online to ease schedule arrangements and allow the participation of all experts simultaneously.

In the beginning of the session, a contextualization of the main topics was provided to ensure that all participants were aware of the meaning of the key concepts. Then, it was asked for the participants to determine positive and/or negative criteria regarding how UAM effects can be assessed. The participants defined 109 criteria, having posteriorly divided them into five distinct clusters: (1) Environmental and Social Impacts (Cluster 1); (2) Urban Planning and Management and Land Use (Cluster 2); (3) Regulation (Cluster 3); (4) Safety and Accidents (Cluster 4); and (5) Operation of the Logistics Activity (Cluster 5). Cluster 1 encompassed 26 criteria, Cluster 2 included 26 criteria, Cluster 3 comprehended 29 criteria, Cluster 4 contained 11 criteria and Cluster 5 counted with 22 criteria. The experts were given freedom to: (1) consider criteria to have both a negative and a positive effect (in this case, the specific criterion would be written twice with different signals according to its effect); (2) define the clusters' names; (3) allocate the criteria to the clusters; and (4) assign criteria to more than one cluster. In this regard, five criteria were allocated to more than one cluster: (1) "*less road congestion*" to Clusters 1 and 4; (2) "*reduction in road traffic for logistics*" to Clusters 2 and 4; (3) "*public space management – conflicts with visually impaired pedestrians*" to Clusters 2 and 3; (4) "*for blind people, possible conflict in the emission and perception of sounds (on which blind people rely for orientation*" to Clusters 3 and 4; and (5) "*number of emergency rescues*" for Clusters 4 and 5.

At last, for each cluster, the participants ordered the criteria in three levels of importance. The criteria defined as most important in each cluster is presented in Table 1.

Table 1: Most important criteria of each cluster.

CLUSTER		*CRITERIA*
Environmental and Social Impacts (Cluster 1)	-	Noise levels (regulatory issues)
	-	Visual noise
	-	Noise emission levels
	-	Visual impact
	-	Noise levels, noise peaks, noise hours, type of noise
	+	Noise levels, noise peaks, noise hours, type of noise
	-	Environmental risk for birds, insects, biodiversity in general – how it affects their habitat (sound, presence, light)
	-	Measurement of pollution generated upstream and downstream of the operation site in the construction/destruction of UAM equipment and structures
	-	Noise generated
	+	Sound level reduction
	-	Occupation of visual space
	-	Alteration of habitats and ecosystems

CLUSTER		*CRITERIA*
	-	Visual impact of operations
	-	Visual pollution (having traffic at ground and air level – visual congestion)
	-	Alteration of migratory patterns of birds
	-	Visual pollution: landscape damaged by the presence of flying objects
Urban Planning and Management and Land Use (Cluster 2)	+	Changes in the design of public space – reallocation of space for new modes – is it possible to manage space optimally?
	+	Public space management – less space taken up by road traffic
	+	Reduction in road traffic for logistics
	+	Number of delivery points (accessibility)
	+	Creation of hubs and landing centers
	-	Level of road traffic congestion (Average Daily Traffic)
	+	Interaction of these services with public space (ground level)/contribution to decongesting urban areas
Regulation (Cluster 3)	-	Safety for people
	-	Safety for city equipment
	-	Airspace conflicts
	-	Airspace occupation
	-	Operational safety
	+	Air traffic regulations (circuits, speeds)
	+	Air route management
	-	Air mobility management
	-	Regulation of air traffic levels
	+	Permanent airspace management and control (number of routes)
Safety and Accidents (Cluster 4)	+	Contributing to better road safety
	-	Safety of people and activities
	+	Reduction in road traffic for logistics
	+	Reduction in the number of road accidents
	-	Increased complexity in air traffic management
Operation of the Logistics Activity (Cluster 5)	+	Reduced delivery time
	+	Travel time for people
	+	Travel time for goods
	+	Faster delivery of urgent goods such as medicines or other items
	+	Reduced delivery costs
	+	Cost associated with deliveries
	-	Travel costs
	-	Number of deliveries by conventional means
	+	Number of urgent deliveries
	-	Order volume
	+	Speed of deliveries

Based on Table 1, it is possible to verify the main topics that the criteria perceived as most important are primarily related to. In this regard, in Cluster 1 these criteria concern environmental impacts, namely noise (7 criteria), visual pollution (6 criteria), effects on wildlife (3 criteria) and general pollution (1 criterion). Although this cluster was named

"Environmental and Social Impacts", no criteria related to social impacts was perceived as being one of the most important. In Cluster 2, the most important criteria are related to urban planning and, more specifically, public space (3 criteria), road traffic (2 criteria), hubs and landing centers (1 criterion), and accessibility (1 criterion). In Cluster 3, these criteria are associated with airspace regulation concerning airspace management and control (7 criteria) and safety (3 criteria). In Cluster 4, the most relevant criteria are related to road aspects (3 criteria), safety (1 criterion) and air traffic management (1 criterion). In Cluster 5, these criteria pertain to improved travel times (5 criteria), costs (3 criteria), number of deliveries (2 criteria) and order volume (1 criterion).

Considering the total number of criteria of each cluster, it is verified that the most important criteria represent: (1) 62% of Cluster 1; (2) 27% of Cluster 2; (3) 34% of Cluster 3; (4) 45% of Cluster 4; and (5) 50% of Cluster 5.

The results of this session led to the development of a cognitive map (Figure 1).

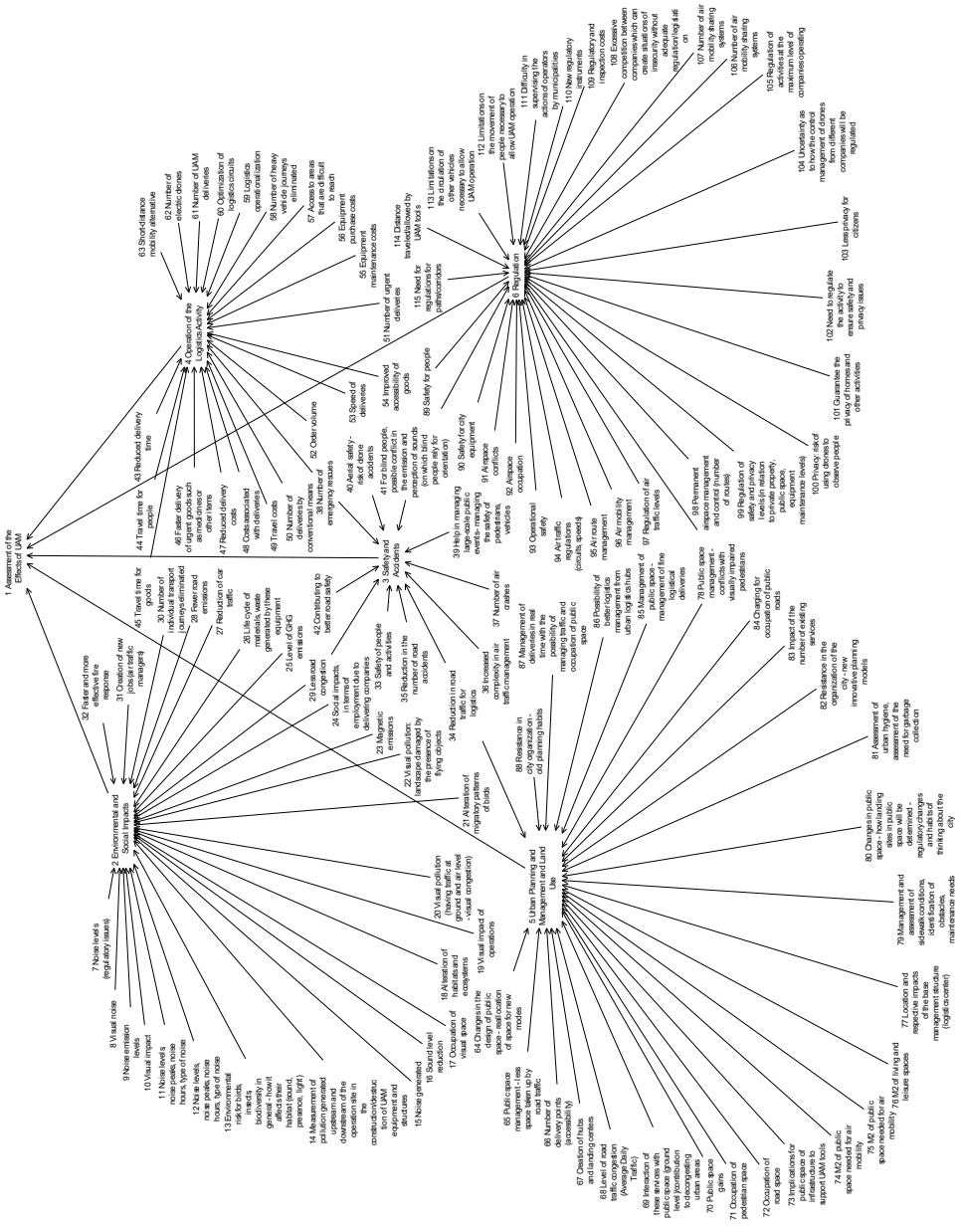


Figure 1: Cognitive Map

Figure 1 illustrates all clusters linked to the main topic (*i.e.*, Assessment of the Effects of UAM) and all criteria linked to the corresponding cluster(s). The arrows show if each criterion is positive (*i.e.*, no signal associated) or negative (*i.e.*, (-) signal associated). The criteria that were assigned to more than one cluster are also linked to the respective clusters in the map.

5. Conclusion

This study highlights the importance of local authorities in the development and management of UAM services. The opinion of local authorities is important because they provide new dimensions when considering the impacts of UAM, which traditionally have been restricted to the safety and environmental impacts, while the social and, especially, the urban planning have been less quantified in the literature. All this highlights that the proper integration of air and ground mobility planning is needed for the successful deployment of UAM in cities. Through the development of a panel session with individuals from a Portuguese local authority, it was possible to gather their perspectives toward the effects of UAM and how these effects can be assessed.

The participants determined 109 criteria and allocated them into five clusters: (1) Environmental and Social Impacts (Cluster 1); (2) Urban Planning and Management and Land Use (Cluster 2); (3) Regulation (Cluster 3); (4) Safety and Accidents (Cluster 4); and (5) Operation of the Logistics Activity (Cluster 5). The cluster which encompasses the most criteria is Cluster 3 with 29 criteria, followed by Cluster 1 and Cluster 2 with 26 criteria each, Cluster 5 with 22 criteria, and Cluster 4 with 11 criteria. Within each cluster, the participants defined which criteria they perceived as most important, which led to the selection of 16 criteria in Cluster 1, 7 criteria in Cluster 2, 10 criteria in Cluster 3, 5 criteria in Cluster 4 and 11 criteria in Cluster 5. Even though Cluster 1 contained criteria related to environmental and to social impacts, all criteria considered most important were related to environmental impacts, which shows that when compared to social impacts, the former were perceived as most important for this group of experts. It is also perceptible that safety is considered as one of the most important topics since in two distinct clusters (*i.e.*, Cluster 3 and Cluster 4) several criteria related to this concept were defined as most important. Similarly, road aspects were also perceived as most important for these participants in two different clusters (*i.e.*, Cluster 2 and Cluster 4).

The insights of this study are important for the integration of UAM in urban planning and, specifically, in Sustainable Urban Mobility Plans (SUMPs) because they provide information on how to quantify the impacts of UAM and, hence, they assist planning and definition of where and how UAM can be deployed in the urban context.

Future research may repeat the process with other local authorities and with other groups of stakeholders to compare their perspectives and understand which elements are common and which are different. Moreover, future studies can work further on the quantification of the indicators that were designated as most important since this information can give support to decision making in the context of UAM. This process may be developed through a Multicriteria Decision Analysis (MCDA) approach, similarly to current evaluation frameworks in the mobility sector (*e.g.*, (Assefa et al., 2024; L'Hostis et al., 2016). This approach can provide an improved understanding of the indicators by, for instance, clarifying the cause-and-effect relationships between them or by ranking them according to their importance.

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