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MESTRADO EM ENGENHARIA DE SERVIÇOS E GESTÃO

# Perceptions and Attitudes towards Urban Air Mobility and Potential for Medical Applications

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**Master Thesis**

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*Godspeed,*

## Abstract

In recent years, Urban air mobility (UAM) has emerged as a promising solution with the potential to revolutionize transportation as it intends to develop efficient and groundbreaking air transport services that connect cities, suburbs, rural areas, and otherwise hard-to-access regions.

This study examines the acceptance of UAM and its implications for medical applications. The research utilized multi-region survey data from the European project ASSURED-UAM to assess public attitudes towards drone delivery. The study revealed that most respondents viewed drone delivery as a positive development, acknowledging its potential to reduce congestion and pollution in city centres. Cluster analysis was employed to identify distinct groups.

The thesis also explored healthcare workers' perceptions of UAM's potential applications in the healthcare sector through a newly developed survey. It was observed that healthcare workers had limited knowledge of medical drone usage, but both urgent and non-urgent medical applications of UAM were viewed positively. Concerns related to safety and security, particularly the fear of drone failures or hijacking, negatively influenced support for these services. Experience emerged as a stronger indicator of acceptance among healthcare workers compared to age.

The study's service design phase involved mapping perceptions derived from empirical evidence and literature findings. Stakeholder analysis was employed to identify key actors and their relationships. This process resulted in the creation of Value Constellation Experiences (VCEs) and a Customer Value Constellation (CVC) for the two proposed concepts of non-urgent and emergency health services.

Contributions include valuable insights derived from survey data and cluster analysis such as the identification of high-acceptance clusters primarily consist of active, frequent online shoppers who appreciate the convenience and speed of drone deliveries. They endorse public investment in UAM, are willing to pay extra and have their homes flown over. Conversely, low-acceptance clusters, predominantly female and non-frequent online shoppers, hold opposing views. These user profiles can inform the development of strategies for public policy and marketing, promoting acceptance and adoption. Furthermore, the study sheds light on the perceptions and attitudes of both citizens and healthcare workers regarding the medical applications of UAM. Notably, the study highlights an overall positive attitude and interest in using UAM applications, despite prevailing safety concerns. It also emphasizes that experience plays a more influential role in acceptance compared to age, and that professional role carries more weight than the place of work.

**Keywords:** urban air mobility; drones; acceptance; medical services.

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**List of abbreviations**

AED: Automated External Defibrillator

CVC: Customer Value constellation

EMS: Emergency Medical Services

GZM: Górnośląsko-Zagłębiowska Metropolia

IT: Italy

OHCA: Out-of-Hospital Cardiac Arrest

PAM: Partitioning around medoids

PL: Poland

PT: Portugal

SD: Standard deviation

SE: Service Experience

SEE: Service Experience Encounter

UAM: Urban Air Mobility

UAV: Unmanned Aerial Vehicle

VCE: Value Constellation Experience

# 1 Introduction

Recent years have shown that urban air mobility (UAM) has the potential to become one of the next big things in transportation. UAM is made possible with the use of unmanned aerial vehicles (UAVs), commonly known as drones, and aims at developing air transport services to enable efficient and ground-breaking travel connections between and within cities, suburbs, rural areas, and hard-to-access regions. Previously a military-only privilege, these capabilities are now rapidly being used in civic spheres. Thus, drones can now be used for various purposes, including passenger transportation, innovative logistics, surveillance operations, and many more [1]

The topic of UAM has been gathering much attention, due to its great potential for innovative solutions and the disruptive nature of the concept itself. There is potential for great economic benefits, more efficient air travel, increased safety, and reduced congestion and pollution [2], [3]. The increasing prevalence of e-commerce has also led to a greater demand for cost-effective and sustainable delivery options, which in turn requires logistics operators to develop more complex and diverse solutions to meet this demand [4].

The adoption of UAM as a part of everyday life is a highly complex subject as it concerns technical, regulatory, and infrastructural issues. Still, one of the main barriers to a successful implementation is public acceptance, being that one of the main topics currently being discussed [5]. Kellermann et al. [1] point out that, even though the public is a central stakeholder in the development of this field, the people's perspective on UAM has played a minor role so far, therefore suggesting that the potential of drone technology can only unfold if it benefits society and leaves the academic circles of discussion.

Overall, there are many studies focused on understanding public perceptions towards new technologies, thus identifying the most important factors towards acceptance and adoption. However, there is a lack of studies on the value perception regarding UAM, with most research about mobility technology acceptance focusing on autonomous ground-based vehicles [6–8]. Without a significant emphasis on UAM acceptance and understanding the main factors that play a role in it, UAM might be doomed to fail, no matter how revolutionary the technology and the services it enables are. Furthermore, it is important to note that as the UAM industry is still in its infancy, all evaluations and considerations are based on potential rather than actual implementation. Since UAM services are not widely implemented yet, it is challenging to quantify these accurately [9]. As the industry evolves and matures, it will be possible to gather more accurate information and measurements regarding adoption and its implications.

Based on a previously conducted survey, this thesis aims to investigate people's attitudes towards UAM. The research approach involves analyzing the opinions of the general public and examining the applications/services with the most potential for adoption. The survey was focused on e-commerce deliveries but allowed to unravel benefits and barriers for different UAM-enabled logistics services.

Being a recent technology, it is only natural that drone delivery is tested in sectors where it has a higher potential for implementation. Therefore, using the literature and the results of the first part of the study, in this work a service-related sector was selected to deepen the acceptance understanding and identify new possible services and value propositions.

According to the literature, one of the applications that shows significant potential for acceptance and overall success within the realm of UAM is its utilization in medical and emergency situations [10]. These specific use cases hold immense promise due to their direct

impact on improving public health and safety, as well as enhancing the efficiency and timeliness of critical services. By leveraging UAM technology, medical professionals can gain faster access to remote and hard-to-reach locations, enabling them to provide prompt medical assistance and improve patient outcomes as already is a common occurrence in some African nations [11, 12]. Additionally, emergency response services can benefit from UAM by reducing response times [10] and swiftly reaching areas affected by natural disasters or accidents. Furthermore, the integration of UAM into delivery services offers the potential for expedited and environmentally friendly transportation of essential goods, leading to increased efficiency and reduced traffic congestion on the ground [3, 13]. Understanding the factors that contribute to the acceptance and adoption of UAM technology in these crucial areas is pivotal, as it can help ensure the successful implementation and widespread adoption of UAM, ultimately improving the lives of individuals and the communities they reside in. Since emergency and common-good applications benefit from higher acceptance, a new survey targeting workers of the healthcare sector was developed to investigate their perceptions and propose service concepts in this sector.

For this reason, the study also explores the attitudes and perceptions of healthcare workers regarding the implementation of UAM in health services.

The following research questions (RQs) have been formulated:

**RQ1**: What is the potential level of acceptance and attitudes of citizens towards UAM?

**RQ2:** What are the potential user's profiles and user attitudes from e-commerce customers towards UAM?

**RQ3**: How do healthcare workers perceive the potential applications of UAM in the healthcare sector?

**RQ4:** What services and value offerings can be proposed based on the potential of UAM applications in healthcare?

The answers to these research questions aim to provide insights into the attitudes, perceptions, and intentions of both potential users and healthcare workers towards UAM. By understanding these perspectives, the thesis seeks to contribute to the overall understanding of public acceptance and potential implementation of UAM services in various contexts and propose relevant service concepts.

It is hypothesized that there are diverse potential user segments, and that regional habits and cultures can motivate differentiated actions to ensure a successful implementation of UAM for e-commerce deliveries across different regions. In this view, we aim to contribute to the existing literature on UAM by providing insights for policymakers and service designers, supporting informed decision-making in the development of UAM-based services, and targeting specific markets and segments. Understanding and catering to these segments is crucial for driving the acceptance and adoption of UAM. Tailoring strategies and offerings based on attitudes within distinct user segments and regional contexts increases the likelihood of successful implementation and enhances the overall user experience, contributing to the long-term sustainability and growth of the UAM industry. To ensure success in the current environment, UAM technology and innovation must adhere to the prevailing trend of *servitization* and embrace comprehensive service integration, incorporating elements of service design. Failing to do so poses a significant risk, as solely focusing on technological advancements without building a robust service infrastructure around it can lead to failure in meeting the evolving demands and expectations of users and stakeholders [5, 14].

This dissertation follows a traditional structure, starting with an introduction that provides an overview of the research topic. It is followed by a literature review, which is divided into two parts: the first part focuses on UAM in general, while the second part specifically explores UAM applications in the medical field and health services. This literature review establishes the theoretical foundation for the research and identifies gaps in existing knowledge.

The theoretical background section of the dissertation provides a framework for the methodologies used in the study. It explains the theoretical underpinnings of the research methods and introduces the service design tools employed in the study.

The methodology section describes the two surveys that supported this research:

- The preexisting, Survey A, which investigates the attitudes of citizens towards UAM, as an initiative from the ASSURED-UAM project [15] which aims to provide insights for UAM deployment,
- Survey B, developed as part of this thesis, which examines the perceptions and attitudes of healthcare workers towards UAM medical applications.
- A detailed characterization of the surveys, their structure, data description, employed methods, analyzed variables, and any limitations found.

The discussion of results section is divided into three parts. The first part analyzes the results of Survey A as an attempt at tackling RQ1 and RQ2, using descriptive statistics and cluster analysis.

It is guided by the relevant literature and aims to identify patterns and trends in citizens' attitudes towards UAM. The results of the first part of this research were published in peer-reviewed journal *Aerospace* [16] .

The second part of the discussion of results focuses on Survey B, which explores the perceptions and attitudes of healthcare workers towards UAM medical applications to respond to RQ3. The results are analyzed using correlation analysis and group comparisons.

The discussion examines the relationships between variables and provides insights into the factors influencing healthcare workers' acceptance and adoption of UAM in the healthcare sector.

The third part of the discussion of results employs tools and frameworks from service design and marketing disciplines. This allows for an analysis of the research findings and enables the proposal of service concepts with potential for UAM in healthcare settings as intended by RQ4. A summary of the relationships between Research Questions and methodology can be seen in Figure 1.

The dissertation concludes with a summary of the main findings, limitations of the study, and suggestions for future research.

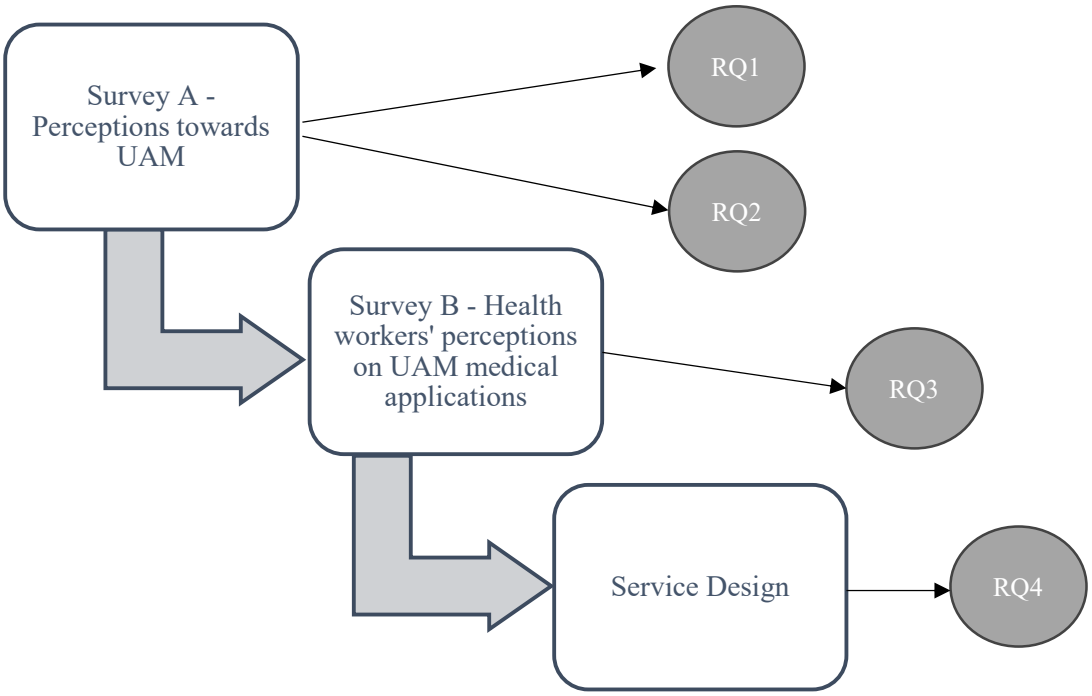


**Figure 1 -** Research Question's diagram

# 2 Literature Review

## 2.1 Urban air mobility (UAM)

The application of drones in logistics presents a transformative opportunity for various industries, streamlining the transportation of goods and providing humanitarian aid and emergency medical care, such as the efficient delivery of medical supplies to remote areas with inadequate road infrastructure [11, 17–20]. Driven by innovation, the potential applications of drones continue to expand, while still sharing the common ambition of developing autonomous flight systems to reduce costs, time, labor, and complexity of operations. Those include, among many, agricultural usages [21], structural inspection [22], people transport [23, 24], and package delivery [1].

Most literature on UAM includes studies i) focusing on the technical side of VTOL (Vertical Take-Off and Landing) vehicles, ii) investigating how to incorporate drones into air traffic management (ATM), iii) investigating users' perceptions and potential demand for UAM, and iv) considering various types of services, such as urban logistics, airport shuttles and other types of urban applications. In this section, we make brief considerations about the current literature on the last two topics.

In a literature review study, Bauranov and Rakas [25] provided recommendations for further research in UAM, including risk analysis, data management, co-creation of new technologies, psychoacoustic effects of drone noise on humans, and the impact of ground infrastructure on urban planning. Sah et al. [26] utilized Fuzzy Delphi Method (FDM) and the Analytic Hierarchy Process (AHP) to identify and prioritize the barriers to the implementation of drone logistics based on their level of criticality. They found that regulations and threats to privacy and security are the most critical barriers to implementing drones in the logistics sector. Other barriers include public perception/psychological effects, environmental issues, economic aspects, and technical issues. About technical issues, Straubinger et al. [5] reviewed the main aspects to be addressed, namely concerning vehicle design, infrastructure requirements, and integration of UAM on multimodal transport modelling. The authors also pointed out the need for robust business cases and regulations for an acceptable deployment.

Social-demographic indicators such as gender, age, income, and education impact individuals' perspectives on UAM [10, 27–31], and urban residents are more likely to participate in UAM compared to those in rural areas [28]. This is consistent with the analysis of Sabino et al. [27] that identified the main factors that influence public opinion on the usage of drones: age, gender, geographical location, technological expertise, type of drone mission, and familiarity with the technology. Fully employed and high-income individuals show greater interest and positive perceptions of UAM. However, women exhibit less immediate adoption interest, lower trust and perceived usefulness of automation, and higher security and safety concerns [29, 30]. Yet, Del-Real & Díaz-Fernández [31] showed that the difference between men and women is minimal, while nationality has a higher influence on UAM acceptance.

People's openness to having their homes flown over by drones is generally positive, albeit with variations based on specific factors. The purpose of the drone flight and the time of day play a significant role in shaping individuals' acceptance levels. For instance, drones used for recreational or leisure purposes during the daytime tend to be more readily accepted compared to drones used for surveillance or delivery purposes at night. Additionally, studies suggest that residents of larger cities exhibit higher levels of openness compared to those residing in rural areas, with industrial zones representing the most receptive group [29].

Regarding the operating conditions of drones, Al Haddad et al. [32] presented a study that assesses users' acceptance and adoption of urban air mobility by analyzing a stated preference survey. Factors on the acceptance of both technology and automation found in the literature (notably on autonomous vehicles) were projected to UAM and included in an extended technology acceptance model. The analysis highlighted the importance of socio-demographic parameters and their attitudes for UAM adoption, but also trust and safety were found to be key components. Particularly, the presence of in-vehicle cameras and operators, as well as performance expectancy in terms of service reliability and on-time performance was noted. Data and ethical concerns, the value of time savings and costs, and social attitudes, including a high affinity to social media, were also found as highly influential for UAM adoption. Finally, public transportation as a commute mode was found to be rather related to late adoption.

Cohen et al. [33] employed a multi-method approach with 106 interviews with transportation industry experts and two stakeholder workshops to construct the history, ecosystem, state of the industry, and potential evolution of UAM, as well as potential barriers for growth and acceptance, infrastructure needs, and environmental impacts. The acceptance challenges identified are distributed in four categories: i) noise, visual, pollution and privacy, ii) social equity, iii) personal safety, and iv) operational safety and security. The authors suggested mitigation strategies, such as restrictions on the use of photo and video equipment, for the first category number 1, ensuring fair treatment for all and community engagement for the second category. This study also highlighted the importance of non-user impacts and social equity.

Eker et al.[34] offered insights into people's perceived benefits and problems associated with the future usage of UAM, which might have a significant impact on the adoption by the commuting population and the establishment in the traffic fleet. The essential components of public perception were determined using data from an online poll, in terms of advantages and problems stemming from different travel times, and environmental, financial, or operational aspects. Among the conclusions, the study draws are about how future policy interventions might try to raise public knowledge of the autonomous aspects of UAM.

Leon et al. [35] assess consumers' perception of last-mile drone delivery by observing if factors such as privacy, usefulness, legislation, and trust would affect the adoption of these services. The authors found that drone acceptance increases if people perceive drone delivery to be useful and if they trust the service provider. This is consistent with the notion that perceived usefulness is the strongest mediator on acceptance of UAM, as stated by Yavas and Tez [36].

Kalakou et al. [37] studied attitudes towards technological innovation in the case of UAM. Their findings revealed three clusters of people that are more open to acceptingt UAM-based services (early adopters, open-minded, and pollution sensitive), and another three with respondents with mixed feelings or misgivings (emergency supporters, skepticals, and deniers). The authors concluded that receptiveness towards UAM is expressed by perceived societal benefits, translating into usefulness at a community level and adding that there is a common understanding of the potential benefits of usage on healthcare issues. Furthermore, the authors suggested that data collection should be expanded to understand how socio-demographic factors and mobility behaviour may affect the views of citizens.

Despite the previous studies on UAM acceptance, the literature continues to highlight the need for further studies to overcome the barriers related to negative public perception [5, 26] by engaging the prospective users in the co-creation of UAM-enabled services [22]. In addition, different attitudes from one region to another arising from economic, lifestyle, and cultural

differences have been acknowledged by other researchers [27, 37], motivating the importance of evaluating UAM acceptance in unstudied locations.

**Key Takeaways**

There are various applications with potential for UAM, especially regarding health and emergency uses but also logistics purposes.

Social-demographic indicators such as gender, age, income, and education impact perspectives on UAM.

There is potential for acceptance and adoption but concerns regarding safety and privacy for those on the ground must be addressed.

## 2.2 Health applications of UAM

In this section, we explore the current literature on the utilization of drones in the medical field, examining their potential to enhance healthcare delivery and emergency services. These have the potential to revolutionize some industries, facilitate the transportation of goods and even serve humanitarian purposes, such as the delivery of medical supplies to regions with bad road infrastructure [11, 17, 18, 38].

The main goal of medical delivery and emergency services is to provide timely and efficient deliveries and effective scouting. The effectiveness of the assistance often depends on the ability to quickly deliver basic supplies, and using drones or unmanned aerial vehicles can greatly improve this process [19]. Studies also show that among the public, there is already a common understanding of the potential for medical/emergency drones, and they are expected to become more common in the future [37, 38]. This is also mentioned by other authors that refer that these types of applications are perceived as the most useful cases for UAM [10] and will become a viable alternative as it becomes more ubiquitous and accepted, especially in emergency situations [39]. Medical supplies used might include medicines, blood, or devices such as automated external defibrillators (AED) [18, 40, 41]. Zhu et al. [42] tested to some success the stability of cancer medicine during transport.

A trial by van Veelen et al. [43] was run where drones were used to deliver medical emergency supplies such as AEDs. The results show that they were much faster than normal emergency medical services (EMS) and bystanders reported that the availability of the supplies was perceived as safe and feasible. This corroborates Claesson et al. [20] that, in an experiment, revealed that drones, in comparison to EMS, are also much faster. They showed a response time from call to dispatch of 3 seconds by medical drone against 3 minutes for EMS, in addition to a median time from dispatch to arrival on the scene of 5 minutes and 21 seconds for drones and 22 minutes for EMS. In a pilot study, it was demonstrated that drones can be utilized to transport AEDs to individuals experiencing out-of-hospital cardiac arrest (OHCA), with a successful delivery rate of 92% [41]. In another study, Baumgarten et al. [44] conducted a simulation in rural Germany to evaluate the feasibility of using drones to deliver AEDs directly to OHCA sites. The study found that integrating airborne AED delivery into the chain of survival is feasible and safe but is still considered an experimental technology. The use of UAM for AED delivery could potentially improve the availability of early public-access defibrillation, especially in rural areas where community first responders may face limitations in accessing

AEDs. There is also interest and potential for transport of specific highly sensible and perishable cargo, such as blood that has a short life outside of storage and that usually requires fast access and the blood banks to be centralized [11]. In a real use case in Valencia (Spain), Garcia et al. [45] found that their experiments prove that there is feasibility for UAM delivery as an extra support for ground transport in dire situations even if implementation on a large scale requires further development to be done safely. Emergency transportation of patients is also a noteworthy application however it requires a higher level of maturity and trust in UAM technologies to ensure safe and reliable operations [46].

Drones can also be utilized as an essential tool in disaster risk assessment due to their surveying and monitoring capabilities. Drones equipped with sensing tools such as thermal cameras, radars, electronic sniffers, and acoustic sensors can provide detailed information on temperature, radiation levels, and toxic chemicals in affected areas [19]. This approach can overcome the logistical challenges and unpredictability of conducting proper post-incident surveying during natural and human-made disasters. They can also play a key role in helping in various ways to prevent the further spread of pandemics by assisting authorities in various tasks [47]. One proposed solution involves the use of drones for aerial surveillance of individuals who do not comply with restrictions or are unaware of the latest restrictions [39]. However, this solution is controversial and raises concerns about privacy and civil liberties that could hinder the acceptance of the technology in the long term.

In their study, Truog et al. [48] highlight the importance of assessing stakeholder and community perceptions before initiating medical drone deliveries. Respondents held optimistic attitudes about drones' potential to reduce transport time but had concerns about drone crashes. Sham et al. [49] conducted a study to assess the attitudes of rural healthcare workers towards the use of drones for medicine and vaccine delivery. The results showed a mixed attitude towards drone usage, with slightly more than half of the respondents having a positive attitude. More than half agreed or strongly agreed that using drones for delivery was a good idea (54,2%), wise idea (54,6%), and desirable (52,5%). Factors that influenced their attitude included *leadership innovativeness*, perceived delivery risk, and being male. The perceived benefits of using drones, such as speed, environmental friendliness, higher compatibility, and lower complexity, were strongly correlated with a positive attitude.

Drones could be especially impactful particularly for rural communities during health emergencies with hindered access due to poor infrastructure [18, 39]. In addition to providing faster and more cost-effective transport of medical supplies, improving the management of emergency situations. African nations have shown such remarkable success that a lot of other countries want to follow in their footsteps. Aerial delivery of medical supplies to health facilities in remote communities has already been done with some success [11, 50]. For example, Zipline, a drone operator, has been delivering blood in Rwanda since 2016 and has seen delivery times drop from 4 hours to 30 minutes and totalling 4000 missions and 7000 delivered units of blood, with one-third of those being emergency situations [17]. These numbers support the estimates that each Zipline drone, in its operating lifetime, will save 8 lives [11]. However, this is not exclusive to Africa, as medical access to rural communities is a challenge all over the world. Matternet, another drone operator, has flown over 1800 flights in Swiss cities to deliver blood and testing specimens [17].

Advancements in technology have made it possible for specialist doctors in urban areas to remotely provide professional care to patients in rural or underserved areas, without the need for transportation to medical centers, reducing costs. This approach allows doctors to obtain

information directly from the patient's living environment, eliminate long wait times, examine multiple patients per day, and ensure constant monitoring of critically ill patients [39].

Scott et al. [38] proposed two novel models for the design of a drone-based healthcare delivery network that aims to improve the timeliness, efficiency, and cost-effectiveness of delivering healthcare via drones, potentially leading to saving lives. They found that a tandem strategy, involving the use of traditional land transportation followed by drone delivery, was found to be the most effective approach for achieving the desired goals. While Jain et al. [51] suggest the use of drones for medical supply deliveries without using a camera for path planning to address privacy concerns. GPS is used for navigation, and medical practitioners can request supplies through a mobile application, which sends the coordinates and requirements to a remote server. The operator loads the supplies into the drone's container. Another study [52], presented an optimization model for the logistics of a fleet of drones to deliver medical items to hard-to-access locations, such as rural and suburban areas. A novel timeslot formulation is proposed to schedule trips and serve demand locations efficiently, while minimizing total completion time. The model addresses the selection of charging station locations, assignment of clinics to providers, and scheduling and sequencing of trips for timely delivery of medical items.

To fully utilize the potential of drone technology, appropriate regulations must be established and enforced worldwide. This includes raising awareness among users and potential users of existing regulations to prevent unauthorized usage [50]. To ensure the sustainability of drone-based medical supply delivery, it is crucial to promote inclusive innovation by creating public awareness about the technology, training health personnel on how to handle medical supply dispatches using drones and establishing a regulatory policy framework to ensure safe and acceptable use of medical drones without high misuses and negative effects [18].

Drone-based medical delivery models offer an innovative approach to address longstanding issues of healthcare accessibility and equity and are particularly relevant in the context of pandemic situations, as they can help prevent the spread of the disease by reducing unnecessary human contact [53]. Even if a region has a robust healthcare system, healthcare inequality can still be pervasive, especially in remote, rural, or poorer communities where access to services can be a challenge. Drones can offer an attractive alternative for the delivery of supplies and telemedicine services, overcoming issues such as poor road quality, seasonal access, severe weather events, and lack of access to specialist services and diagnostics. The potential for offering screening services is also an attractive feature. Other authors have highlighted potential uses in managing remote workforces, emergency medical response, and expanding the reach of specialized hospital programs beyond urban areas [53].

**Key takeaways**

Health, medical and emergency applications of UAM are seen as some with the most potential.

There is potential to significantly impact lives by using drones to access remote areas or with poor road infrastructure (e.g., African countries).

Optimism for improvement in emergency response times especially in cases such as delivering AEDs to OHCA occasions.

## 3 Theoretical Background

Following the contextualization of drones and the diverse perspectives on their utilization as a service, this section aims to provide the background for the main frameworks employed in developing the subsequent topics, namely methodology and results.

### 3.1 Statistical analysis

Cluster analysis has been widely employed for market segmentation [54]. The Partitioning around medoids (PAM) cluster algorithm minimizes the distance between the points in their assigned cluster and the point designated to be the center of the cluster (medoid). The medoid is the data point in the cluster with a minimal average dissimilarity to all the other points in the same cluster [55], i.e., it is the most centrally located data point in the cluster. There are several advantages of using PAM clustering over other algorithms, such as the k-means; it is intuitive, less sensitive to noise and outliers, and copes with categorical variables compared [56]

The Gower distance [57] is a common measure applied to clustering with mixed data, fitting well with PAM [55, 56]. We used the Gower distance to measure the dissimilarity between observations. It ranges between 0 and 1 and can be defined as the mean of variable-specific dissimilarities across observations, as depicted by equation 1:

$$d_{ij} = \frac{1}{p}\sum_{i=1}^{p} d_{ij}^{f} \tag{1}$$

Where $d_{ij}$ is the dissimilarity between observations *i* and *j*, $d_{ij}^{f}$ is a partial dissimilarity between *i* and *j* for variable *f*, and *p* is the number of variables. $d_{ij}^{f}$ is standardized using equation 2 when *f* is numerical, such as:

$$d_{ij}^{f} = \frac{|x_{if} - x_{jf}|}{R_f} \tag{2}$$

where $x_{if}$ and $x_{jf}$ are the observed values for the two individuals and the same variable *f*, and $R_f = |max(n) - min(n)|$ is the maximum observed range from all individuals for variable *f*, being *n* the number of individuals in the dataset. When *f* is categorical, the partial dissimilarity is equal to 0 only if observations $x_{if}$ and $x_{jf}$ belong to the same category, and to 1 otherwise. Missing values are allowed, as the dissimilarities for a given feature are computed considering only the non-missing values [58].

However, when running the PAM algorithm, the number of clusters must be provided beforehand. Performance measures such as the silhouette coefficient indicate an optimal number of clusters. Based on pairwise differences between and within cluster distances, the silhouette coefficient represents the contrast between the average distance between data points within the same cluster and the average distance to data points in the nearest cluster. For a good partitioning, this coefficient should be maximized [56]. On the one hand, interpretability is key to the presentation of meaningful insights, as a low number of clusters may produce uninformative results, while a high number can lead to over-segmentation, isolating small groups that cannot be considered representative of general patterns [58].

Correlation analysis is a statistical technique used to measure the strength and direction of the relationship between two or more variables. It helps determine whether variables are positively

or negatively correlated and the extent to which changes in one variable are associated with changes in another [59]. Group comparisons, on the other hand, involve comparing different groups based on specific characteristics or variables of interest. This allows to investigate whether there are statistically significant differences across various groups. Nonparametric statistics do not rely on specific parameterized probability distributions or make assumptions about the underlying probability distribution of the data. Unlike parametric statistics, which are suitable for continuous, interval data with equal intervals or differences, nonparametric methods are specifically designed for analyzing ordinal data [60]. Thus, as Likert scales [61] are ordinal in nature they were analyzed when it came to correlations by both Spearman (ρ) and Kendall (τ) in addition to Kruskal-Wallis for group comparisons. However, Murray's findings [62] support the use of both parametric tests, such as Pearson correlation, and non-parametric tests, such as Spearman, for analyzing Likert scale data without significant impact on the conclusions; it should be noted that the application of Kendall (τ) yielded divergent outcomes.

Spearman rank correlation (ρ) [63] instead of working with the actual values of the variables ranks the data points and computes the correlation based on the ranks. It assesses whether there is a consistent increase or decrease in the values of one variable as the values of the other variable increase or decrease, without assuming a linear relationship. The resulting correlation coefficient, ranging from -1 to 1, indicates the strength and direction of the monotonic relationship between the variables. A coefficient of +1 or -1 indicates a perfect monotonic relationship, while a coefficient of 0 suggests no monotonic relationship [64]. Equation (3) is used to calculate the coefficient (ρ) and is defined as follows:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \tag{3}$$

For each point ($x_i$,$y_i$), the square of the difference in the ranks of the two coordinates is represented by $di2$, and the sum of each of these squares is represented by the expression $\sum d_i^2$.

Kendall correlation (τ) [65] is a statistical measure used to quantify the strength and direction of association between two variables similar to Spearman's (ρ) . The definition can be given as two observations are called concording if the two members of one observation are larger than the respective members of the other observation. The coefficient can range from -1 to 1 and is formulated in equation 4 as follows [66]:

$$\tau = \frac{2(N_c - N_d)}{n(n-1)} \tag{4}$$

If $N_c$ and $N_d$ account for the total number of pairs of concording and discording observations, respectively. Two pairs for which $X_i = X_j$ and $Y_i = Y_j$ are neither concording nor discording and are therefore not counted either in $N_c$ or in $N_d$.

The Kruskal-Wallis test [67], is a nonparametric statistical test designed to compare the differences among three or more independent groups on a single continuous variable that is not normally distributed. The test is used when we have k samples, with $k \geq 2$, coming from k populations that can be different [66].

It is specifically suited for non-normally distributed data, such as ordinal or rank data. In contrast, the one-way analysis of variance (ANOVA), which is a parametric test, is typically used when the continuous variable follows a normal distribution [68]. It serves as the nonparametric counterpart to the one-way ANOVA, allowing for the comparison of groups that

do not meet the assumptions of normality. By applying the Kruskal-Wallis test we can determine whether there are statistically significant differences among the groups based on their ranks or orderings, without relying on the assumption of normality.

The data is represented in *k* samples. We designate by $n_i$ the dimension of the sample *i*, for *i* = 1,...,*k*, and by *N* the total number of observations, as represented by equation 5 [66]:

$$N = \sum_{i=1}^{k} n_i \tag{5}$$

The N observations are classified in increasing order without taking into account whether or not they belong to the same samples. Then its given rank 1 to the smallest value, rank 2 to the next greatest value, and so on until N, which is given to the greatest value. Let $X_{ij}$ be the *j*th observation of sample *i*, and set *i* = 1,...,*k* and *j* = 1,...,$n_i$; then the denoted the rank given to $X_{ij}$ by R ($X_{ij}$) . If many observations have the same value, we give them a mean rank. The sum of the ranks given to the observations of sample *i* is denoted by $R_i$, giving us equation 6 [66]:

$$R_i = \sum_{J=1}^{n_i} R(X_{ij}), \quad i = 1, \dots, k \tag{6}$$

Post hoc tests, such as the Dunn test, are used to determine significant differences between specific pairs of groups after an initial analysis indicates the presence of overall group differences. The Dunn test allows for pairwise comparisons while controlling for the familywise error rate, which is the probability of making at least one Type I error (false positive) across all comparisons. This test provides a more detailed understanding of group differences and ensures that the probability of false positive findings is reduced and is also found to an appropriate test following Kruskal-Wallis [69]. Dunn's z-test statistic (7) approximates exact rank-sum test statistics by using the mean rankings of the outcome in each group from the preceding Kruskal–Wallis test ($\overline{W}_i = W_i/n_i$, where $W_i$ is the sum of ranks, and $n_i$ is the sample size for the *i*th group) and basing inference on the differences in mean ranks in each group. To compare group A with group B, we calculate [69]:

$$Z_i = \frac{y_i}{\sigma_i} \tag{7}$$

where *i* is one of the 1 to m multiple comparisons, $y_i = \overline{W}_A - \overline{W}_B$, and $\sigma_i$ is the standard deviation of $y_i$, given by (8):

$$\sigma_i = \sqrt{\left\{\frac{N(N+1)}{12} - \frac{\sum_{s=1}^{r} \tau_s^3}{12(N-1)}\right\}\left(\frac{1}{n_A} + \frac{1}{n_B}\right)} \tag{8}$$

The Bonferroni correction is a commonly used approach to adjust the significance level when conducting multiple comparisons, making the threshold for declaring statistical significance more stringent. By employing the Bonferroni adjustment, the Dunn test maintains the desired level of significance and reduces the likelihood of falsely concluding a significant difference between groups. The Bonferroni adjustment multiplies each p-value by *m*, as shown in (9) where $p*$ indicates an adjusted p-value.

$$p* = pm \tag{9}$$

## 3.2 Service design

The importance of innovation in services that truly serve customer needs has become increasingly recognized and emphasized in research. Patricio & Fisk [70] highlight that services are essential for human well-being, spanning sectors such as healthcare, education, finance, government, hospitality, tourism, and entertainment. To achieve true innovation, it is not sufficient to simply refine existing services. Instead, a more comprehensive and holistic approach is needed [71]. This aligns with the understanding that customer experiences are inherently holistic [72] and should consider broader user goals and contextual factors [73]. Service design, as an interdisciplinary field, integrates concepts from service science and design thinking, drawing on contributions from services marketing, interaction design, operations management, and information systems. This integration enables the development of service offerings that allow customers to co-create valuable [70].

### *3.2.1 Mind-maps*

Mind mapping is a powerful technique that harnesses the human brain's divergent and expansive thinking. It simplifies complex ideas by representing them in a clear and natural way using color lines, graphic symbols, and concise words. Mind maps serve as effective visual diagrams, facilitating problem-solving, analysis, and design management processes. By tapping into the brain's unlimited potential, mind mapping unlocks creativity and enhances cognitive abilities, making it an invaluable tool for designers and individuals seeking to organize and explore ideas [74]. Which corroborates its usefulness before the perspective of holistic necessity [71] and interdisciplinary nature of service design [70] .

### *3.2.2 Stakeholder Analysis*

Stakeholder analysis is often considered a valuable approach to apply to recognize conflicts potential that can arise between different stakeholders when exploring a complex innovation avenue such as UAM applications.

The popular stakeholder analysis method, known as the stakeholder power/interest matrix (Figure 2), is widely used across various industries for categorizing stakeholders based on their power, interest, and influence. This top-down approach, introduced by Eden & Ackermann [75], has been applied in diverse contexts, including renewable energy [76] and corporate social responsibility [77] demonstrating the flexibility of the tool. Nonetheless, relations between stakeholders might be displayed in several different ways such as ecosystems, stakeholder maps, actor-network maps, or more complex iterations such as multi-layered maps [78].

The matrix provides guidance on the actions to be taken with different stakeholder groups based on their power and interest levels. Stakeholders who have high power and high interest should be managed closely, with significant efforts made to fully engage and satisfy them. Stakeholders with high power but less interest should be kept satisfied, with enough attention given to prevent disengagement. Stakeholders with low power but high interest should be kept informed, ensuring they are adequately informed and addressing any emerging concerns. Finally, stakeholders with low power and less interest should be monitored, without overwhelming them with excessive communication [79]. Even though the specific definition of the quadrants in the stakeholder matrix, such as "Manage Closely," cannot be attributed to one author, the term "Manage Closely" is commonly used and can be found in various stakeholder management frameworks, including the work of Chinyio et al [79].

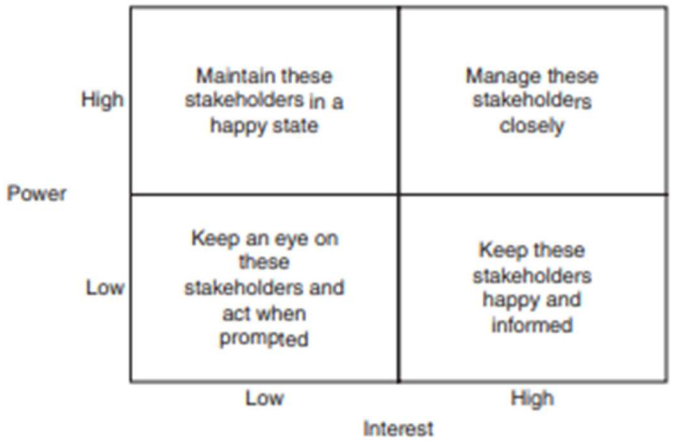


**Figure 2 -** Stakeholder Power/Interest matrix by Chinyio [79].

### *3.2.3 Multilevel service design*

Multilevel Service Design [71] (MSD) is an interdisciplinary approach that integrates iterative design, service science, management, and engineering to design complex service systems. It comprises three hierarchical levels: service concept, service system, and service encounter. MSD emphasizes the importance of customer experience across all three levels of interaction between the customer and the company [70]. The Value Constellation Experience (VCE) is co-created through interactions with high-level services that enable a given user activity, these are the high-level service enabled activities that allow for the functioning of the core service offering. The Service Experience (SE) represents the services' processes, artifacts and technologies that allow for the co-creation of value throughout customer interactions at the service system level, and the Service Encounter Experience (SEE). SEE maps the moments of interaction between the user and the service. This holistic analysis of the customer experience helps identify opportunities for service providers to enhance their offerings and can also be used to explore new possible service concepts [70].

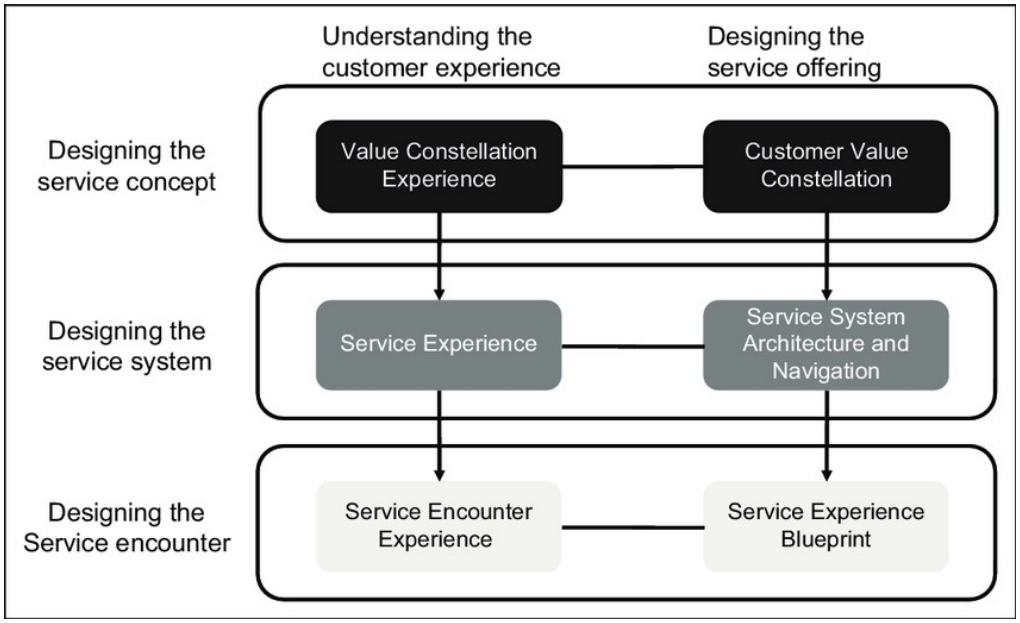


**Figure 3 -** Multilevel Service Design diagram by Patricio et al. [71]

### Service Concept

After a comprehensive analysis of the customer experience across all three levels, the next step in MSD implementation is to design the service concept [71]. In this phase, service designers should consider the Value Constellation Experience (VCE) to gain a broader understanding of the customer's activities and explore new service possibilities beyond the company's existing boundaries. To do so, they should establish connections between high-level services and a range of offerings, considering the interrelationships among service providers. This process helps define the Customer Value Constellation (CVC) by mapping the customer's activities at the center of the value network, with offerings positioned and connected to the main node[70, 71]. Through this approach, value is co-created within the company's boundaries and extends beyond its dependencies.

### Service System

Based on an understanding of the service experience, the design of the service system aims to operationalize the value proposition. This is achieved through the use of the service system architecture (SSA) and service system navigation (SSN) to design the service system. The SSA depicts the main tasks customers perform to engage with the service. The columns of the SSA represent the service interfaces (frontstage) and the support processes and technologies (backstage) that enable customers to co-create their experiences. The body of the matrix illustrates the service interfaces and backstage activities that support each customer service task. Each cell represents a service task performed at a specific service interface, representing a service encounter or touchpoint [71].

### Service encounter

In the third level of MSD, the focus is on designing the touchpoints between the customer and the service provider. This involves defining the interaction settings, processes, and participant roles in detail. The customer's co-creation of the service is facilitated through each interaction with a service interface while they are executing or going through a service task [70, 71].

## 4 Methodology

To understand attitudes and perceptions towards UAM, firstly at a macro level and later to specifically explore its medical applications the following macro steps were undertaken (Figure 4):

1. Literature Review on UAM.
2. Survey A on citizens' attitudes towards UAM.
3. Literature Review on Health applications of UAM.
4. Survey B on Healthcare workers' perceptions on medical applications on UAM.
5. Proposing service concepts.

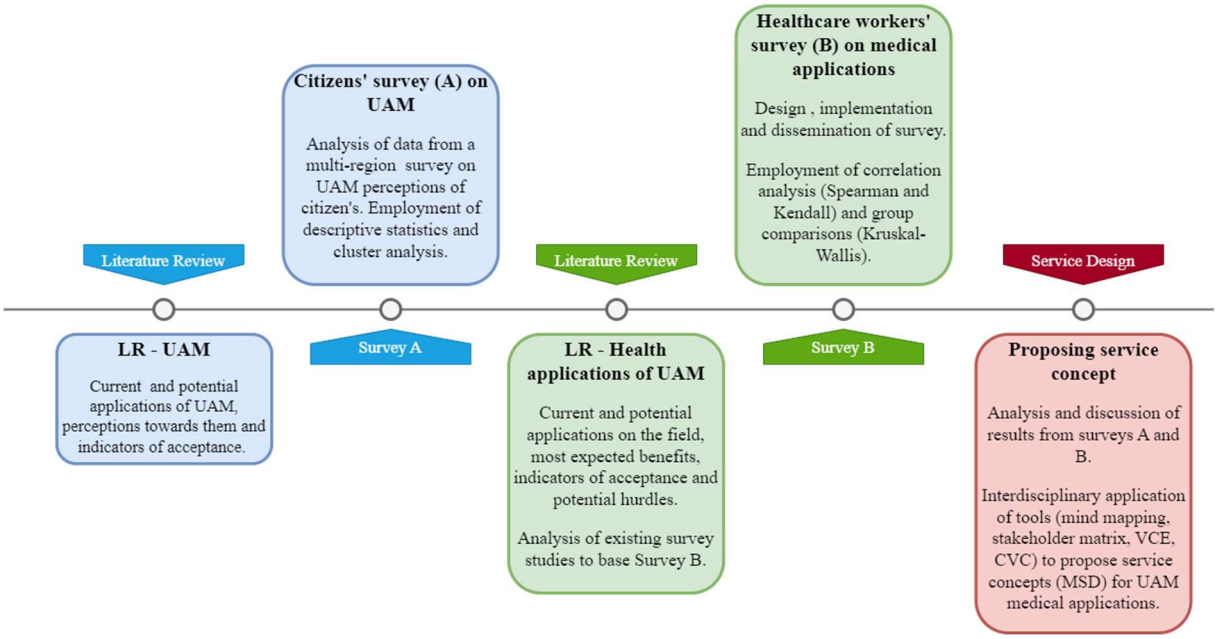


**Figure 4** - Dissertation Macro-steps

The dissertation began with an initial phase led by Literature review on UAM, followed by an analysis of existing survey data (survey A) from the ASSURED-UAM project, an European Union-funded project, ASSURED-UAM (Acceptance, Safety and Sustainability recommendations for efficient deployment of UAM), that aims to ensure robust conditions for safety, sustainability, and acceptance of UAM while promoting best practices, standards, and solutions for several relevant entities. The research is conducted in three EU regions: Porto (Portugal), Bari (Italy) and the Górnośląsko-Zagłębiowska Metropolitan area (Upper-Silesian region in Poland).

The findings from survey A revealed that the anticipated benefits of UAM primarily revolved around societal advantages, such as the reduction of pollution. These insights align with the concept that perceived usefulness plays a mediating role in the acceptance of UAM, as suggested by Kalakou et al. [37]. However, the analysis also uncovered concerns regarding safety, security, and privacy, particularly regarding the presence of remotely controlled flying objects equipped with cameras near people. This highlights the need to consider niche applications for UAM [9], as widespread implementation may lead to the replication of existing ground-related issues in the airspace. Furthermore, as one of the main advantages of UAM is the alleviation of congestion in cities caused by conventional forms of transportation like cars and trucks, careful consideration must be given to prevent the potential replication of these problems in the sky. In addition to the considerations, social equity concerns are also relevant in the context of UAM. There is apprehension that UAM services may predominantly cater to

the elite, further exacerbating existing inequalities. However, by focusing on niche applications like health services, UAM has the potential to address social inequality issues, particularly in terms of healthcare accessibility [80]. For instance, it can serve as a tool to bridge the gap in healthcare access between rural and urban areas, thereby contributing to the fight against social inequality in healthcare [33].

Given the potential of UAM in medical applications, it was logical to explore this area in the research. The literature supports the idea that medical applications of UAM are highly promising [80], widely recognized as having significant potential [37, 38], and perceived as highly useful [10]. This is particularly evident in emergency situations where UAM can contribute to reducing response times and improving access to remote or difficult-to-reach areas, thus enhancing emergency medical services [10].

The second phase of the research involved conducting a comprehensive literature review on medical applications of UAM. This was followed by the design, implementation, and analysis of a survey (Survey B) to gather insights into the attitudes and perceptions of medical workers regarding the use of UAM in healthcare. The findings from Survey B served as a valuable resource for understanding the current landscape and identifying key considerations for implementing UAM in medical settings. Based on the analysis of the survey results, a service concept proposal was developed for the sub-applications with the highest potential in the healthcare sector.

## 4.1 Citizen's attitudes towards UAM (survey A)

### *4.1.1 Survey Structure*

To deepen the understanding of public acceptance and identify potential for new drone delivery services, a survey was conducted by the ASSURED-UAM project. The data collection for this survey was conducted in 2021, prior to the start of this master thesis, thus the author was not involved in the design nor the implementation of the same. The survey comprised an online questionnaire with three parts:

1. Socio-demographic characterization.
2. Attitudes towards online shopping and home delivery services.
3. Acceptance of UAM technology and UAM delivery services.

The surveys were structured around topics such as: (i) online shopping habits (frequency, location, types of products, motives for online shopping, and satisfaction), (ii) preference for physical/online store, (iii) most used delivery methods (e.g., truck, van, bike, etc.), (iv) knowledge about and intention-to-use drone delivery, (v) willingness to pay for drone deliveries, and (vi) attitudes towards public investment in UAM infrastructure, expected benefits, and safety and security. Full list of questions (Portuguese example) available in Appendix 1. The survey was conducted online, firstly in Portugal, and later replicated in a large metropolitan area in the upper Silesian region of Poland, Górnośląsko-Zagłębiowska Metropolia (GZM), and Bari, in Italy.

### *4.1.2 Data Description*

After cleaning the data and harmonizing the variables from different countries (e.g.: categories for the level of education were created using EU equivalent levels), the results from the questionnaires were analysed. In this section, we describe the data collected and compare survey results.

From the Portuguese responses, 72% come from some of the most populated areas of the country (Porto, Aveiro, Braga and Coimbra). The sample size for the Portuguese survey is 300 respondents, while the polish survey counts with 500 responses. The Portuguese sample is not representative of the entire country, being concentrated around the larger Porto metropolitan area. The same applies to the Polish results in relation to GZM, and the Italian responses in Bari. The sociodemographic characteristics of the sample are presented in Table 1 for both Portugal and Poland and Table 2 for Italy.

**Table 1 -** Distribution of respondents' sociodemographic characteristics for Portugal and Poland.

| | | **Portugal (N=300)** | **Poland (N=500)** |
|---|---|---|---|
| **Gender** | Female | 45,3% | 51,2% |
| | Male | 32,7% | 48,8% |
| | N/A | 22,0% | - |
| **Age group** | Under 18 | 1,3% | - |
| | 18-24 | 25,3% | 9,6% |
| | 25-34 | 27,0% | 16,4% |
| | 35-44 | 14,7% | 20,0% |
| | 45-54 | 11,7% | 16,2% |
| | 55-64 | 2,3% | 16,2% |
| | 65 and over | 0,7% | 21,6% |
| **Education level** | Basic | 4,3% | 2,0% |
| | Secondary (grades 10-12) | 31,0% | 56,6% |
| | Higher education (Bsc, Msc) | 54,3% | 40,0% |
| | Doctorate/PhD | 10,0% | 1,6% |
| | Other | 0,3% | - |
| **Professional status** | Employee | 44,0% | 54,3% |
| | Self-employed | 2,7% | 8,5% |
| | Student | 42,0% | 4,2% |
| | Student-worker | 8,3% | 2,4% |
| | Unemployed | 2,0% | 3,8% |
| | Retired | 0,7% | 26,8% |
| | Other | 0,3% | - |

**Table 2 -** Distribution of respondents' sociodemographic characteristics for Italy.

| | | **Italy (N=125)** |
|---|---|---|
| **Gender** | Female | 20,0% |
| | Male | 79,2% |
| | N/A | 0,8% |
| **Age group** | 0-20 | 4,8% |
| | 20-40 | 42,4% |
| | 40-60 | 40,0% |
| | 60 and over | 12,8% |
| **Education level** | No education | 5,6% |
| | Secondary | 30,4% |
| | Higher Education (Bsc, Msc) | 54,4% |
| | Doctorate/PhD | 9,6% |
| **Professional status** | Employee | 45,6% |
| | Self-employed | 8,8% |
| | Student | 18,4% |
| | Student-worker | 1,6% |
| | Unemployed | 2,4% |
| | Other | 23,2% |

The sample in Portugal (PT) is not evenly gender-distributed, as females account for 45% of the sample while the rest is divided between males (33%) and N/A (22%). Regarding age, the 18-24 and 25-34 groups account for a cumulative majority of sample, with 52%. In the Poland (PL), both gender and age are more evenly distributed. About 64% of PT respondents have higher education, among which 10% have a doctoral degree, whilst the bigger group for PL is secondary education, with 57%. Approximately 44% of the PT sample is employed in comparison with 54,3% in the PL sample. The second largest group in the PT respondents are students, in contrast with PL which are retirees.

As for the italian sample, it is composed mainly by males (79%), young adults (42%), and people with higher education (64%). Employed respondents can be divided in manual labour and office workers. In terms of professional status, the second most selected option was “other”, which may include retirees since this option is not available.

### *4.1.3 Cluster Analysis*

To create a prospective users’ classification of drone delivery according to shopping habits and potential acceptance, the PAM algorithm was used. The algorithm was applied separately to the responses of the Portuguese and Polish surveys to highlight the differences between both regions. Due to some differences in the Italian survey in relation to its counterparts, a direct comparison was not possible, thus the clustering algorithm was only applied to the Portuguese sample (300 responses) and the Polish sample (500 responses).

**Table 3 -** Included variables used in cluster analysis.

| | Variables | Categories |
|---|---|---|
| **Demographics** | Gender | Female, Male, N/a |
| | Age | Under 25, 25-55, 55 and over |
| | Education level | Basic/secondary and Higher education |
| | Professional status | Active population, retired, student |
| **Shopping habits** | Online shopping frequency | Doesn’t shop, not frequently, frequently |
| | Types of stores and products used and bought online | Binary (Yes/No) |
| | Motives for shopping online | Convenience, diversity of choice, economy/cost, comparability between choices and speed of delivery |
| | Store preference | Online, physical, and indifferent |
| | Online shopping satisfaction | Likert scale (1-5) |
| | Perceived security when shopping online | Likert scale (1-5) |
| **Drone related** | Knowledge of drone utilization for deliveries | Binary (Yes/No) |
| | Willingness to pay extra for drone delivery | If faster, more flexible, and environmentally friendly |
| | Perception of the added value of drones in urban logistics | Binary (Yes/No) |
| | Expected benefits in cities from drones | Pollution reduction, congestion reduction, reduction of noise, improved deliveries, and better access to hard-to-reach locations |
| | Openness towards public investment | Binary (Yes/No) |
| | Willingness to have drone’s flyover their homes | Binary (Yes/No) |

Each respondent was considered as an observation, and the variables included in the cluster calculations represented sociodemographic characteristics, online shopping habits, and perceptions towards UAM (Table 3). Still, data cleaning and homogenization of specific variables was required. Examples of data treatment were the uniformization of types of higher education and age groups, which were treated equally in both countries despite depicting different categories in each country's survey. Higher education was aggregated according to European classifications.

Even though silhouette should be maximized to obtain optimal number of clusters interpretability also plays an important role therefore to define the number of clusters for the segmentation of the Portuguese and Polish respondents, we ran several iterations, starting with two clusters and increasing, using the software R [81]. Thus, number of clusters to retain in each case was determined considering a balance between interpretability and cluster performance.

#### *4.1.4 Survey limitations (A)*

During the analysis, several limitations were identified that affected the reliability and generalizability of the findings. One limitation was the imbalance in sample sizes, which could introduce a potential bias in the results. Additionally, there was a lack of representation across different demographics, which limited the ability to draw comprehensive conclusions.

Furthermore, the survey questions themselves posed limitations. The excessive use of categorical data without incorporating scales or dimensions hindered the ability to capture nuanced responses. Similarly, the inclusion of binary options in the survey limited the suitability of the data for statistical a more in-depth analysis.

Another limitation stemmed from the lack of language uniformity. The surveys were conducted in native languages, and the translations may not have been ideal, leading to potential discrepancies in responses. Direct comparisons between countries may not have been ideal due to variations in language interpretation and cultural contexts. For example, the perception of a reference marker, such as a price difference of 1€, may vary between countries like Poland and Portugal.

### 4.2 Perception and attitude of healthcare professionals towards the use of drones in healthcare services (survey B)

#### *4.2.1 Survey Design*

This study aims to understand the potential of using drones in healthcare services to help developing solutions that meet the needs of the sector.

The objective of this questionnaire is to gather information on the perception and attitude of healthcare professionals towards the use of drones in healthcare services, namely in the transportation of medications, vaccines, medical equipment, among others. The survey contained 32 questions divided as follows:

- Demographics and questions about professional career and professional position.
- Knowledge and attitudes towards the use of drones for medical or emergency purposes.
- Intention to use drones for medical purposes.
- Perceptions of using drones for medical purposes.
- Risk of using drones for medical or emergency purposes.

This questionnaire was developed, firstly, as a logical continuation of the survey on attitudes towards deliveries (survey A) and, secondly, based on the work of Yoo et al. [82], that studied factors affecting public's attitudes and intentions towards drone delivery, and Sham et al. [49], who, on a more specific note inquired rural workers about drone usage for medicine and vaccine delivery. Survey B addressed the limitations of Survey A by including Likert scales for dimensional measurement and conducting careful translations. Additionally, a validation phase involving four volunteers was carried out to ensure clarity and appropriateness of the survey. These improvements aimed to enhance data quality and provide a comprehensive understanding of medical workers' attitudes towards UAM applications in healthcare. The full list of questions is available in Appendix 2.

The survey was conducted online and disseminated via social media and through personal connections and those inquired were asked to share with healthcare professionals they know therefore employing a snowball sampling.

### *4.2.2 Data Description*

To address the limitations identified (see 4.2.4), certain modifications were made to ensure better representativity in the statistical analysis. Specifically, the following changes were implemented:

- Professional role responses that did not fit into other categories merged with "Others".
- Medical professors, researchers, and related roles were consolidated under the category of "Academic/Research."
- The category of large hospitals remained as a separate group.
- Labs and pharmacies were merged into a single category called "Labs and pharmacies."
- Academic/research institutions were combined with the "Others" category.
- Smaller hospitals, private practices, and health centers ("Centros de saúde") were grouped together as healthcare facilities/centers.

Mergers of workplaces into the same category were made on the criteria of size of location, and type of services and potential needs from UAM services, for example labs and pharmacies both have patient contact and need medical supplies however they don't have consultations or usually give urgent care. These refinements allowed for a clearer understanding of the data and facilitated the subsequent analysis of perceptions regarding the medical applications of UAM.

Most of the respondents fall into the age range of 18-34, comprising 60,4% of the sample. The distribution of respondents across different regions shows a significant concentration in Porto, accounting for 73,4% of the sample. This regional skew should be considered when generalizing the findings to other areas. Urban areas are the most common typology of regions, representing 86,4% of the respondents, followed by suburban areas (7,8%) and rural areas (5,9%).

In terms of professional roles, medical doctors are the largest group, representing 24,7% of the sample. Other notable professional groups include nursing professionals (21,4%), pharmacists (16,2%). The sample also comprises individuals with various levels of experience in their roles, ranging from less than six months to over 10 years. Additionally, respondents have diverse workplace typologies, with large hospitals being the most common (41,6%), followed by Labs & pharmacies (21,4%). In addition, most respondents (85,7%) have direct contact with patients, while 47,4% have direct contact with the process of delivering medical supplies/materials in their profession. A complete sample characterization is available in Table 4.

**Table 4 -** Distribution of respondents' sociodemographic characteristics for survey B.

| **Sample characterization** | | ***N=154*** |
|---|---|---|
| **Age** | 18-24 | 21,4% |
| | 25-34 | 39,0% |
| | 35-44 | 22,7% |
| | 45-54 | 9,1% |
| | 55 and over | 7,8% |
| **Region** | Porto | 73,4% |
| | Lisboa | 6,5% |
| | Vila Real | 5,8% |
| | Aveiro | 3,9% |
| | Coimbra | 3,2% |
| | Others (< 2%) | 7,1% |
| **Typology of region** | Urban | 86,4% |
| | Suburban | 7,8% |
| | Rural | 5,8% |
| **Professional roles** | Academic/research | 13,0% |
| | Administrative | 5,8% |
| | Medical Doctor (M.D.) | 24,7% |
| | Health aid | 2,6% |
| | Nursery | 21,4% |
| | Paramedic/Emergency | 3,9% |
| | Pharmacist | 16,2% |
| | Technician (pharmacy, laboratory, etc.) | 6,5% |
| | Others | 5,8% |
| **Experience in the role** | <6m | 9,7% |
| | 6m-1 year | 7,1% |
| | 1-2 years | 11,7% |
| | 2-5 years | 24,7% |
| | 5-10 years | 11,0% |
| | >10 years | 35,7% |
| **Typology of workplace** | Large hospital | 41,6% |
| | Health facilities/centers | 17,5% |
| | Labs & pharmacies | 21,4% |
| | Others | 19,5% |
| **Direct contact with patients** | Yes | 85,7% |
| | No | 14,3% |
| **Direct contact with supplies** | Yes | 47,4% |
| | No | 52,6% |

### *4.2.3 Statistical Analysis*

In the correlation analysis, both Spearman and Kendall correlation coefficients were employed and compared to identify any irregularities. To establish a valid correlation, it was required for both coefficients to confirm the presence of a significant correlation between the variables. By utilizing multiple correlation measures, the analysis aimed to ensure the robustness and reliability of the observed correlations.

Group comparisons were conducted using the Kruskal-Walli's test, which allowed for comparisons between a categorical variable, such as "professional roles" and survey questions (2.1-22) to determine if there were significant differences among the groups. To further investigate the nature of the differences, a post hoc Dunn test was employed. The Dunn test, which conducted pairwise comparisons to identify which specific groups, such as "doctor" and "nurse" in the case of professional roles, exhibited significant differences. The p-values resulting from the post hoc test were adjusted using the Bonferroni method to account for multiple comparisons and noted, however, since this study focused on evaluating the potential of UAM and there is no large-scale implementation of UAM currently, more conservative methods were not extensively used in the analysis as they could overly restrict the findings.

#### *4.2.4 Survey limitations (B)*

The research limitations of Survey B were primarily related to the sample size and the need for a higher representativeness of certain groups, which was not possible to obtain due to time constraints. Additionally, a broader geographical spread, including a mix of urban, rural, and suburban regions, would have provided more diverse perspectives, and potentially yielded different results. For example, regional factors, such as the type of region, can be crucial in understanding the nuances and variations in perceptions and attitudes towards the research topic.

### 4.3 From statistical analysis to Service design

The factors derived from the statistical analysis, including descriptive statistics, clustering, correlations, and group comparisons, can provide valuable inputs for service design. Through the surveys conducted, participants' perceptions of the technology, intention to use, attitudes towards it, and concerns about its utilization were assessed, enabling the identification of various service offerings. Additionally, these surveys offer insights into the overall landscape, stakeholders involved, and potential service ecosystem.

To facilitate the design process, this dissertation proposes the use of mind maps to visualize and organize the collected perceptions and attitudes. Furthermore, a stakeholder analysis can be conducted to identify key actors and their management in the UAM services context. By understanding the relationships and interactions among stakeholders, a more comprehensive service concept can be developed. Service concept itself comes from proposal of a Value Constellation Experience and to further explore the service concepts at hand in the Customer Value Constellation. As Patricio & Fisk stated [70] “The CVC can be used (…) to explore new possible service concepts that involve repositioning the organization’s offering and/or a reconfiguration of the value constellation”.

**Key takeaways**

Surveys A and B data description, statistical analysis, and survey limitations.

Two separate surveys, one preexisting (A) that regards UAM perceptions of citizens’ and a created one (B) about perceptions of health care workers in UAM.

# 5 Results and Discussion

## 5.1 Citizen's attitudes towards drone delivery

### *5.1.1 Survey (A) Results*

This section outlines the key takeaways from the survey responses and compares the results between Portugal (PT), Poland (PL) and Italy (IT).

More than 90% of respondents in the three regions stated that they have shopped online before. While most respondents shop online at least once a month, in all three regions, the second most selected option shows that Polish respondents shop more frequently than Portuguese and Italian.

Regarding shoppers' motivations, in both PT and PL, the ones who shop online are driven by convenience, others by easy access and speed of purchase, and diversity of choice. In the case of PT, this contrasts with a preference for physical stores, which is the least selected option in PL. In Italy, there is no clear preference for online shopping, as 39% refer that it is indifferent to shop online or in a physical store.

When it comes to awareness and attitudes towards drone delivery, the results show that there are significant differences between Portugal, Poland, and Italy. Of the three countries, Portuguese and Polish showed the least knowledge about drone delivery services, whereas most Italians are quite aware of drone deliveries (83%). The stated knowledge in Italy is remarkably high.

When presented with the scenario of using drone delivery services, PT and PL respondents are willing to pay an added value if the solution is more flexible than other delivery modes. Other drivers for opting for this kind of delivery are environmental concerns. Flexibility and environmental benefits contrast with the criterion of time as a motivator for online shopping, as both samples are divided in terms of paying for a faster delivery by drone (approximately 55% in both countries) and do not show a clear preference for faster deliveries. More than just a representation of the potential users, this may present a portrait of the online delivery markets, as one-day deliveries are currently offered independently of the transport mode.

In general, regardless of the acceptance of drone delivery services, there is a positive perception of using drones in the city centers, especially among the Portuguese respondents. Most significant expected benefits are lower congestion and pollution levels. Italians are the most supportive of public investment in these services and more open to have their home flown over by drones. In Portugal, people are less receptive to both situations. Therefore, it is interesting to note that although Portuguese respondents see more benefits in drone delivery, they are less open to facilitate the implementation of these services, while exactly the opposite happens with the Italian respondents. The main results about the shopping habits and perceptions towards drone deliveries are described in Table 5.

**Table 5 -** Survey's (A) main results

| Questions | Options | Portugal | Poland | Italy |
|---|---|---|---|---|
| **Has shopped online** | Yes | 90,0% | 96,8% | 92,7% |
| **Online shopping frequency** | One to four times a year | 40,0% | 18,2% | 23,2% |
| | Once a month | 44,1% | 38,4% | 53,6% |
| | Once a week | 12,6% | 29,0% | 19,2% |
| | Two or more times a week | 3,3% | 11,2% | 4,0% |
| | N/A | - | 3,2% | - |
| **Motives to shop online** | Convenience | 71,9% | 80,2% | - |
| | Ease of access and speed | 61,5% | 75,2% | - |
| | Diversity of choice | 48,1% | 66,5% | - |
| **Store preference** | Online | 24,1% | 43,4% | 31,2% |
| | Physical | 42,6% | 18,0% | 29,6% |
| | Indifferent | 33,3% | 38,6% | 39,2% |
| **Had previous knowledge of drone deliveries** | Yes | 33,0% | 39,6% | 83,9% |
| **Willingness to pay for drone delivery** | If faster | 44,7% | 54,8% | 45,2% |
| | If more flexible | 65,7% | 60,2% | 67,2% |
| | If more environmentally friendly | 69,0% | 52,0% | - |
| **Expected Benefits** | Decreased congestion | 92,0% | 81,0% | 66,8% |
| | Lower pollution | 86,0% | 74,1% | 55,2% |
| **Openness to public investment** | Yes | 52,5% | 66,8% | 81,6% |
| **Openness to having their home flown over by drones** | Yes | 62,0% | 70,8% | 76,8% |

### *5.1.2 Cluster Results*

The above-described methods were then used as a basis to perform the cluster analysis. In both datasets, the maximum silhouette coefficient values were observed for two clusters (0,21 for Portugal and 0,28 for Poland). However, in both cases, the option for three clusters, corresponding to the second highest silhouette values (0,11 for Portugal and 0,17 for Poland), favored interpretability and provided a better knowledge on different user profiles without incurring in oversegmentation. Particularly, it allowed to represent the respondents that are closer to a 'middle term' in terms of their acceptance towards drone deliveries. Both in Portugal and Poland, the clusters characterize the following profiles and are represented in Figure 5:

Cluster 1: low acceptance.

Clusters 2: potential acceptance.

Clusters 3: high acceptance.

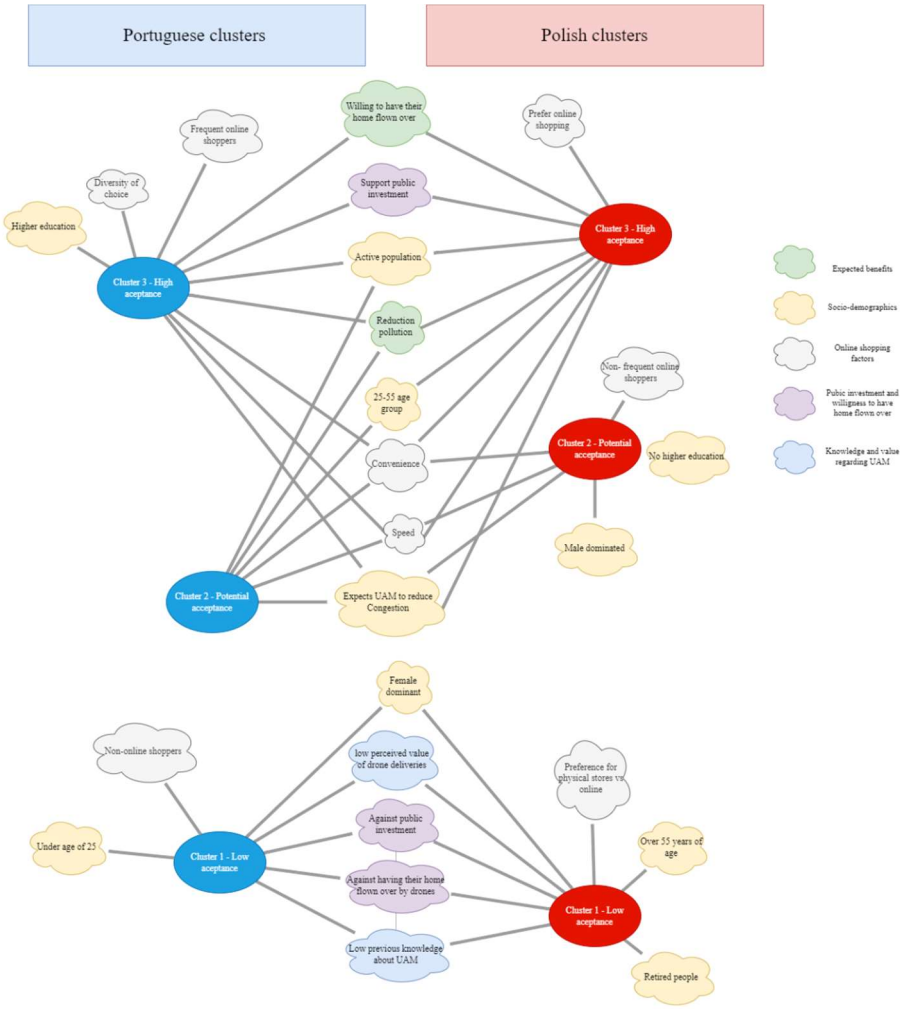


**Figure 5-** Cluster's summary diagram

#### 5.1.2.1 PORTUGUESE PROFILES

Cluster 1, the smallest cluster of the Portuguese sample (30%), is predominantly composed by female (55%) and young respondents under the age of 25 (52%). Interestingly, respondents in this cluster correspond to the highest percentages of non-online shoppers (16%) and non-frequently shoppers (76%), preferring to shop in physical stores (59%). When asked about their previous knowledge of drones for delivery purposes, only 23% of respondents in this cluster reported having some, and only 16% perceive value in this service. In terms of willingness-to-pay an increased fee for drone delivery, only less than 8% of respondents in this cluster reported that they would do so if the delivery was faster, while 36% reported that they would be willing to pay more if the delivery was environmentally friendlier, and 18% would pay for increased flexibility (e.g., change de delivery spot after the purchase). Overall, respondents in this cluster had low expectations of the benefits that drones could bring to cities, with more than 90% being against public investment in drone infrastructure and more than 80% being against having their houses flown over by drones. Thus, this cluster is considered to have low acceptance and low potential for adoption, as the respondents do not seem to believe in the concept.

Cluster 2 is the largest with 35% of the total sample and comprises most of the 25-55 age group (70%), and active population (68%). Concerning motives for shopping online, only convenience received an overwhelming majority of affirmative responses, while the responses to other options were mostly negative. The respondents appear to be environmentally cautious,

as they would pay more for environmentally friendly drone delivery (81%), while they foresee the most important benefits in congestion and pollution reduction, at 88% and 78%, respectively. There is also a high acceptance towards having their home flown over (79%), but in contrast, the support of public investment is moderate (57%). The respondents in this cluster have the potential for acceptance, but do not see relevant benefits (e.g., for operations) besides the environmental ones, showing some reserve about public investment.

Finally, cluster 3, which is considered of high acceptance, also accounts for around 35% of the sample, is gender-balanced and dominated by respondents with higher education (76%). 21% of the respondents claim to shop frequently online, which is the highest of all three clusters. When it comes to motivation to shop online, this segment values convenience, speed, and diversity of choice over economic reasons and comparability between options. This segment has also the highest ranking for online shopping satisfaction and perceived security, at 4.3/5 and 4.0/5 respectively. The respondents also show the highest previous knowledge (45%) and perceived value of drones (90%). They are most likely to pay extra for drone delivery if more environmentally friendly (86%) or flexible (91%). This segment is more positive about the potential benefits for city centres, with congestion (91%) and pollution (89%) reductions as the most expected benefits. Around 84% are open to both drone infrastructure public investment and have drones flying over their houses. Generically, this cluster is quite positive about UAM and its various implications.

#### 5.1.2.2 POLISH PROFILES

Cluster 1, of low acceptance towards UAM application in e-commerce, is also female-dominated (63%), but in contrast with the Portuguese sample, includes a significant amount of people over 55 years old (59%) and retired people (51%). These respondents prefer physical stores (39%) and have less habits of shopping online, and the lowest levels of online shopping satisfaction and perceived security. They also report the lowest level of knowledge about drone delivery applications (11%) and perceive the lowest value in using drones (18%). Less than 6% of this segment is available to pay more for drone delivery, even if it was faster, more environmentally friendly, or more flexible, with 85% claiming that they would not pay at all. The overwhelming majority does not expect any benefits for cities from drones, as 90% oppose to public investment in drone infrastructure, and 86% oppose drones flying over their houses.

Cluster 2, which has potential for acceptance, is dominated by males (58%) and by people without university degree (66%). 78% claim that they are not frequent online shoppers, but when they do, they prioritize convenience (78%) and speed (70%). Most respondents (52%) do not prefer either physical or online stores. Despite this, they still perceive value in drone usage for deliveries (89%) and would pay more for this service if faster (73%) and more flexible (79%). The only expected benefit for cities that the overwhelming majority expects is congestion reduction (83%). However, they still support public investment in drone infrastructure (87%).

Cluster 3, of high acceptance, is comprised of individuals aged 25-55 (74%) and by active population (82%). Approximately 70% of this segment shop frequently online and prefer online shopping to physical stores, primarily due to convenience (93%) and speed (88%). This group has also the highest levels of satisfaction when shopping online and of perceived security, scoring 4.6/5 and 4.1/5 respectively. Around 90% perceive value in using drones for delivery and the majority would pay more for faster, more environmentally friendly, or flexible drone-enabled deliveries. The most expected benefits are the reduction of congestion (77%) and pollution (78%). Additionally, they are in favour of public investment in drone infrastructure

(90%). This segment of high acceptance seems to value more the personal benefits this technology would bring rather than the benefits towards cities.

Generically, the sample distribution of the Polish respondents is similar to the Portuguese, with 28% of the respondents falling on the low acceptance cluster, 36% on the potential acceptance cluster, and also 36% on the high acceptance cluster.

### *5.1.3 Profile analysis*

Cluster 1, for both the Portuguese and Polish cases, represents a group with negative attitudes towards UAM deliveries. In both countries, this segment is female-dominated and, not surprisingly, contains most of the respondents who do not usually shop online. This predisposition of females to have lower UAM acceptance is consistent with the findings of previous research that revealed that women exhibit lower interest in immediate adoption and express greater security and safety concerns [29, 30, 37, 83]. Yet, Del-Real and Díaz-Fernández [31] showed that the difference between men and women is minimal. The clusters contrast in terms of age, as the PT cluster is composed by youth and the PL cluster is dominated by adults over 55 years of age. Another interesting characteristic of this cluster is that there is not a clear relation between drone delivery acceptance and the type of store or products bought online, but rather with the shopping frequency. The most important result to highlight in this cluster is the fact that PL respondents are more extreme in rejecting drone deliveries, while the PT results show some disbelief, but not a total rejection.

On the other hand, cluster 2 represents users that will potentially accept UAM. The similarities between the two regions are visible in the sense that users in cluster 2 support the introduction of UAM and see high value in it, but not as much of a positive or negative attitude as the other groups. Some differences between the regions are found in the motives to accept UAM. For instance, the PT cluster was more environmentally cautious and showed some interest in drone delivery. This aligns with Eißfeldt et al. [29] and Kalakou et al. [37] , who suggested that applications with benefits for all have a higher potential for agreement from the public. However, they are still reluctant, as suggested by their lesser positive attitude towards investment and expected benefits. The PL case for clusters is more pragmatic, as they also see a lot of value in application of UAM for e-commerce deliveries, but care mostly for the practical benefits it may bring, such as speed or flexibility of delivery, in addition to reducing congestion in cities. They also show the highest lack of preference for physical *versus* online stores and the highest acceptance of having their home flown over by drones.

In both regions, cluster 3 showed the most openness towards UAM application, showing high levels of satisfaction with online shopping and a strong willingness-to-pay for drone-enabled delivery. In both cases, the majority are young people, but there are mostly students in the PT sample, while in PL there is mostly active population (i.e., those of working age that are not currently studying). This confirms that age is a marker for acceptance of UAM [29–31]. However, the Polish have a slightly more positive predisposition towards UAM acceptance than the Portuguese.

Figure 6 presents the obtained clusters in relation to the willingness-to-pay an additional fee for drone delivery and the openness to public investment in UAM infrastructure.

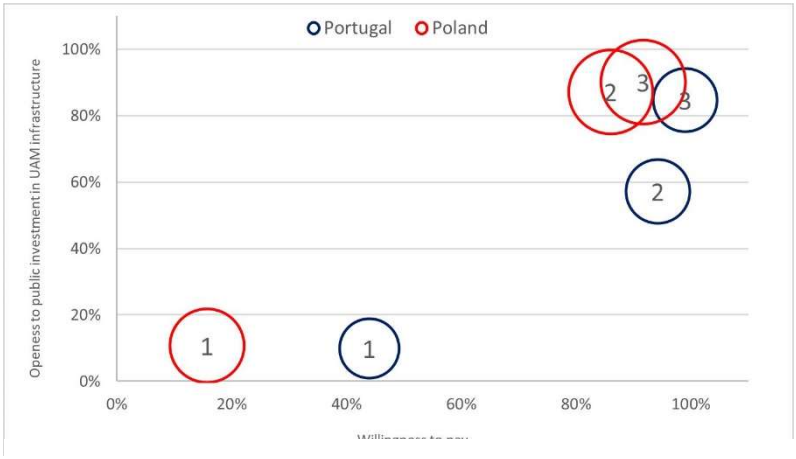


**Figure 6** - Willingness-to-pay *versus* openness to public investment.

In both regions, cluster 1 (low acceptance), share similar views on public investment, but the willingness-to-pay is much higher in PT. The Polish cluster representing potential acceptance is more open to public investment than its Portuguese counterpart (cluster 2). The high acceptance clusters are more similar in both regions in relation to the depicted variables, as it is visible from the overlap between both clusters 3. Additionally, in the Polish sample, the potential acceptance cluster is like the high acceptance one, which makes it also very close to the high acceptance Portuguese cluster regarding public investment and willingness-to-pay. This further strengthens the idea of the Polish being more open to spend money on drone-enabled services.

When it comes to the expected benefits for city centers (Figure 7), the overall reductions in traffic and pollution are the most anticipated, even by the clusters with low acceptance. This is consistent with the findings of Kalakou et al. [37] regarding societal benefits dictating receptiveness of UAM and also aligned with the expected benefits of a study published by the European Union Aviation Agency [10]. In contrast, the reduction in noise is not expected, even by people belonging to the most optimistic clusters.

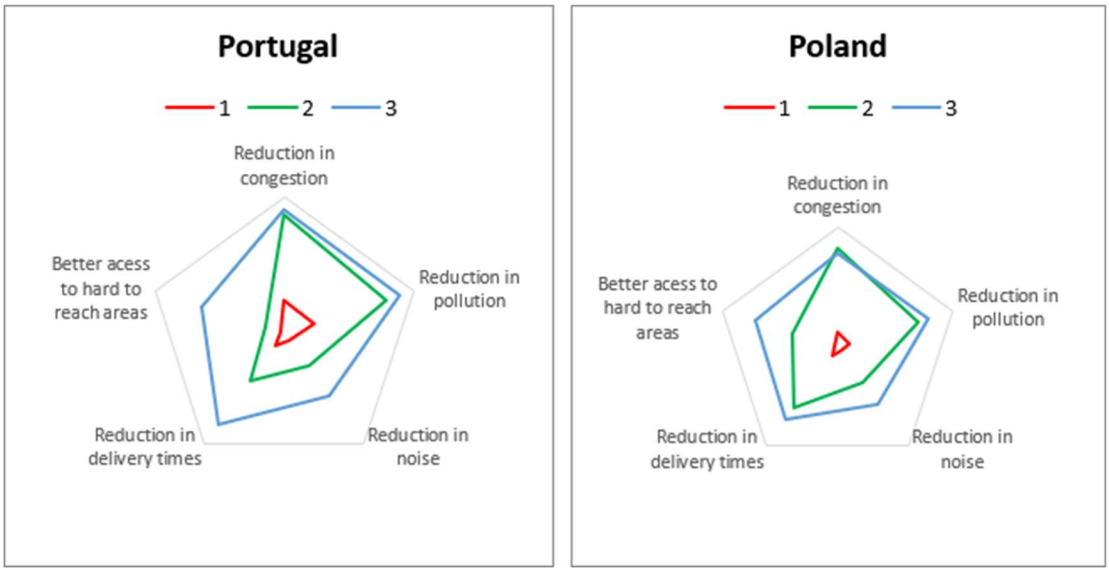


**Figure 7 –** Radar chart of expected benefits for Portugal and Poland

When studying attitudes towards UAM and its potential adoption, it is important to consider the attitudes of different groups of potential users. As represented by the clusters extracted in this analysis, there is a clear distinction between potential acceptors/potential acceptors and non-acceptors. However, all can have an impact on the deployment of UAM, but in different ways. Customer segments represented by clusters 3 will play an important role in the adoption of this innovative technology since they are likely to be early adopters and will naturally act as co-promoters of UAM. Their attitude can result in a word-of-mouth effect that spreads positive experiences and information about UAM technology and may stimulate non-users in trying the technology [84]. In the case of cluster 1, non-adopters or late adopters should also be considered in deployment and marketing studies, since non-users can create implementation barriers regarding public policy or opinion, especially if negatively impacted.

**Key takeaways**

Low previous knowledge of UAM for deliveries but overall positive attitudes.

Most expected benefits are reduction in pollution and congestion in city centers.

Identification of tree different clusters: low, potential, and high acceptance. That have different views and need to be catered to differently.

## 5.2 Perception and attitude of healthcare professionals towards the use of drones in healthcare services

### *5.2.1 Survey (B) results*

The survey responses from a sample of participants (N = 154) aimed to explore their knowledge and attitudes regarding the use of drones in medical applications. Participants were asked to rate their agreement or disagreement on a 6-point Likert scale for a series of statements related to drones in healthcare. Statistical measures, including mean, median, variance, and standard deviation, were calculated for each Likert scale question to provide a comprehensive understanding of the participant's responses, as per Table 6.

The analysis of the survey results revealed several significant findings. Participants demonstrated a moderate level of knowledge about the use of drones for delivery purposes (mean = 2,513, SD = 1,746) and for medical purposes such as emergencies or deliveries (mean = 2,617, SD = 1,73). These findings suggest that participants have some awareness of the use of drones in healthcare, although there is variability in their level of knowledge, as indicated by the standard deviation.

Regarding attitudes towards the use of drones in healthcare, participants expressed a generally positive view. They considered the use of drones for non-urgent health services (mean = 4,305, SD = 1,424) and urgent and emergency medical services (mean = 4,695, SD = 1,254) as favourable ideas. This indicates that participants perceive the potential benefits of utilizing drones in healthcare, with relatively low variance in their responses, suggesting a degree of consensus.

Participants also exhibited a supportive stance towards the use of drones for non-urgent health services (mean = 4,24, SD = 1,468) and urgent medical care and emergency services (mean = 4,734, SD = 1,204). They recognized the benefits associated with drone usage in the medical field (mean = 4,831, SD = 1,13) and expressed interest in utilizing drone delivery of medical supplies (mean = 3,656, SD = 1,548). The low variance values indicate that there was a

relatively narrow range of responses, suggesting a high degree of agreement among participants in these aspects.

Participants perceived the use of drones for the delivery of medical materials as a concept that is relatively easy to understand (mean = 3,896, SD = 1,5) and use (mean = 3.532, SD = 1,279). This suggests that participants believe that incorporating drone technology into healthcare operations would not pose significant challenges in terms of comprehension and usability.

Participants recognized the potential benefits of using drones for medical purposes, particularly in terms of faster access to items that are not easily available everywhere (mean = 4,565, SD = 1,131). This indicates that participants acknowledge the role of drones in improving the accessibility of medical supplies, especially in remote or underserved areas.

While participants generally demonstrated acceptance of drone technology in healthcare, some concerns and apprehensions were also evident. Participants expressed moderate levels of fear related to potential drone failures and damage to the materials carried (mean = 4,37, SD = 1,323). Additionally, concerns about privacy, security, and criminal activities, such as theft or hijacking of drones (mean range: 3,526 to 4,162, SD range: 1,407 to 1,513), were reported. The standard deviation values indicate some variability in responses, suggesting differing levels of concern among participants.

**Table 6 -** Survey's (B) descriptive statistics results

| Questions - Variables | Mean | Median | Variance | Standard deviation |
|---|---|---|---|---|
| 2.1 - I have knowledge about the use of drones for delivery purposes. | 2,513 | 2 | 3,048 | 1,746 |
| 2.2 - I have knowledge about the use of drones for medical purposes, such as emergencies or deliveries. | 2,617 | 2 | 2,996 | 1,730 |
| 2.3 - I think the use of drones for non-urgent health services (delivery of medications, vaccines, etc.) is a good idea. | 4,305 | 4 | 2,030 | 1,424 |
| 2.4 - I think that the use of drones for urgent and emergency medical services (defibrillators, organs, blood, first aid kits, etc.) is a good idea. | 4,695 | 5 | 1,572 | 1,254 |
| 2.5 - I support the use of drones for non-urgent health services. | 4,240 | 4 | 2,157 | 1,468 |
| 2.6 - I support the use of drones for urgent medical care and medical emergency services. | 4,734 | 5 | 1,451 | 1,204 |
| 2.7 - I see benefits in the use of drones for medical purposes | 4,831 | 5 | 1,278 | 1,130 |
| 2.8 - I have interest in using drone delivery of medical supplies. | 3,656 | 4 | 2,397 | 1,548 |
| 2.9 - I can imagine myself using the medical supplies delivery service by drones, if necessary. | 4,084 | 4 | 2,012 | 1,418 |
| 2.10 - The use of drones for medical material deliveries would improve the efficiency of my work. | 3,201 | 3 | 2,527 | 1,589 |
| 2.11 - The use of drones for the delivery of medical materials is a compatible option with my work | 3,149 | 3 | 2,781 | 1,667 |
| 2.12 - I consider that the delivery of medical materials by drones is an easy concept to understand. | 3,896 | 4 | 2,250 | 1,500 |
| 2.13 - I consider that the delivery of medical materials by drones would be easy to use. | 3,532 | 4 | 1,636 | 1,279 |
| 2.14 - I consider that I would be able to interact with drone delivery services for medical supplies in my day-to-day. | 3,955 | 4 | 1,886 | 1,373 |
| 2.15 - Delivery of medical supplies by drones enables faster access to items that are not always easily available everywhere. | 4,565 | 5 | 1,280 | 1,131 |
| 2.16 - The delivery of medical materials by drones is a useful tool in emergency situations that require speed above all else. | 4,701 | 5 | 1,583 | 1,258 |
| 2.17 - The delivery of medical supplies by drones is a more environmentally friendly option. | 4,545 | 5 | 1,412 | 1,188 |
| 2.18 - I am afraid that a drone may fail and end up damaging the materials it carries. | 4,370 | 4 | 1,750 | 1,323 |
| 2.19 - I am afraid that a drone may fail more often than current transportation modes. | 3,916 | 4 | 2,208 | 1,486 |
| 2.20 - I am afraid that a drone could fail and end up damaging property or injuring people on the ground. | 3,916 | 4 | 2,169 | 1,472 |
| 2.21 - I'm afraid that a drone may be stolen or hijacked during its route for criminal purposes. | 4,162 | 4 | 1,980 | 1,407 |
| 2.22 - I'm afraid that the use of drones for regular deliveries may lead to a loss of privacy and security. | 3,526 | 3 | 2,290 | 1,513 |

### *5.2.2 Quantitative analysis*

In this statistical analysis, we employed both correlation and group analysis. For all cases a p-value < 0,05 is chosen to signify statistical significance.

The key variables of interest for correlation analysis were:

- Support the use of drones for non-urgent health services (2.5).
- Support the use of drones for urgent medical care and medical emergency services (2.6).
- Seeing benefits in the use of drones for medical purposes (2.7).
- Having interest in personally using drone delivery of medical supplies (2.8).

Additionally, the variables concerning potential fears regarding usage of drones (2.18-22) also are crucial to this analysis.

For group comparisons, our analysis focused on exploring the influence of several categorical factors on participants' responses. We specifically examined the following main categories:

- Age groups (1.1).
- Experience in the medical field (1.5).
- Role in the healthcare field (1.4).
- Type of workplace (1.7).
- Type of region (1.3).

It is important to emphasize that the selection of the main variables for this analysis was purposefully done to provide insights for the design and development of urban air mobility (UAM) based healthcare services. Consequently, variables related to the support of drone usage, perception of benefits, and personal interest in using drones were given priority over others. To visually present the findings of this analysis, a diagram was created, Figure 8, specifically illustrating the analysed variables, their correlations, and the relationships between them. It is worth noting that the diagram focuses solely on the variables and correlations discussed in this section and does not encompass all possible correlations between the variables.

The variable 2.7 that concerns “seeing benefits in the use of drones for medical purposes” displayed a strong positive correlation ((ρ)=0,609, (τ) = 0,557, $p < 0,01$) with support the use of drones for urgent medical care and medical emergency services (2.6) and moderate correlation ((ρ)= 0,479, (τ) = 0,427, $p < 0,01$) with support for the use of drones for non-urgent medical services (2.5). This corroborates the literature notions that emergency services are better perceived and more supported [10]. There is also a notable correlation ((ρ)= 0,451, (τ) = 0,393, $p < 0,01$) between seeing benefits in the usage of drones for medical purposes and the agreement that drones provide a more environmentally friendly option (2.17), which is consistent with literature findings [2,3,49] and the conclusions from survey A that environmentally friendliness is one of the most expected benefits.

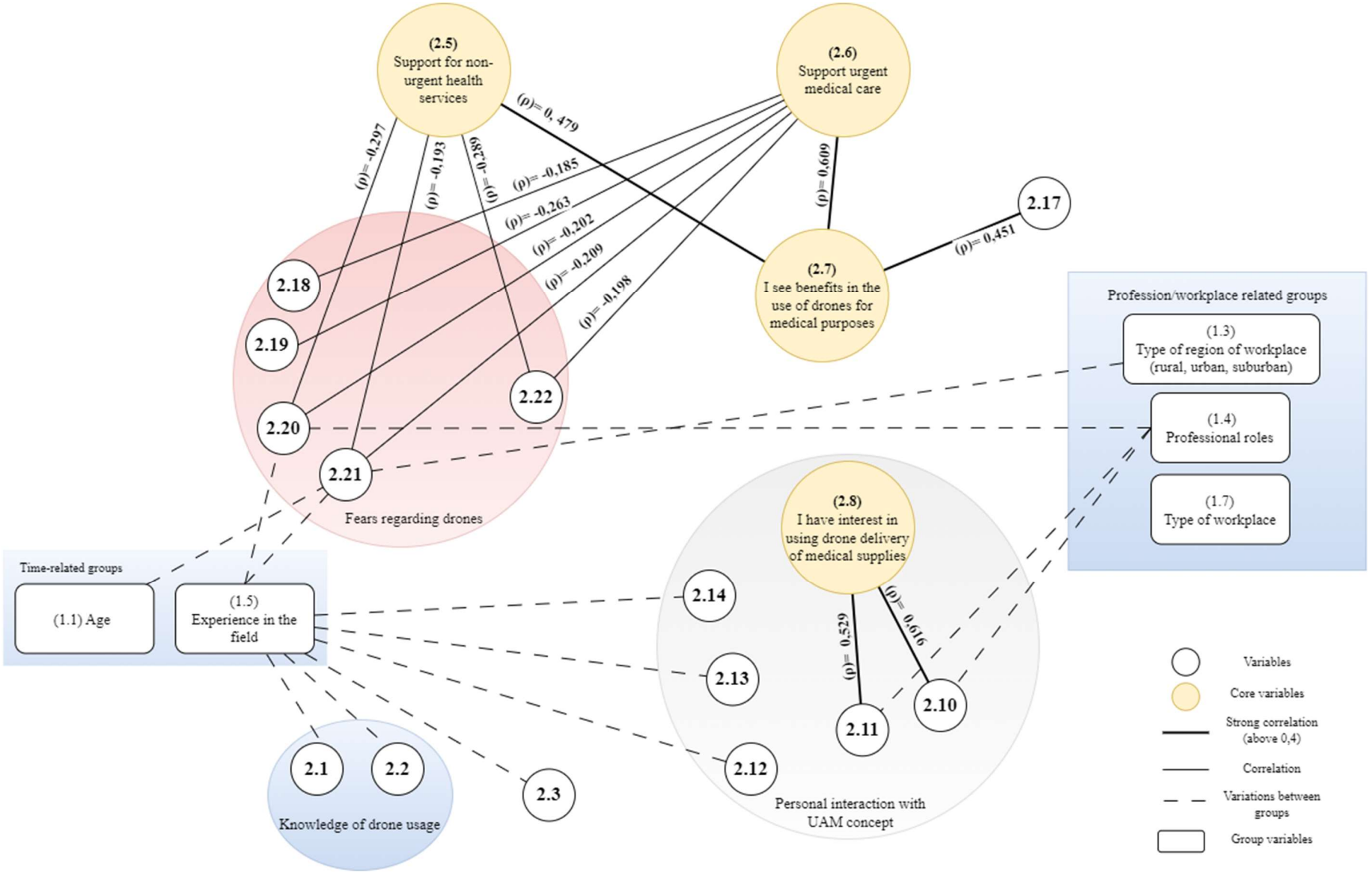


**Figure 8 –** Correlation results diagram

Support for using drones in non-urgent health services (2.5) correlates with fears of property damage or injuries caused by drone failures (2.20), drone hijacking for criminal purposes (2.21), and loss of privacy and security (2.22). A moderate negative correlation suggests that greater support leads to reduced fear of unintended outcomes or accidents (Table 7).

**Table 7 -** Correlations with variable 2.5 – "I support the use of drones for non-urgent health services".

| Tested variable | Spearman (ρ) | | Kendall (τ) | |
|---|---|---|---|---|
| | Coeff. | P-value | Coeff. | P-value |
| **2.20** - I am afraid that a drone could fail and end up damaging property or injuring people on the ground. | -0,29713 | 0,00018 | -0,24231 | 0,00017 |
| **2.21** - I'm afraid that a drone may be stolen or hijacked during its route for criminal purposes. | -0,19342 | 0,01624 | -0,15932 | 0,01384 |
| **2.22** - I'm afraid that the use of drones for regular deliveries may lead to a loss of privacy and security. | -0,28980 | 0,00027 | -0,23758 | 0,00021 |

Support for using drones in urgent medical care and medical emergency services (2.6) is associated with moderate negative correlations regarding fears of potential failures (variables 2.18-22). This reinforces the notion that increased support corresponds to reduced concerns about failure, as shown in (Table 8). These findings align with those from chapter 2 on perceived usefulness a driver for acceptance.

**Table 8 -** Correlations with variable **2.6** – "I support the use of drones for urgent medical care and medical emergency services".

| Tested variable | Spearman (ρ) | | Kendall (τ) | |
|---|---|---|---|---|
| | Coeff. | P-value | Coeff. | P-value |
| **2.18** - I am afraid that a drone may fail and end up damaging the materials it carries. | -0,18549 | 0,02127 | -0,15734 | 0,01780 |
| **2.19** - I am afraid that a drone may fail more often than current transportation modes. | -0,26353 | 0,00096 | -0,21848 | 0,00086 |
| **2.20** - I am afraid that a drone could fail and end up damaging property or injuring people on the ground. | -0,20258 | 0,01175 | -0,16718 | 0,01086 |
| **2.21** - I'm afraid that a drone may be stolen or hijacked during its route for criminal purposes. | -0,20911 | 0,00925 | -0,17441 | 0,00825 |
| **2.22** - I'm afraid that the use of drones for regular deliveries may lead to a loss of privacy and security. | -0,19897 | 0,01337 | -0,16479 | 0,01172 |

Variable 2.8, which assesses personal interest in using drone delivery of medical supplies, demonstrated strong correlations with variables 2.10 and 2.11. Specifically, there was a significant positive correlation between personal interest in drone technology and the agreement that drone usage would improve work efficiency ((ρ) = 0,616, (τ) = 0,523, $p < 0,001$). Additionally, a positive correlation was observed between personal interest in drone technology and the compatibility of drone deliveries with respondents' work ((ρ) = 0,529, (τ) = 0,439, $p < 0,001$). These findings suggest that individuals who express a higher personal interest in utilizing drone technology are more likely to perceive it as beneficial and compatible with their professional healthcare work. This highlights the importance of considering individual attitudes

and interests when implementing drone technology in healthcare settings, as it can potentially enhance efficiency and align with the preferences of healthcare professionals.

As for group comparisons based on the Kruskal-Wallis test all complete tables and post hoc tests will be available in annex for all the mentioned variables. We first looked at age as it is indicated by the literature that age [10, 28] plays an important factor regarding perception towards overall acceptance of UAM. However in the case of medical workers when tested against all variables only significant difference between groups were found for one variable, 2.21, concerning fears of criminal usages of drones, with results of value of 12,559 and p-value of 0,0136, indicating that this group is more concerned with this topic. Post hoc test found most differences pairwise between 45-54 group and all other but the 35-44 (Appendix 3). On the other hand when looking at experience as the tested factor significant differences between groups (Table 9) were found in several variables indicating from the start that, in the case of healthcare workers, might be a better indicator for acceptance.

**Table 9 -** Summary results of Kruskal-Wallis test for "Experience in the healthcare field"**.**

| Tested variable | Kruskal-Wallis | | |
|---|---|---|---|
| | Test statistic | Degrees of freedom | P-value |
| **2.1** - I have knowledge about the use of drones for delivery purposes. | 11,751158 | 5 | 0,038 |
| **2.2** - I have knowledge about the use of drones for medical purposes, such as emergencies or deliveries. | 11,863014 | 5 | 0,036 |
| **2.3** - I think the use of drones for non-urgent health services (delivery of medications, vaccines, etc.) is a good idea. | 11,994953 | 5 | 0,034 |
| **2.12** - I consider that the delivery of medical materials by drones is an easy concept to understand. | 13,88024 | 5 | 0,016 |
| **2.13** - I consider that the delivery of medical materials by drones would be easy to use. | 11,750118 | 5 | 0,038 |
| **2.14** - I consider that I would be able to interact with drone delivery services for medical supplies in my day-to-day. | 13,93477 | 5 | 0,0160 |
| **2.20** - I am afraid that a drone could fail and end up damaging property or injuring people on the ground. | 11,986931 | 5 | 0,0349 |
| **2.21** - I'm afraid that a drone may be stolen or hijacked during its route for criminal purposes. | 15,874676 | 5 | 0,0072 |

Afterwards it was conducted the post hoc Dunn test (Appendix 3), allowing pairwise comparisons to examine significant differences among the variables. The analysis revealed that the groups with more pronounced differences were the participants with over 10 years of experience and those with 5-10 years of experience. These groups consistently exhibited significant differences compared to others, even when employing the more conservative Bonferroni p-value correction. Notably, the most prominent differences were observed between these two experience groups when compared to each other. These significant differences between the groups suggest that the duration of experience in the medical field may play a role in shaping individuals' perceptions and attitudes towards drone technology in healthcare. It implies that professionals with varying levels of experience may have distinct perspectives and considerations when evaluating the use of drones for medical purposes. The range of topics covered in these variables, such as knowledge about drone technology, support for different types of medical services, ease of understanding and use, and concerns related to privacy and security, also indicate that differences as a group are broad and not related to a specific topic.

There was also a statistically significant difference among the professional roles (Appendix 3) in their responses to the agreement that the use of drones would improve respondents' efficiency in their work (2.10) and its compatibility with their work (2.11). The Kruskal-Wallis test revealed a significant difference, with a test statistic of 17,335 and a p-value of 0.03 for variable

2.10, and a test statistic of 15,580 and a p-value of 0,05 for variable 2.11. These findings suggest that there are notable variations in the responses to these variables across different professional roles. Pairwise comparisons were conducted to further examine the significant differences. For variable 2.10, significant differences were found between academic/research roles and most other roles, including nurses and pharmacists, even after adjusting the p-values using the Bonferroni correction. This indicates that the agreement on improving efficiency at work differed significantly between academic/research roles and practical roles such as nurses and pharmacists. This distinction may be attributed to the more theoretical and scientific nature of academic work compared to the practical nature of the other roles. Regarding variable 2.11, which pertains to the agreement on the compatibility of drone deliveries with their work, the pairwise comparison revealed that nurses had the most noticeable differences in their responses compared to other professional roles. This finding suggests that nurses had distinct opinions regarding the compatibility of drone deliveries with their work. The reasons behind these differences and their potential implications could be the nature of nursing work, patient care responsibilities, and concerns about patient privacy and safety.

Significant differences were also observed among the professional roles concerning the fear that a drone could fail and potentially cause damage or injury to people on the ground (2.20). The test yielded a result of 17,876 with a p-value of 0,02. Upon conducting pairwise comparisons, it became evident that the paramedics and emergency respondents exhibited more distinct responses compared to other professional roles. This suggests that paramedics and emergency respondents have concerns regarding the reliability and safety of using drones for emergency services, a field in which they are directly involved. The nature of their work, which often involves critical and time-sensitive situations, may contribute to their increased apprehension about potential drone failures and the associated risks.

The type of workplace where respondents are employed was also examined using the Kruskal-Wallis test. However, the results indicated that none of the groups exhibited significant differences (p-value < 0.05) on any of the variables analysed (Appendix 3). This suggests that the type of workplace, whether it be hospitals, health-centres, pharmacies or academic, does not have a substantial impact on the respondents' attitudes and perceptions towards drone technology in healthcare. These results indicate that the professional role of individuals may be a more influential factor than the specific conditions of the workplace when it comes to acceptance and attitudes towards drone technology in healthcare. While the type of workplace did not show significant differences in the variables analyzed, the variations observed in the responses based on different professional roles suggest that the role itself plays a more significant role in shaping perceptions and acceptance of drone technology. This highlights the importance of considering the specific responsibilities, expertise, and perspectives of individuals within the healthcare system when implementing and promoting the use of drones in healthcare settings.

In terms of the type of region where respondents are located (rural, urban, or suburban), the analysis revealed that significant differences were observed specifically for variable 2.21, which relates to the fear of drones being stolen or hijacked for criminal purposes. Post hoc testing indicated that the most notable difference was observed between urban and suburban respondents. This finding suggests that different types of areas may have varying levels of vulnerability to such concerns, with urban areas potentially experiencing higher apprehension regarding the potential criminal misuse of drones. Understanding these regional variations in perception and fear is crucial for implementing drone technology in a way that addresses specific concerns and ensures public safety across different types of regions (Appendix 3).

**Key takeaways**

Overall positive attitudes towards UAM medical applications.

Negative correlation between support of usage and concerns.

Experience as a better indicator than age, and professional role rather than type of workplace when it comes to acceptance.

# 6 Service Design

Before embarking on the design of new services, it is crucial to understand the contextual factors surrounding the intended services. In the case of novel services, such as those related to urban air mobility (UAM), where widespread adoption is limited or non-existent, it becomes even more important to assess the potential, perceptions, and attitudes surrounding these services. While the current work is based on the potential of UAM services, as practical implementation is yet to be observed, it is essential to gather insights into various aspects.

## 6.1 Perceptions and Attitudes of UAM

To organize the most relevant and promising factors, a mind map was created (Figure 9). This mind map is based on insights derived from existing literature, documented evidence, as well as the results obtained from both surveys. The mind map aims to capture key elements such as anticipated benefits, potential applications of UAM with the highest perceived value, expected societal impacts, and factors influencing acceptance, including barriers, drivers, and individual profile indicators. The colours in the map indicate source of the insight: blue for the survey A, green for literature, and yellow for a mix a both.

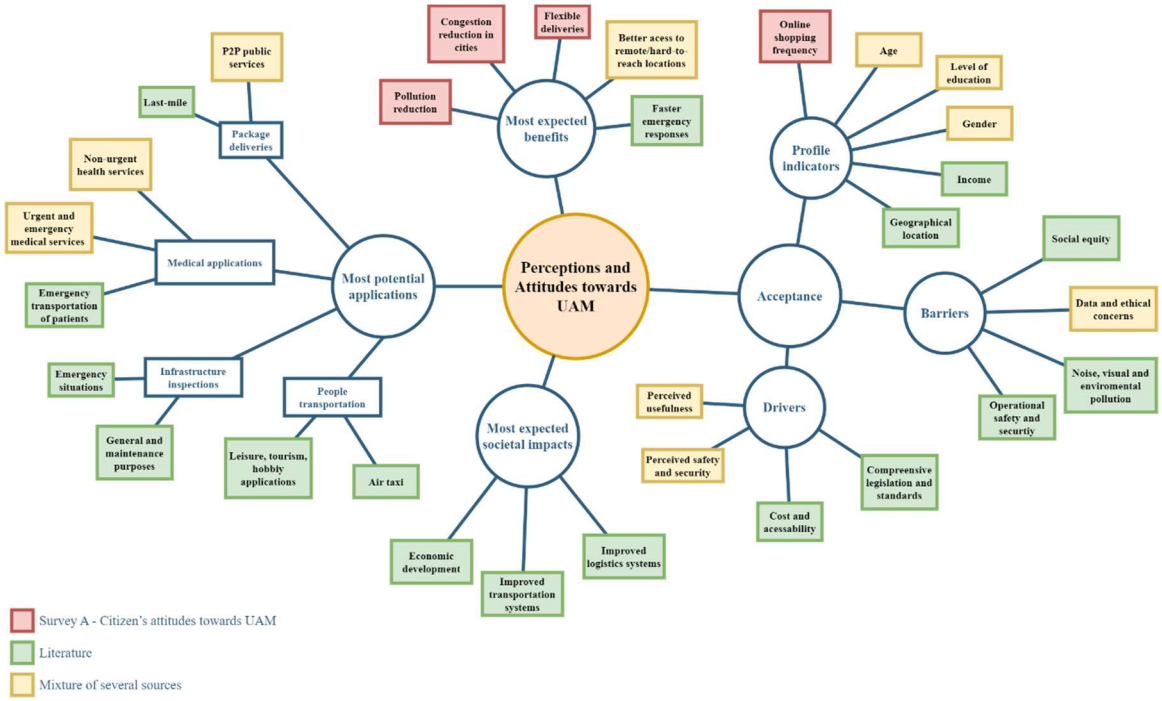


**Figure 9 -** Mind map on perceptions and attitudes towards UAM

### *6.1.1 Acceptance*

When it comes to acceptance, our analysis focuses on three main factors: drivers, barriers, and profile indicators. In the section discussing Survey A, three distinct clusters were identified: low acceptance, potential acceptance, and high acceptance. These cluster classifications, in alignment with existing literature on the subject, allowed for the identification of profile indicators at the individual level that might contribute the most to acceptance. One noteworthy finding from Survey A is that online shopping frequency appears to be a relevant indicator for acceptance, whereas specific shopping habits, such as the types of products or stores preferred, do not seem to have a significant impact. In our analysis of survey A, we also found that demographic factors such as age, gender, and level of education might have an impact on acceptance/support of UAM, as it is reported in the literature in chapter 2.

When examining the drivers for acceptance several key factors emerge. One important driver is the perceived usefulness of UAM services [36]. Individuals are more likely to accept and embrace UAM if they believe it offers tangible benefits as it is also confirmed by the expected benefits results from survey A. Some other crucial drivers are the perceived safety and security, cost and accessibility, affordability, and convenience and lastly, comprehensive legislation and standards as is aligned with literature in chapter 2.

When considering the barriers to the acceptance of urban air mobility (UAM), several factors come into play. Social equity concerns are an important barrier as well as data and ethical concerns. Operational safety and security are another important barrier. A safe and secure operation of UAM vehicles is paramount to gain public trust and regulatory approval as its heavily emphasised in the literature.

### *6.1.2 Most expected benefits*

The most anticipated benefits, as confirmed by the results of Survey (A), include the reduction of pollution and congestion in urban areas, as well as more flexible delivery services and improved access to hard-to-reach locations. The latter is particularly relevant for areas with inadequate road infrastructure, those affected by natural disasters, and rural or suburban regions [13]. Additionally, faster emergency response times are highlighted as a significant benefit, emphasizing the perceived usefulness and societal impact of UAM applications in emergency/health situations.

### *6.1.3 Expected societal impacts*

The most anticipated societal impacts of UAM include economic development, enhanced transportation systems, and improved logistics systems. These impacts are expected to arise from the implementation and integration of UAM technologies, which can bring about increased efficiency, cost savings, and overall improvements in various sectors. The potential economic benefits encompass job creation, increased productivity, and the stimulation of new business opportunities.

### *6.1.4 Most Perceived potential applications*

The applications that exhibit the highest perceived potential are various and closely intertwined with the drivers for acceptance and align with the most anticipated benefits.

Regarding *package deliveries*, last-mile deliveries and peer-to-peer public services have some of the most potential of leveraging UAM it can potentially disrupt the delivery industry, by addressing challenges such as congested areas. In the case of *infrastructure inspections*, UAM can play a crucial role in emergency situations as well as routine maintenance tasks. By utilizing drones for inspections, critical infrastructure such as bridges, power lines, and pipelines can be assessed more efficiently and effectively. As for the application of drones for transporting people (*people transport*), it holds promise for leisure, tourism, and hobby-related purposes. *People transport* includes air taxi services, particularly for airport transfers, offering convenient and efficient transportation options for travellers.

Lastly, the application that is the focus of this body of work, revolves around using drones for emergency or health related services (*medical applications*) such as the delivery of medical supplies, emergency supplies, and scouting during emergency situations. By utilizing UAM, it becomes possible to overcome challenges such as remote or inaccessible areas, enabling faster

response times and the delivery of essential resources. Focusing on this application, the next section discusses the results from survey B.

## 6.2 Perception and attitude of healthcare professionals towards the use of drones in healthcare services

The medical application of UAM is highly regarded for its significant potential. In this study, we shift our focus towards the perceptions and attitudes surrounding UAM-enabled healthcare services and medical applications. By incorporating insights from survey B on the perception and attitude of healthcare professionals towards the use of drones in healthcare services, we aim to build a comprehensive understanding of this specific domain. To facilitate this analysis, a targeted mind map (Figure 10) is developed, which combines survey findings and relevant literature in the field.

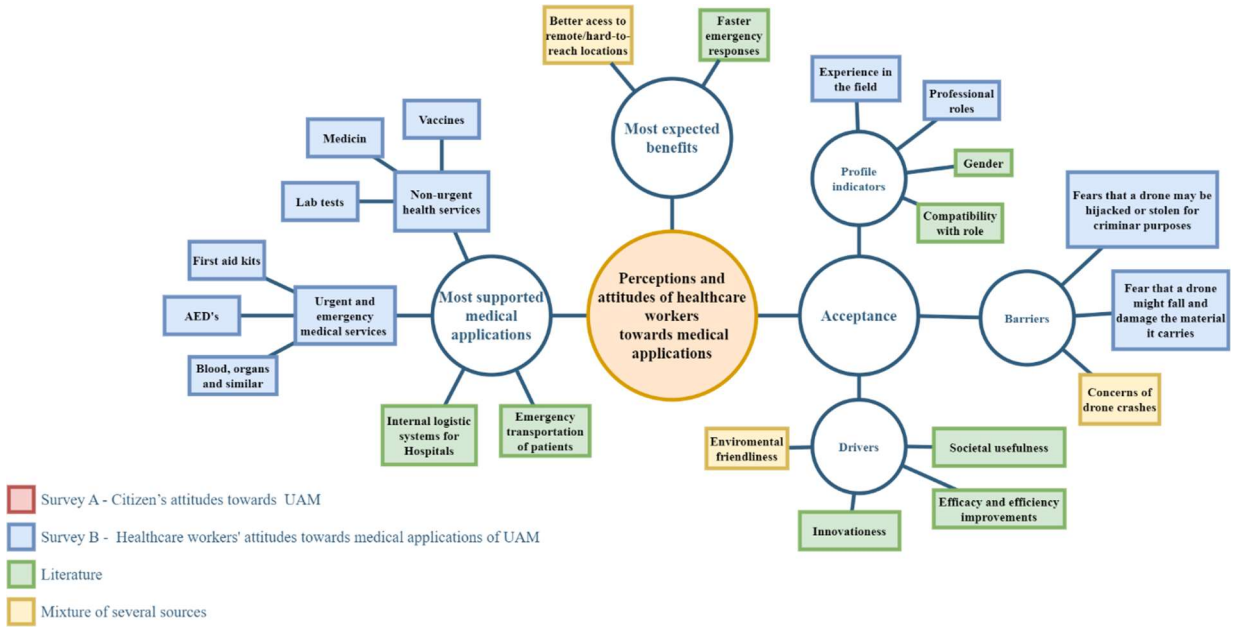


**Figure 10 –** Mind map on perceptions and attitudes of healthcare workers towards medical applications of UAM

### *6.2.1 Acceptance*

In our analysis of acceptance, we conducted group comparisons as part of the statistical analysis of survey B. These comparisons allowed us to identify significant factors that influence perceptions and attitudes among healthcare professionals. Specifically, we found that experience and professional roles played a crucial role in mediating these perceptions and attitudes, as evidenced by the variations observed within different groups in relation to specific variables. This is consistent with the findings of Sham et al. [49] , who also noted the importance of compatibility between UAM and professional roles.

The main drivers identified for acceptance of UAM-enabled healthcare services are rooted in societal usefulness and innovation, as evidenced by the literature. Additionally, insights from survey B revealed that factors such as environmental friendliness, efficacy, and efficiency improvements also contribute significantly to the positive attitudes towards UAM in healthcare.

Barriers to the acceptance of UAM-enabled healthcare services primarily revolve around concerns related to potential mishaps and safety issues. In the context of medical applications, the main barriers identified in survey B include fears of drone hijacking or theft for criminal purposes, concerns about drones falling and causing damage to materials or individuals, as well as apprehensions about the potential consequences on the ground.

### *6.2.2 Most expected benefits*

In the context of UAM-enabled healthcare services, the most anticipated benefits are twofold. Firstly, the ability to achieve faster emergency response times holds great value, as timely interventions can significantly impact patient outcomes. Secondly, the improved access to remote and hard-to-reach areas becomes particularly invaluable in emergency situations, where reaching individuals in urgent need of medical attention can be challenging. These expected benefits align with the unique capabilities of UAM technologies, making them well-suited for addressing emergency healthcare needs effectively.

### *6.2.3 Most perceived potential applications*

This niche area of UAM-enabled healthcare services offers numerous potential applications that can cater to specific needs within the healthcare sector. Some of the intriguing applications identified in the literature include internal logistics systems for large hospitals operating on campus-like structures, acting as hubs for smaller healthcare facilities in the region [85]. However, these applications may require extensive testing to determine if the advantages justify their implementation.

In contrast, the usage of UAM for non-urgent health services, such as the delivery of medication, vaccines, or lab tests/specimens, has already gained acceptance, as confirmed by the results of survey B. This application addresses the need for efficient and timely delivery of essential healthcare resources. Additionally, the most widely accepted application within this context is the utilization of UAM for urgent and emergency medical services, as demonstrated in the literature review (see chapter 2). These applications hold significant potential for improving response times and outcomes in emergency healthcare situations.

## 6.3 Building the scenery (stakeholder analysis)

After examining perceptions towards UAM as a whole and specifically focusing on perceptions of medical applications, particularly among healthcare workers, it is crucial to establish the landscape for these applications. Identifying relevant stakeholders and developing tailored strategies for each stakeholder group becomes essential. In order to achieve this, a stakeholder power/interest matrix (Figure 11) was devised, drawing from literature and insights gathered from the surveys. The matrix identifies the following key stakeholders, that are divided into five main types: citizens, service providers, R&D and sustainability institutions, healthcare related institutions, and government and regulators (Table 10).

The stakeholder matrix for UAM medical applications is divided into four quadrants [79] , based on power and interest levels: monitor, keep informed, keep satisfied, and manage closely. This categorization helps prioritize engagement and develop strategies tailored to the needs and expectations of each stakeholder group.

It is important to note that both the stakeholder list and the placements on the matrix are derived from a thorough analysis of relevant literature, as well as insights gained from surveys. However, it is crucial to acknowledge that this analysis and its resulting outcomes have not yet undergone validation through in-depth qualitative studies.

**Table 10 -** Stakeholders list

| Type of stakeholders | Groups |
|---|---|
| **Citizens'** | Cluster 1 – low acceptance |
| | Cluster 2 – Potential acceptance |
| | Cluster 3 – High acceptance |
| **Service providers** | Ground infrastructure |
| | Technology |
| | Public services |
| | UAM services |
| | Smart cities services |
| **R&D and sustainability** | Research institutions and Academia |
| | Enviromental and sustainability organizations |
| **Healthcare related institutions** | Medical institutions and hospitals |
| | Pharmaceutical and medical supplies providers |
| | Healthcare workers |
| **Government and regulators** | Government and regulators |
| | Air traffic authorities |
| | City authorities |

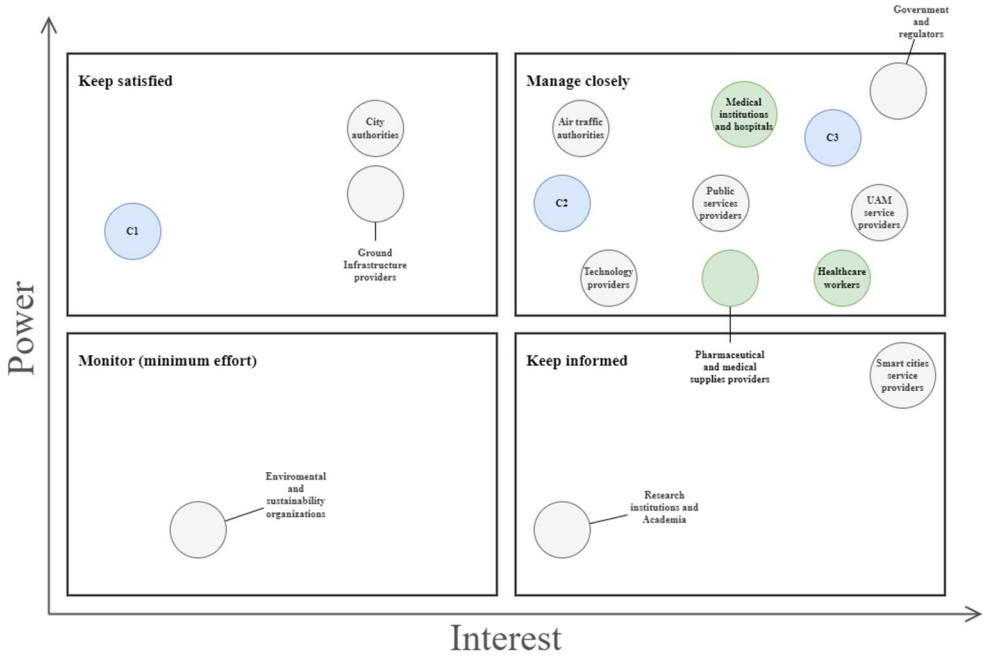


**Figure 11 -** Stakeholder Power/Interest Matrix (inspired by Chinyio et al. [79])

### *6.3.1 Monitor*

Under the *monitor* category of the stakeholder matrix, we find the environmental and sustainability organizations. While these stakeholders may have low power and limited interest in UAM medical applications, it is important to closely monitor their activities. When their objectives align with our goals, they can become valuable partners, particularly in communication efforts to promote acceptance and positive attitudes.

### *6.3.2 Keep informed*

In the *keep informed* category of the stakeholder matrix, we have research institutions and academia, including universities and centers like CEiiA. While these stakeholders have a high interest in UAM applications and play a crucial role in driving innovation, they often have limited power and rely on external sources for funding. It is important to keep them well-informed as they can be significant partners, who can greatly contribute to the success of new UAM services. Strategies such as periodic briefings and workshops can help ensure their continued engagement and collaboration.

Similarly, smart cities service providers are also highly aligned with the potential of UAM applications. Integration of UAM into their services could offer significant enhancements. However, the number of such services is currently limited, so merely keeping them informed about the progress and possibilities of UAM is apt.

### *6.3.3 Keep satisfied*

The *keep satisfied* block in the stakeholder matrix consists of stakeholders with high power but low interest. This includes city authorities, ranging from local political powers to urban planners, who hold significant power in determining the implementation of UAM-based services. They can impose restrictions or create barriers to the adoption of these services within their jurisdictions. To effectively engage with these stakeholders, appropriate lobbying efforts should be undertaken, accompanied by clear communication about the benefits UAM can bring to their cities and citizens.

Ground infrastructure providers, such as helipads or airports, also fall into this category. In the early stages of UAM implementation, existing infrastructure is crucial for its operation, as building new infrastructure requires substantial investment and industry maturity. Engagement with these stakeholders should focus on demonstrating the advantages UAM can bring to their businesses without disrupting their existing services.

While both city authorities and ground infrastructure providers currently exhibit low interest, it is important to recognize that their level of interest may change as the UAM industry matures. Depending on the success of UAM and the realization of its potential benefits, their position in the stakeholder matrix may shift to other blocks.

The *low acceptance* cluster, represented by Cluster 1, consists of individuals who have shown the lowest interest and even some aversion towards UAM-based services. To facilitate generalization, the stakeholder matrix does not differentiate between regions. Instead, clusters are treated as collectives and serve as the sole representative of citizens' and their public opinions in this matrix. They were placed in this block because they showed the lowest interest and even some aversion towards these types of services based on the results of survey A. Despite their lack of interest, they were classified as high-power stakeholders due to their significant impact on perceptions and potential adoption, given their size and influence. It is

crucial to prioritize their satisfaction by minimizing any negative indirect effects on their daily lives.

### *6.3.4 Manage closely*

The final block, *manage closely*, encompasses most stakeholders as we are still assessing the potential for these types of services and the industry is in its early stages of maturity. It is expected that as the industry matures, the placement of stakeholders will change significantly.

Stakeholders such as air traffic management authorities and government regulatory bodies are crucial as they regulate and oversee the implementation of UAM medical applications. These stakeholders should be handled carefully, ensuring regular communication to address any regulatory concerns and keep them informed about the benefits and safety measures associated with UAM.

Technology providers, including drone manufacturers and IT service providers, are vital for enabling and maintaining UAM medical services. Engaging with these stakeholders is essential to understand the latest technological advancements, collaborate on innovation, and ensure the availability of reliable and efficient solutions.

Public service providers, such as first responders, firefighters, and emergency medical technicians (EMTs), can greatly benefit from UAM technology in emergency response situations. Developing partnerships with these stakeholders can lead to collaborative projects, training programs, and demonstration initiatives to showcase the value of UAM in enhancing their operations and improving public safety.

UAM service providers, though still limited in number, should be closely monitored as they can potentially become competitors or, more likely, valuable partners. Building relationships with these service providers can facilitate knowledge sharing, identify areas of collaboration, and explore joint initiatives to expand UAM medical applications.

Cluster 3, representing citizens with high acceptance of UAM, is of paramount importance to keep satisfied. These early adopters can act as ambassadors for the technology if they are satisfied. Engaging with them through targeted marketing campaigns, community events, and involvement in decision-making processes can strengthen their support and foster positive word-of-mouth.

Cluster 2, consisting of stakeholders with potential acceptance, should also be managed closely. By effectively marketing the benefits of UAM medical applications to this group, they can potentially transition to Cluster 3. Engaging them through informative campaigns, pilot projects, and interactive demonstrations can help address their concerns and build their confidence in adopting UAM.

For health-related stakeholders, including medical institutions, hospitals, health centres, private clinics, and pharmaceutical and medical supplies providers, it is crucial to emphasize the efficiency improvements and innovation that UAM can bring. Engaging with these stakeholders can pass through collaborative research projects, pilot deployments within healthcare facilities, and partnerships to optimize logistics and enhance patient care.

Lastly, healthcare workers, both those in direct contact with patients and those in supportive roles, are concerned with improving service experiences and the efficiency of their work. Engaging them through training programs, workshops, and involvement in the design and implementation of UAM medical services can address their needs and harness their expertise

to optimize workflows and improve patient outcomes. User centred-design, collaborative design and extensive proof of concept will be key.

Overall, each stakeholder in the "Manage closely" requires a tailored engagement strategy to address their specific interests, concerns, and potential contributions. Regular communication, collaboration, and demonstration of the benefits of UAM medical applications will be essential in building trust, fostering adoption, and ensuring the successful implementation of these innovative services.

## 6.4 Proposing the service concepts

### *6.4.1 Potential actor relationships*

With the identified stakeholders in mind and focusing on the two main prospects of non-urgent medical delivery (green) and urgent and emergency medical services (red), a simplified visual representation of what the high-level core relationships between the actors would be was created (Figure 12).

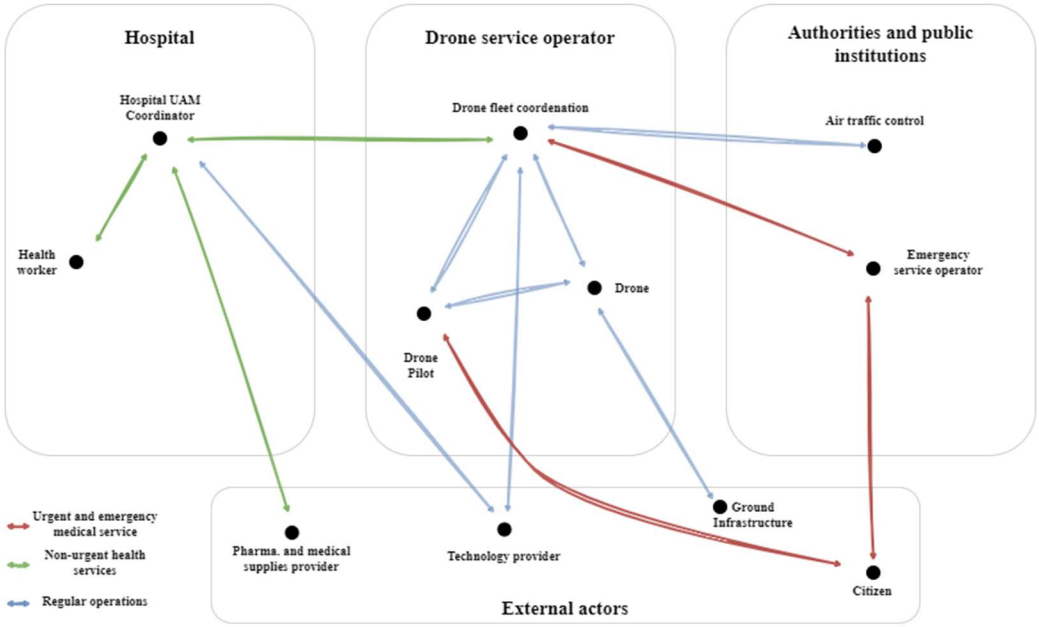


**Figure 12 –** Main actor's relationships for proposed services (inspired by: De Silvestri et al.).

The interactions shown in the diagram are limited to the key activities that would be performed directly by the involved parties. The potential service exchange relations are color-coded, with green representing non-urgent medical services, red representing urgent and emergency medical services, and blue representing regular day-to-day operations that may occur in both cases. It's important to note that while this diagram provides a visual representation of the potential main actors and their interactions in regard to the two proposed services, it should be acknowledged that it does not capture all possible interactions or include every actor involved.

The relationships between actors can take different forms, including physical interactions such as drone transportation, information exchanges for communication and coordination, and commercial relationships such as service agreements or contracts. These various forms of interactions contribute to the overall functioning and effectiveness of the UAM medical applications.

### *6.4.2 The service concepts*

Based on the analysis of the relevant literature, in addition to survey A and B results, we focus on two service concepts that exhibit the most potential (Figure 13).

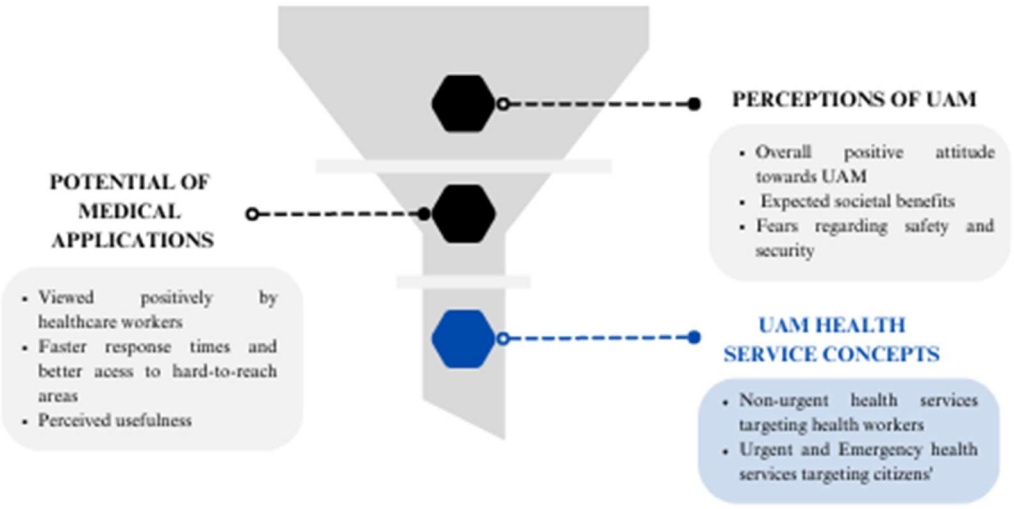


**Figure 13 –** Funneling on service concepts

It is evident that there is a low level of previous knowledge about UAM in two-thirds of the surveyed regions. However, despite this lack of knowledge, the attitudes towards UAM are predominantly positive, indicating a potential for acceptance of the concept. Furthermore, survey B suggests that both non-urgent health services and urgent and emergency medical services were perceived as valuable concepts with significant potential. Thus, being the base for the proposed concepts in this work.

One notable concern that emerged from the research is the issue of safety and security. Participants expressed apprehension about potential drone failures leading to damage to cargo or the risk of drones being hijacked or stolen for criminal purposes. It is essential to address these concerns and emphasize the importance of security and safety measures. Clear and transparent reporting of usage, adherence to comprehensive standards and practices, and effective communication about the benefits and safety of the UAM services are critical factors for gaining acceptance.

The proposition of value must align with the anticipated benefits identified in the surveys. From a societal perspective, reducing congestion in cities and minimizing pollution were highlighted as significant advantages of UAM (survey A). Additionally, faster response times in emergency situations and improved access to hard-to-reach or remote locations were deemed practical benefits. At an individual level, healthcare workers expressed expectations of efficiency and efficacy improvements.

To promote acceptance of UAM, it is crucial to address the identified concerns by emphasizing safety and security measures, providing clear and transparent reports on usage, standards, and practices, and effectively communicating the usefulness of UAM services. Awareness campaigns and targeted communication strategies should be implemented to enhance

knowledge and understanding of UAM, ultimately fostering acceptance and adoption of UAM medical applications.

### *6.4.3 Potential Value Constellation Experiences for non-urgent health services and emergency and urgent medical services*

To consolidate these findings into a service concept proposal, Figure 14 and Figure 15 depict the high-level activities within a potential VCE for customers utilizing non-urgent health services (green) and emergency/urgent medical services (red). The figures outline the proposed activities within the VCE, showcasing the steps involved in accessing and utilizing the services

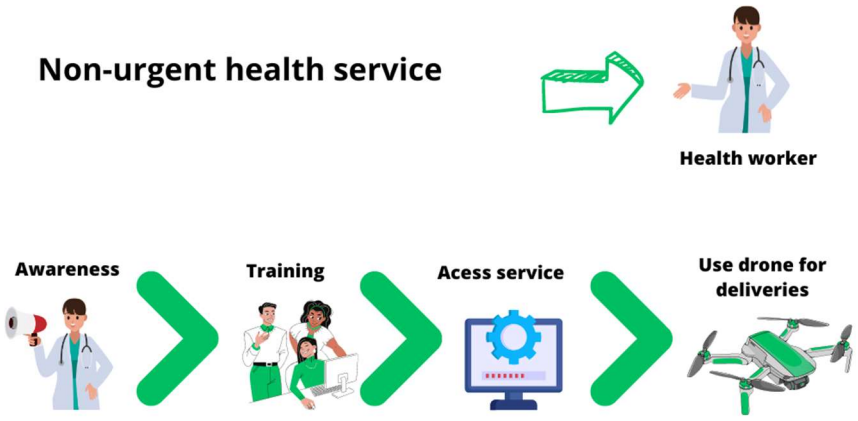


**Figure 14 -** Value Constellation Experience (VCE) for non-urgent services

effectively.

The case for non-urgent health service, is targeted towards health workers who might need something delivered. The high-level activities are the following:

- Being made aware of these kinds of services which may done via public entities, research institutions and academia, as well as common dissemination channels such as TV or social media.
- Go through training specific for health workers on how to interact with these UAM services.
- Access service, this might be done via integrated hospital systems or third-party applications on multiple platforms.
- Use drones to transport medication, lab results and other non-urgent supplies.

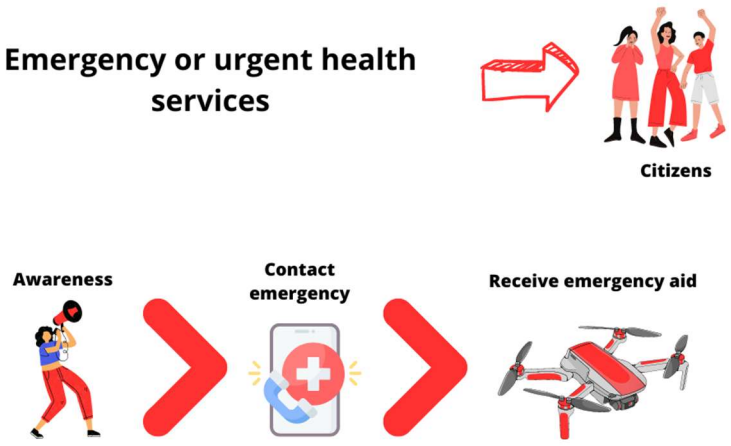


**Figure 15 -** Value Constellation Experience (VCE) for Emergency or urgent health services.

The case for Emergency and urgent health service (Figure 15) targets citizens who might be in distress situations such as assisting someone having OHCA:

- Being made aware, as the previous case.
- Contact regular emergency in an applicable situation where the emergency services would instruct drone services to appear on scene with emergency aid.
- Receive emergency aid via drone (e.g., AED for OHCA).

It should be noted that this specific use case of the concept for Emergency and urgent health service can also be designed from the point of view of those who are assisting in the emergency as a target user of the service.

### *6.4.4 Customer Value Constellation for UAM medical services*

Following the definition of the VCEs and their high-level activities involving multiple actors, this dissertation proceeds to map the proposed service offerings that have the potential to be provided, enabling customers to co-create value. Figure 16 illustrates the suggested Customer Value Constellation (CVC), with citizens and healthcare workers as the primary focus and core users. The diagram showcases the interdependent relationships and collaborative value creation among these key stakeholders within the service ecosystem.

The proposed CVC revolves around two core services and focuses on both citizens and health workers as its primary customers. This CVC highlights the potential of these concepts and their interrelations, while also emphasizing the crucial role of support services that complement the core offerings. Considering the concerns surrounding the safety and security of drones, it becomes imperative to prioritize base services such as awareness, training, and quality control. Without addressing these, it would be challenging to compete with traditional public services such as EMS and traditional delivery services. It is crucial to develop these services in a manner that retains the expected benefits of UAM while incorporating the perceived reliability, trust, and security associated with traditional services.

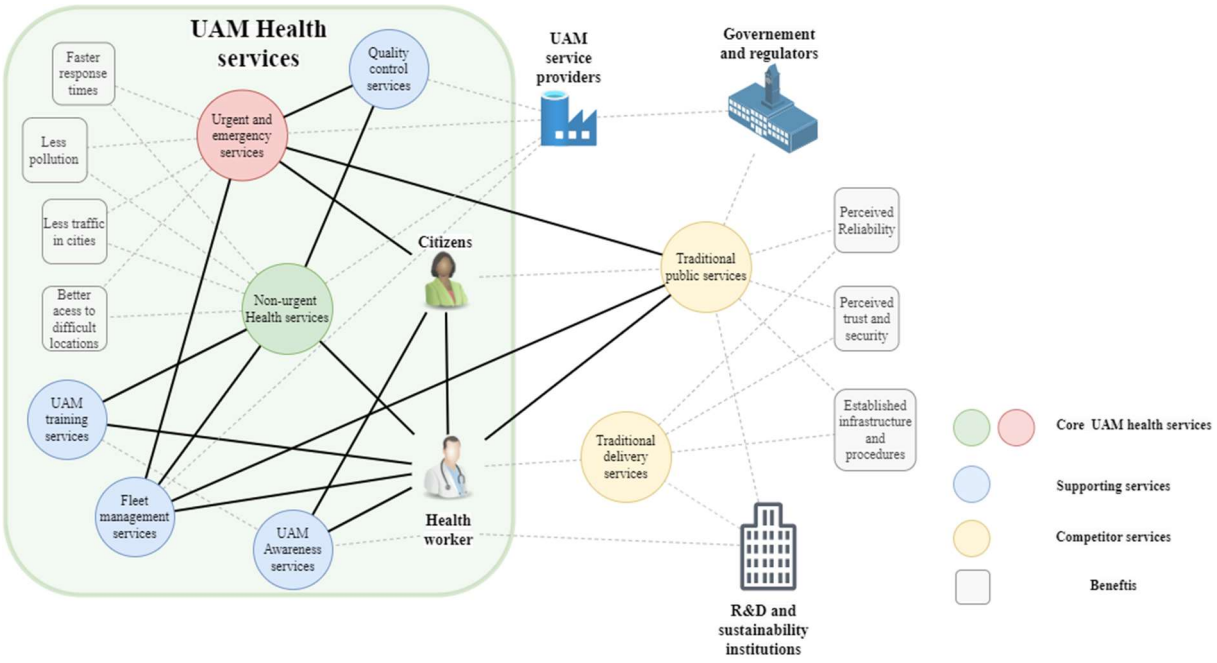


**Figure 16 -** Customer Value Constellation (CVC) for medical applications of UAM

### Awareness services

As stated earlier, the domain, UAM suffers from a lack of sufficient public knowledge. To generate interest and promote confidence, it becomes imperative to raise awareness among both the public and professionals. This objective can be accomplished through the implementation of comprehensive strategies, encompassing marketing campaigns, workshops, and favourable reporting on UAM operations.

### Fleet management services

To ensure the seamless functioning of the core service, fleet management services will assume a critical role. These services will be responsible for receiving service requests, overseeing drone operations, and maintaining overall operational efficiency. By effectively managing the fleet, reliable and punctual service delivery can be achieved, ultimately enhancing the customer's experience, and fostering trust in the UAM solution.

### Training services

In the context of health workers, their involvement in, and utilization of, the UAM service would require them to actively participate and request its services. Given the highly regulated nature of the healthcare field, additional training would be necessary to ensure compliance with protocols. This training not only serves to meet the requirements of the field but also contributes to increasing acceptance levels among health workers.

### Quality control services

Quality control services are of paramount importance in the UAM industry, especially considering the critical emphasis on safety and the establishment of perceived standards for acceptance. These services play a crucial role in ensuring that all operations and processes adhere to rigorous quality standards and regulatory requirements. By implementing robust quality control measures, the UAM solution can demonstrate its commitment to safety, thereby instilling trust among stakeholders and enhancing acceptance levels.

# 7 Conclusions

This study aimed to explore the acceptance and attitudes of citizens towards UAM and investigate the perceptions of healthcare workers regarding the potential applications in the healthcare sector. Additionally, the study sought to identify services with the most potential based on the findings from both groups. The research questions guided the analysis and provided valuable insights into the attitudes and preferences of the target audience and were all answered.

## 7.1 Contributions and final remarks

The analysis of survey data from three countries revealed that most respondents viewed drone delivery as a positive development and supported public investment in UAM infrastructure, which answers. The anticipated benefits of drone delivery, such as decreased congestion and pollution in city centres, were widely recognized. Interestingly, online shopping habits did not significantly influence the acceptance of UAM, but the frequency of online shopping appeared to have a notable impact. There results contributed to the answering of **RQ1** that concerns the potential level of acceptance and attitudes of citizens towards UAM.

Cluster analysis, whilst addressing **RQ2**, further identified distinct groups, with low-acceptance clusters characterized by females and individuals who do not typically shop online, while high-acceptance clusters consisted of frequent online shoppers. These findings indicate a typical resistance to adoption in the low-acceptance clusters and a profile of early adopters in the high-acceptance clusters.

Regarding healthcare workers' perceptions, the study revealed low knowledge of usage drones for medical applications. However, both urgent and non-urgent medical applications of UAM were viewed positively. Concerns related to safety and security, particularly the fear of drones failing or being hijacked, negatively influenced support for these services. It was also observed that experience, rather than age or professional role, appeared to be a stronger indicator for acceptance among healthcare workers. Thus, answering **RQ3.**

Lastly, to answer **RQ4**, the proposed services with the most potential are non-urgent health services targeting healthcare workers and or urgent medical services targeting citizens. These service concepts align with the perceived value of UAM and cater to specific needs within the healthcare sector. By providing niche health services, UAM can capitalize on the desired public acceptance and societal benefits associated with these applications.

The service design phase of this thesis concluded with a comprehensive mapping of perceptions derived from empirical evidence and literature findings. This was followed by an analysis of the scenery through stakeholder analysis, which helped identify key actors and their roles within the UAM ecosystem. A high-level potential ecosystem was then developed to support the two main proposed service concepts. The non-urgent health services targeted healthcare workers as users, while emergency or urgent medical services focused on citizens as recipients. This process culminated in the creation of Value Constellation Experiences (VCEs) and a Customer Value Constellation (CVC), which further solidified the service concept design.

The main contributions of this thesis (Figure 17) to the field of UAM acceptance and its medical applications were the insights derived from survey A that provide valuable knowledge that contributes to the existing studies on UAM acceptance. Additionally, the profile definitions obtained through cluster analysis offer valuable information for legislators, service designers,

and business developers, enabling them to address acceptance barriers and leverage drivers while targeting specific groups.

Furthermore, survey B has yielded substantial contributions by charting, through mind-maps, the perceptions and attitudes of both citizens and, importantly, health workers towards the medical applications of UAM. This includes the development of service concepts for non-urgent health services and emergency and urgent health services. The thesis also outlines the potential environment of UAM health services through the creation of stakeholder related visual elements, along with a Customer Value constellation.


**Figure 17 -** Main conclusions

In addition to the body of work presented in this thesis and the publication in the *Aerospace* peer-reviewed journal, the results have been disseminated though presentations in different conferences and workshops, namely: (i) GET 2023 – 19th Annual Meeting of the Transport Study Group (6-7 February 2023, Oeiras, Portugal), (ii) ASSURED-UAM final workshop for Portuguese stakeholders (17 March 2023, Matosinhos, Portugal), (iii) CITTA 15th Annual Conference on Planning Research (22 June 2023, Coimbra, Portugal), and (iv) DynamiCITY final workshop (27 June 2023, Maia, Portugal).

## 7.2 Limitations and future research

The limitations of this study and areas for future research are as follows. Firstly, the technical limitations identified in the surveys were addressed individually in the methodology section for each respective limitation. However, it is important to acknowledge that the study primarily focused on quantitative data and lacked qualitative insights from stakeholders beyond the perspective of future users or citizens. Future research could benefit from incorporating interviews with experts to gain contextual reasoning and a deeper understanding of the findings.

Secondly, the study encountered a limitation in terms of sample size in the second part of the research. Although efforts were made to collect data from a diverse range of respondents, the sample size remained small. To overcome this limitation, it is recommended to continue collecting responses from the survey, which is still open for participation. Analyzing a larger and more diverse sample would allow for more robust statistical methods, such as structural equation modeling, to be applied.

Additionally, future research should consider conducting service pilot tests to validate the proposed service concepts and evaluate their feasibility and effectiveness. This would involve prototyping the service design and assessing its performance in real-world scenarios. Such pilot tests would provide valuable insights into the practical implementation and potential challenges of the service.

Furthermore, it is recommended to explore the MSD from the beginning stages of implementation. This could involve selecting one of the proposed service concepts and implementing it in a practical use case, such as a large metropolitan area hospital. By applying MSD, the study can gain a comprehensive understanding of the service ecosystem and effectively design and deliver the UAM services.

# 8 Appendix 1

**ASSURED-UAM survey – Versão Portuguesa**

- Q1.Género
- Q2. Idade:
- Q3. Habilitações literárias
- Habilitações literárias [Outro]
- Q4.Concelho de residência
- Q5.Situação profissional
- Situação profissional [Outro]
- Q6.Setor de atividade
- Setor de atividade [Outro]
- Q7.Qual a função que desempenha atualmente?
- Qual a função que desempenha atualmente? [Outro]
- Q8. Fez compras online durante o ano de 2021?
- Q9.1 Quais os principais motivos que o levaram a não fazer compras online? [Preocupações de privacidade]
- Q9.2 Quais os principais motivos que o levaram a não fazer compras online? [Preocupações de segurança ]
- Q9.3 Quais os principais motivos que o levaram a não fazer compras online? [Desconhecimento do processo de compra e pagamento ]
- Q9.4 Quais os principais motivos que o levaram a não fazer compras online? [Dificuldade em aceder às plataformas ]
- Q9.5 Quais os principais motivos que o levaram a não fazer compras online? [Preferência por lojas físicas ]
- Q9.6 Quais os principais motivos que o levaram a não fazer compras online? [Impossibilidade de ter os produtos imediatamente ]
- Q9.7 Quais os principais motivos que o levaram a não fazer compras online? [Dificuldade em trocar o produto em caso de insatisfação/defeito]
- Q9.8 Quais os principais motivos que o levaram a não fazer compras online? [Outro]
- Q10. Com que frequência faz compras online?
- Q11.1 Que tipo de lojas virtuais utiliza para fazer compras? [Sites de marcas e lojas (do tipo: FNAC, Zara, …) ]
- Q11.2 Que tipo de lojas virtuais utiliza para fazer compras? [Supermercados ]
- Q11.3 Que tipo de lojas virtuais utiliza para fazer compras? [Amazon / ebay, etc. ]
- Q11.4 Que tipo de lojas virtuais utiliza para fazer compras? [Sites de classificados (do tipo: OLX, Custo Justo, ...) ]
- Q11.5 Que tipo de lojas virtuais utiliza para fazer compras? [Aplicações em dispositivos móveis (do tipo: Glovo, UberEats, …) ]
- Q11.6 Que tipo de lojas virtuais utiliza para fazer compras? [Redes sociais (do tipo: Facebook, ...) ]
- Q12.1 Que tipos de produtos costuma comprar online com entrega em casa? [Bens alimentares (mercearia, café, …)]
- Q12.2 Que tipos de produtos costuma comprar online com entrega em casa? [Roupa, calçado e acessórios de moda]
- Q12.3 Que tipos de produtos costuma comprar online com entrega em casa? [Livros, CD's, vinis ]
- Q12.4 Que tipos de produtos costuma comprar online com entrega em casa? [Produtos farmacêuticos ]
- Q12.5 Que tipos de produtos costuma comprar online com entrega em casa? [Tecnãologia e software]

- Q12.6 Que tipos de produtos costuma comprar online com entrega em casa? [Cosméticos e itens pessoais]
- Q12.7 Que tipos de produtos costuma comprar online com entrega em casa? [Desporto e lazer]
- Q12.8 Que tipos de produtos costuma comprar online com entrega em casa? [Mobiliário, decoração e bricolage]
- Q12.9 Que tipos de produtos costuma comprar online com entrega em casa? [Outro]
- Q13.1 Quando faz compras online como é efetuado o transporte da encomenda? [Camião]
- Q13.2 Quando faz compras online como é efetuado o transporte da encomenda? [Carrinhas/Van]
- Q13.3 Quando faz compras online como é efetuado o transporte da encomenda? [Mota&bicicleta]
- Q13.4 Quando faz compras online como é efetuado o transporte da encomenda? [Não sei e outros]
- Q14.1 Quais os principais motivos que o levam a fazer compras online? [Comodidade]
- Q14.2 Quais os principais motivos que o levam a fazer compras online? [Diversidade de escolha]
- Q14.3 Quais os principais motivos que o levam a fazer compras online? [Economia ]
- Q14.4 Quais os principais motivos que o levam a fazer compras online? [Comparabilidade entre diversas opções]
- Q14.5 Quais os principais motivos que o levam a fazer compras online? [Facilidade de acesso e rapidez]
- Q14.6 Quais os principais motivos que o levam a fazer compras online? [Outro]
- Q15. Prefere fazer compras online ou deslocar-se a uma loja física?
- Q16. Considerando a sua experiência com compras online como avalia a sua satisfação? (1 corresponde a totalmente insatisfeito e 5 totalmente satisfeito)
- Q17. Como classifica a segurança não tratamento dos seus dados pessoais e de modo de pagamento quando efetua compras online) (1 significa extremamente inseguro e 5 muito seguro)
- Q18. Conhece a solução do uso de drones para entrega de mercadorias?
- Q19. Se a entrega das mercadorias fosse efetuada por drones, consideraria a existência dessa solução uma mais-valia como método de entrega?
- Q20. Caso fosse possível utilizar drones para a entrega de mercadorias na sua área de residência, consideraria optar por este método de entrega, admitindo que Não haveria um custo adicional?
- Q21. Estaria disposto a pagar por esse serviço caso garantisse uma entrega mais rápida do que os outros modos de transporte?
- Q22. Estaria disposto a pagar por esse serviço caso garantisse uma entrega mais amiga do ambiente do que os outros modos de transporte?
- Q23. Estaria disposto a pagar por esse serviço caso garantisse uma maior flexibilidade do que outros modos de transporte na escolha do local e momento de entrega?
- Q24. Quanto seria o valor adicional que estaria disposto a pagar por um serviço de entrega por drones (em Euros)?
- Q25. Considera que o uso de drones para a entrega de mercadorias poderá trazer benefícios para os centros das cidades e para os consumidores?
- Q26.1 Selecione os benefícios que considera mais relevantes [Diminuição do tráfego motorizado]
- Q26.2 Selecione os benefícios que considera mais relevantes [Diminuição da poluição]
- Q26.3 Selecione os benefícios que considera mais relevantes [Diminuição do ruído]

- Q26.4 Selecione os benefícios que considera mais relevantes [Diminuição do tempo de entrega]
- Q26.5 Selecione os benefícios que considera mais relevantes [Aumento da acessibilidade ]
- Selecione os benefícios que considera mais relevantes [Outro]
- Q27. Acha que deveria haver investimento público em infraestruturas específicas para a utilização de drones?
- Q28. Aceitaria que a sua residência fosse sobrevoada por drones para efetuarem entregas de mercadorias?

# 9 Appendix 2

**Survey on Perceptions and Attitudes of health workers regarding medical applications of UAM**

- Q1 Age
- Q2 Where do you work?
- Q3 Do you consider the area where you work to be:
- Q4 What is your role/function?
- Q5 Experience in the field
- Q6 Do you work in emergency services (INEM)?
- Q7 Type of workplace where you predominantly work
- Q8 Do you have contact with patients in the exercise of your profession?
- Q9 In the course of your profession, do you have contact with the process of delivering medical supplies/materials?
- Q10 I have knowledge about the use of drones for delivery purposes.
- Q11 I have knowledge about the use of drones for medical purposes, such as emergencies or deliveries.
- Q12 I think the use of drones for non-urgent health services (delivery of medications, vaccines, etc.) is a good idea.
- Q13 I think that the use of drones for urgent and emergency medical services (defibrillators, organs, blood, first aid kits, etc.) is a good idea.
- Q14 I support the use of drones for non-urgent health services.
- Q15 I support the use of drones for urgent medical care and medical emergency services.
- Q16 I see benefits in the use of drones for medical purposes
- Q17 I have interest in using drone delivery of medical supplies.
- Q18 I can imagine myself using the medical supplies delivery service by drones, if necessary.
- Q19 The use of drones for medical material deliveries would improve the efficiency of my work.
- Q20 The use of drones for the delivery of medical materials is a compatible option with my work
- Q21 I consider that the delivery of medical materials by drones is an easy concept to understand.
- Q22 I consider that the delivery of medical materials by drones would be easy to use.
- Q23 I consider that I would be able to interact with drone delivery services for medical supplies in my day-to-day.
- Q24 Delivery of medical supplies by drones enables faster access to items that are not always easily available everywhere.
- Q25 The delivery of medical materials by drones is a useful tool in emergency situations that require speed above all else.
- Q26 The delivery of medical supplies by drones is a more environmentally friendly option.
- Q27 I am afraid that a drone may fail and end up damaging the materials it carries.
- Q28 I am afraid that a drone may fail more often than current transportation modes.
- Q29 I am afraid that a drone could fail and end up damaging property or injuring people on the ground.
- Q30 I'm afraid that a drone may be stolen or hijacked during its route for criminal purposes.

- Q31 I'm afraid that the use of drones for regular deliveries may lead to a loss of privacy and security.

# 10 Appendix 3

## 10.1 Group comparisons – Age

| Kruskal-Wallis | | | | |
|---|---|---|---|---|
| discrete variable | tested variables | Test_Statistic | Degrees_of_Freedom | P_Value |
| age | q2 | 6,48 | 4 | 0,17 |
| age | q3 | 5,16 | 4 | 0,27 |
| age | q4 | 2,96 | 4 | 0,56 |
| age | q5 | 3,99 | 4 | 0,41 |
| age | q6 | 6,22 | 4 | 0,18 |
| age | q7 | 3,04 | 4 | 0,55 |
| age | q8 | 5,69 | 4 | 0,22 |
| age | q9 | 3,42 | 4 | 0,49 |
| age | q10 | 7,48 | 4 | 0,11 |
| age | q11 | 7,04 | 4 | 0,13 |
| age | q12 | 5,56 | 4 | 0,23 |
| age | q13 | 4,97 | 4 | 0,29 |
| age | q14 | 5,01 | 4 | 0,29 |
| age | q15 | 1,93 | 4 | 0,75 |
| age | q16 | 4,63 | 4 | 0,33 |
| age | q17 | 0,22 | 4 | 0,99 |
| age | q18 | 5,61 | 4 | 0,23 |
| age | q19 | 3,20 | 4 | 0,52 |
| age | q20 | 2,35 | 4 | 0,67 |
| age | q21 | 12,56 | 4 | 0,01 |
| age | q22 | 2,38 | 4 | 0,67 |

**Post hoc:**

| | Dunntest | | | bonferroni method |
|---|---|---|---|---|
| tested variables | Comparison | Z | P,unadj | P,adj |
| q21 | 18-24 - 25-34 | 0.9766589 | 0,33 | 1,00 |
| | 18-24 - 35-44 | 2.0712704 | 0,04 | 0,38 |
| | 25-34 - 35-44 | 1.3677397 | 0,17 | 1,00 |
| | 18-24 - 45-54 | 3.2102726 | 0,00 | 0,01 |
| | 25-34 - 45-54 | 2.7366565 | 0,01 | 0,06 |
| | 35-44 - 45-54 | 1.6486684 | 0,10 | 0,99 |
| | 18-24 - 55+ | 0.3844098 | 0,70 | 1,00 |
| | 25-34 - 55+ | -0.2595654 | 0,80 | 1,00 |
| | 35-44 - 55+ | -1.1149942 | 0,26 | 1,00 |
| | 45-54 - 55+ | -2.2733840 | 0,02 | 0,23 |

## 10.2 Group comparisons – Experience

| Kruskal-Wallis | | | | |
|---|---|---|---|---|
| discrete variable | tested variables | Test_Statistic | Degrees_of_Freedom | P_Value |
| | | | | |
| | | | | |
| experience | q1 | 11,751158 | 5 | 0,038361255 |
| experience | q2 | 11,863014 | 5 | 0,036713793 |
| experience | q3 | 11,994953 | 5 | 0,034856997 |
| experience | q4 | 9,466906 | 5 | 0,09182858 |
| experience | q5 | 7,8716 | 5 | 0,163455428 |
| experience | q6 | 8,638746 | 5 | 0,124370339 |
| experience | q7 | 5,575519 | 5 | 0,349735954 |
| experience | q8 | 4,684309 | 5 | 0,455608361 |
| experience | q9 | 5,363213 | 5 | 0,373178229 |
| experience | q10 | 2,627401 | 5 | 0,757197731 |
| experience | q11 | 7,622885 | 5 | 0,178280464 |
| experience | q12 | 13,88024 | 5 | 0,016388315 |
| experience | q13 | 11,750118 | 5 | 0,038376896 |
| experience | q14 | 13,93477 | 5 | 0,016029118 |
| experience | q15 | 6,489316 | 5 | 0,261472682 |
| experience | q16 | 9,918269 | 5 | 0,07758446 |
| experience | q17 | 8,704824 | 5 | 0,121432938 |
| experience | q18 | 7,178524 | 5 | 0,207698196 |
| experience | q19 | 8,070546 | 5 | 0,152390332 |
| experience | q20 | 11,986931 | 5 | 0,034967293 |
| experience | q21 | 15,874676 | 5 | 0,007211139 |
| experience | q22 | 8,638025 | 5 | 0,124402764 |

**Post hoc:**

| | Dunntest | | | bonferroni method |
|---|---|---|---|---|
| tested variables | Comparison | Z | P,unadj | P,adj |
| q1 | | | | |
| | <6m - >10 years | -1.3375075 | 0,18105704 | 1 |
| | <6m - 1-2 years | -1.2147209 | 0,224472543 | 1 |
| | >10 years - 1-2 years | -0.1291516 | 0,897237694 | 1 |
| | <6m - 2-5 years | 0.7384774 | 0,460224386 | 1 |
| | >10 years - 2-5 years | 2.9144316 | 0,003563369 | 0,05345053 |
| | 1-2 years - 2-5 years | 2.2711714 | 0,023136602 | 0,34704903 |
| | <6m - 5-10 years | 0.4485027 | 0,653790452 | 1 |
| | >10 years - 5-10 years | 1.9765148 | 0,048096499 | 0,72144748 |
| | 1-2 years - 5-10 years | 1.7254603 | 0,084444549 | 1 |
| | 2-5 years - 5-10 years | -0.2272342 | 0,820241672 | 1 |
| | <6m - 6m-1 year | -0.4246503 | 0,671091619 | 1 |
| | >10 years - 6m-1 year | 0.6692046 | 0,503364981 | 1 |
| | 1-2 years - 6m-1 year | 0.6691846 | 0,503377721 | 1 |
| | 2-5 years - 6m-1 year | -1.1500412 | 0,250126885 | 1 |
| | 5-10 years - 6m-1 year | -0.8462233 | 0,397428173 | 1 |
| q2 | | | | |
| | <6m - >10 years | -0.4358369 | 0,662955099 | 1 |
| | <6m - 1-2 years | -1.0532127 | 0,292243527 | 1 |
| | >10 years - 1-2 years | -0.8884393 | 0,374304492 | 1 |
| | <6m - 2-5 years | 1.5047760 | 0,132381688 | 1 |
| | >10 years - 2-5 years | 2.7770595 | 0,005485314 | 0,08227971 |
| | 1-2 years - 2-5 years | 2.8904801 | 0,003846539 | 0,05769808 |

| | | | | |
|---|---|---|---|---|
| | <6m - 5-10 years | 0.6687344 | 0,503664914 | 1 |
| | >10 years - 5-10 years | 1.3111801 | 0,189796924 | 1 |
| | 1-2 years - 5-10 years | 1.7891873 | 0,073584664 | 1 |
| | 2-5 years - 5-10 years | -0.7606771 | 0,446849971 | 1 |
| | <6m - 6m-1 year | 0.2273739 | 0,820132985 | 1 |
| | >10 years - 6m-1 year | 0.6576414 | 0,510768558 | 1 |
| | 1-2 years - 6m-1 year | 1.1979509 | 0,230936132 | 1 |
| | 2-5 years - 6m-1 year | -1.0765596 | 0,281677044 | 1 |
| | 5-10 years - 6m-1 year | -0.3789569 | 0,704719834 | 1 |
| q3 | | | | |
| | <6m - >10 years | -1.8764871 | 0,060588427 | 0,9088264 |
| | <6m - 1-2 years | -1.2720411 | 0,203358503 | 1 |
| | >10 years - 1-2 years | 0.3752147 | 0,70750081 | 1 |
| | <6m - 2-5 years | -0.4503047 | 0,652490758 | 1 |
| | >10 years - 2-5 years | 1.9402537 | 0,052348868 | 0,78523302 |
| | 1-2 years - 2-5 years | 1.0743228 | 0,282678009 | 1 |
| | <6m - 5-10 years | 0.8346524 | 0,403913475 | 1 |
| | >10 years - 5-10 years | 3.0352239 | 0,002403572 | 0,03605358 |
| | 1-2 years - 5-10 years | 2.1891841 | 0,028583463 | 0,42875195 |
| | 2-5 years - 5-10 years | 1.4839064 | 0,137833759 | 1 |
| | <6m - 6m-1 year | -0.8241100 | 0,409877059 | 1 |
| | >10 years - 6m-1 year | 0.6644491 | 0,506402916 | 1 |
| | 1-2 years - 6m-1 year | 0.3072120 | 0,758682039 | 1 |
| | 2-5 years - 6m-1 year | -0.5544278 | 0,579286118 | 1 |
| | 5-10 years - 6m-1 year | -1.6095221 | 0,107502233 | 1 |
| q12 | | | | |
| | <6m - >10 years | -2.2453331 | 0,024746758 | 0,37120137 |
| | <6m - 1-2 years | -1.4573575 | 0,145017728 | 1 |
| | >10 years - 1-2 years | 0.5322897 | 0,594525359 | 1 |
| | <6m - 2-5 years | -1.1363609 | 0,25580556 | 1 |
| | >10 years - 2-5 years | 1.4578567 | 0,144880034 | 1 |
| | 1-2 years - 2-5 years | 0.5696177 | 0,56893704 | 1 |
| | <6m - 5-10 years | 0.7263823 | 0,467604457 | 1 |
| | >10 years - 5-10 years | 3.2841841 | 0,001022781 | 0,01534172 |
| | 1-2 years - 5-10 years | 2.2673417 | 0,023369358 | 0,35054037 |
| | 2-5 years - 5-10 years | 2.0694204 | 0,038506653 | 0,5775998 |
| | <6m - 6m-1 year | -1.4068148 | 0,159482326 | 1 |
| | >10 years - 6m-1 year | 0.2894167 | 0,772262495 | 1 |
| | 1-2 years - 6m-1 year | -0.1279049 | 0,89822427 | 1 |
| | 2-5 years - 6m-1 year | -0.6190052 | 0,535912909 | 1 |
| | 5-10 years - 6m-1 year | -2.1081748 | 0,035015876 | 0,52523814 |
| q13 | | | | |
| | <6m - >10 years | -1.45879313 | 0,144622054 | 1 |
| | <6m - 1-2 years | 0.21372187 | 0,830763952 | 1 |
| | >10 years - 1-2 years | 1.84000393 | 0,06576766 | 0,9865149 |
| | <6m - 2-5 years | -0.50733372 | 0,611920686 | 1 |
| | >10 years - 2-5 years | 1.28103328 | 0,200181979 | 1 |
| | 1-2 years - 2-5 years | -0.80179582 | 0,422671079 | 1 |
| | <6m - 5-10 years | 1.23301918 | 0,217568607 | 1 |
| | >10 years - 5-10 years | 3.10531713 | 0,001900751 | 0,02851127 |
| | 1-2 years - 5-10 years | 1.07059286 | 0,284352536 | 1 |
| | 2-5 years - 5-10 years | 2.02714519 | 0,042647566 | 0,63971349 |

| | | | | |
|---|---|---|---|---|
| | <6m - 6m-1 year | 0.19584400 | 0,84473227 | 1 |
| | >10 years - 6m-1 year | 1.52190981 | 0,128031682 | 1 |
| | 1-2 years - 6m-1 year | 0.00790179 | 0,993695349 | 1 |
| | 2-5 years - 6m-1 year | 0.67890196 | 0,497199981 | 1 |
| | 5-10 years - 6m-1 year | -0.92789097 | 0,35346413 | 1 |
| q14 | | | | |
| | <6m - >10 years | -0.6027752 | 0,54665826 | 1 |
| | <6m - 1-2 years | 1.3623368 | 0,173091614 | 1 |
| | >10 years - 1-2 years | 2.4005409 | 0,01637086 | 0,24556289 |
| | <6m - 2-5 years | 0.1571677 | 0,875112717 | 1 |
| | >10 years - 2-5 years | 1.0595491 | 0,289349762 | 1 |
| | 1-2 years - 2-5 years | -1.4970442 | 0,134381751 | 1 |
| | <6m - 5-10 years | 2.0886372 | 0,03674039 | 0,55110585 |
| | >10 years - 5-10 years | 3.2990184 | 0,000970235 | 0,01455353 |
| | 1-2 years - 5-10 years | 0.7794633 | 0,435706825 | 1 |
| | 2-5 years - 5-10 years | 2.3714815 | 0,017716933 | 0,26575399 |
| | <6m - 6m-1 year | 0.2713854 | 0,786094663 | 1 |
| | >10 years - 6m-1 year | 0.8577623 | 0,391023705 | 1 |
| | 1-2 years - 6m-1 year | -0.9630039 | 0,335545549 | 1 |
| | 2-5 years - 6m-1 year | 0.1746692 | 0,861339565 | 1 |
| | 5-10 years - 6m-1 year | -1.6336937 | 0,102323183 | 1 |
| q21 | | | | |
| | <6m - >10 years | -0.26178538 | 0,79348691 | 1 |
| | <6m - 1-2 years | -2.64886516 | 0,008076255 | 0,12114382 |
| | >10 years - 1-2 years | -3.12947125 | 0,001751212 | 0,02626818 |
| | <6m - 2-5 years | -2.01184892 | 0,044235865 | 0,66353798 |
| | >10 years - 2-5 years | -2.54672955 | 0,010873767 | 0,1631065 |
| | 1-2 years - 2-5 years | 1.09242524 | 0,274646233 | 1 |
| | <6m - 5-10 years | -0.99444346 | 0,32000702 | 1 |
| | >10 years - 5-10 years | -0.99468232 | 0,319890795 | 1 |
| | 1-2 years - 5-10 years | 1.69655201 | 0,089781389 | 1 |
| | 2-5 years - 5-10 years | 0.89516165 | 0,370700683 | 1 |
| | <6m - 6m-1 year | 0.01665083 | 0,986715177 | 1 |
| | >10 years - 6m-1 year | 0.25088481 | 0,80190317 | 1 |
| | 1-2 years - 6m-1 year | 2.43700993 | 0,014809273 | 0,22213909 |
| | 2-5 years - 6m-1 year | 1.81109035 | 0,070126868 | 1 |
| | 5-10 years - 6m-1 year | 0.92746989 | 0,353682617 | 1 |
| q22 | | | | |
| | <6m - >10 years | -0.7406069 | 0,45893184 | 1 |
| | <6m - 1-2 years | -1.8917758 | 0,05852086 | 0,8778129 |
| | >10 years - 1-2 years | -1.6411228 | 0,10077193 | 1 |
| | <6m - 2-5 years | -1.1707607 | 0,24169498 | 1 |
| | >10 years - 2-5 years | -0.6697055 | 0,50304557 | 1 |
| | 1-2 years - 2-5 years | 1.0637411 | 0,287446 | 1 |
| | <6m - 5-10 years | -1.7307286 | 0,08350018 | 1 |
| | >10 years - 5-10 years | -1.4319867 | 0,15214762 | 1 |
| | 1-2 years - 5-10 years | 0.1427168 | 0,88651388 | 1 |
| | 2-5 years - 5-10 years | -0.8777079 | 0,38010223 | 1 |

| | | | | |
|---|---|---|---|---|
| | <6m - 6m-1 year | 0.5060191 | 0,61284323 | 1 |
| | >10 years - 6m-1 year | 1.2613132 | 0,20719604 | 1 |
| | 1-2 years - 6m-1 year | 2.2529998 | 0,02425916 | 0,3638874 |
| | 2-5 years - 6m-1 year | 1.6293791 | 0,1032328 | 1 |
| | 5-10 years - 6m-1 year | 2.1035424 | 0,03541839 | 0,5312758 |

## 10.3 Group comparisons – Professional roles

| Kruskal-Wallis | | | | |
|---|---|---|---|---|
| discrete variable | tested variables | Test_Statistic | Degrees_of_Freedom | P_Value |
| | | | | |
| | | | | |
| role | q1 | 7,751927554 | 8 | 0,46 |
| role | q2 | 6,66268195 | 8 | 0,57 |
| role | q3 | 2,809138074 | 8 | 0,95 |
| role | q4 | 9,780539248 | 8 | 0,28 |
| role | q5 | 3,675364185 | 8 | 0,89 |
| role | q6 | 6,076014876 | 8 | 0,64 |
| role | q7 | 8,130328778 | 8 | 0,42 |
| role | q8 | 9,490032553 | 8 | 0,30 |
| role | q9 | 8,783282253 | 8 | 0,36 |
| role | q10 | 17,33501833 | 8 | 0,03 |
| role | q11 | 15,58057754 | 8 | 0,05 |
| role | q12 | 10,33941541 | 8 | 0,24 |
| role | q13 | 14,14006545 | 8 | 0,08 |
| role | q14 | 10,73787919 | 8 | 0,22 |
| role | q15 | 10,05049747 | 8 | 0,26 |
| role | q16 | 9,805113809 | 8 | 0,28 |
| role | q17 | 9,388731552 | 8 | 0,31 |
| role | q18 | 7,158407066 | 8 | 0,52 |
| role | q19 | 9,684109064 | 8 | 0,29 |
| role | q20 | 17,87668733 | 8 | 0,02 |
| role | q21 | 9,886594571 | 8 | 0,27 |
| role | q22 | 8,744757398 | 8 | 0,36 |

**Post hoc:**

| | Dunntest | | | bonferroni method |
|---|---|---|---|---|
| tested variables | Comparison | Z | P,unadj | P,adj |
| q10 | Academic/research - Administrative | -1,47272582 | 0,140825 | 1 |
| q10 | Academic/research - Doctor | -2,66996391 | 0,007586 | 0,2730938 |
| q10 | Administrative - Doctor | -0,39506111 | 0,692798 | 1 |
| q10 | Academic/research - Health aid | -0,7592742 | 0,447689 | 1 |
| q10 | Administrative - Health aid | 0,29165132 | 0,770553 | 1 |
| q10 | Doctor - Health aid | 0,61202261 | 0,540523 | 1 |
| q10 | Academic/research - Nurse | -3,46997779 | 0,000521 | 0,0187381 |
| q10 | Administrative - Nurse | -1,04289857 | 0,296995 | 1 |
| q10 | Doctor - Nurse | -1,03270486 | 0,301742 | 1 |
| q10 | Health aid - Nurse | -1,07178739 | 0,283816 | 1 |
| q10 | Academic/research - Others | -0,57892053 | 0,562643 | 1 |
| q10 | Administrative - Others | 0,76104778 | 0,446629 | 1 |
| q10 | Doctor - Others | 1,36282584 | 0,172937 | 1 |
| q10 | Health aid - Others | 0,30536368 | 0,760089 | 1 |
| q10 | Nurse - Others | 1,99692246 | 0,045834 | 1 |

| | | | | |
|---|---|---|---|---|
| q10 | Academic/research - Paramedic/Emergency | -1,31216961 | 0,189463 | 1 |
| q10 | Administrative - Paramedic/Emergency | -0,03728226 | 0,97026 | 1 |
| q10 | Doctor - Paramedic/Emergency | 0,28865201 | 0,772848 | 1 |
| q10 | Health aid - Paramedic/Emergency | -0,30195344 | 0,762688 | 1 |
| q10 | Nurse - Paramedic/Emergency | 0,83939305 | 0,401249 | 1 |
| q10 | Others - Paramedic/Emergency | -0,71798408 | 0,472767 | 1 |
| q10 | Academic/research - Pharmacist | -3,30491475 | 0,00095 | 0,0342019 |
| q10 | Administrative - Pharmacist | -1,02987178 | 0,30307 | 1 |
| q10 | Doctor - Pharmacist | -0,98590404 | 0,32418 | 1 |
| q10 | Health aid - Pharmacist | -1,0688676 | 0,285129 | 1 |
| q10 | Nurse - Pharmacist | -0,03077321 | 0,97545 | 1 |
| q10 | Others - Pharmacist | -1,95277777 | 0,050846 | 1 |
| q10 | Paramedic/Emergency - Pharmacist | -0,83741232 | 0,402361 | 1 |
| q10 | Academic/research - Technician | -2,23298248 | 0,02555 | 0,9198036 |
| q10 | Administrative - Technician | -0,59568454 | 0,551386 | 1 |
| q10 | Doctor - Technician | -0,35802246 | 0,720327 | 1 |
| q10 | Health aid - Technician | -0,75887886 | 0,447925 | 1 |
| q10 | Nurse - Technician | 0,32823482 | 0,742734 | 1 |
| q10 | Others - Technician | -1,37650308 | 0,168666 | 1 |
| q10 | Paramedic/Emergency - Technician | -0,49196316 | 0,622745 | 1 |
| q10 | Pharmacist - Technician | 0,3384704 | 0,735009 | 1 |
| | | | | |
| q11 | Academic/research - Administrative | -0,27139777 | 0,786085 | 1 |
| q11 | Academic/research - Doctor | -2,33686734 | 0,019446 | 0,700059 |
| q11 | Administrative - Doctor | -1,4475724 | 0,147737 | 1 |
| q11 | Academic/research - Health aid | -0,26938276 | 0,787635 | 1 |
| q11 | Administrative - Health aid | -0,06425361 | 0,948768 | 1 |
| q11 | Doctor - Health aid | 0,94742282 | 0,343423 | 1 |
| q11 | Academic/research - Nurse | -3,04575312 | 0,002321 | 0,0835554 |
| q11 | Administrative - Nurse | -2,00548403 | 0,044911 | 1 |
| q11 | Doctor - Nurse | -0,91420404 | 0,36061 | 1 |
| q11 | Health aid - Nurse | -1,35153519 | 0,176524 | 1 |
| q11 | Academic/research - Others | 0,14807816 | 0,882281 | 1 |
| q11 | Administrative - Others | 0,35717088 | 0,720964 | 1 |
| q11 | Doctor - Others | 1,90175857 | 0,057203 | 1 |
| q11 | Health aid - Others | 0,3444415 | 0,730514 | 1 |
| q11 | Nurse - Others | 2,45322142 | 0,014158 | 0,5096994 |
| q11 | Academic/research - Paramedic/Emergency | -0,79021082 | 0,429405 | 1 |
| q11 | Administrative - Paramedic/Emergency | -0,49120492 | 0,623282 | 1 |
| q11 | Doctor - Paramedic/Emergency | 0,63224505 | 0,527227 | 1 |
| q11 | Health aid - Paramedic/Emergency | -0,34125028 | 0,732915 | 1 |
| q11 | Nurse - Paramedic/Emergency | 1,11595725 | 0,26444 | 1 |
| q11 | Others - Paramedic/Emergency | -0,81066827 | 0,417556 | 1 |
| q11 | Academic/research - Pharmacist | -1,94488611 | 0,051789 | 1 |
| q11 | Administrative - Pharmacist | -1,22071948 | 0,222192 | 1 |
| q11 | Doctor - Pharmacist | 0,24115186 | 0,809437 | 1 |
| q11 | Health aid - Pharmacist | -0,80948093 | 0,418239 | 1 |
| q11 | Nurse - Pharmacist | 1,05463412 | 0,291593 | 1 |
| q11 | Others - Pharmacist | -1,65385279 | 0,098157 | 1 |
| q11 | Paramedic/Emergency - Pharmacist | -0,47435073 | 0,63525 | 1 |

| | | | | |
|---|---|---|---|---|
| q11 | Academic/research - Technician | -1,8459875 | 0,064894 | 1 |
| q11 | Administrative - Technician | -1,318943 | 0,187188 | 1 |
| q11 | Doctor - Technician | -0,19521428 | 0,845225 | 1 |
| q11 | Health aid - Technician | -0,95908252 | 0,337517 | 1 |
| q11 | Nurse - Technician | 0,41041949 | 0,681498 | 1 |
| q11 | Others - Technician | -1,68539259 | 0,091913 | 1 |
| q11 | Paramedic/Emergency - Technician | -0,67220421 | 0,501454 | 1 |
| q11 | Pharmacist - Technician | -0,35140056 | 0,725288 | 1 |
| | | | | |
| q20 | Academic/research - Administrative | -0,6513336 | 0,514831 | 1 |
| q20 | Academic/research - Doctor | -1,7191264 | 0,085591 | 1 |
| q20 | Administrative - Doctor | -0,5758592 | 0,56471 | 1 |
| q20 | Academic/research - Health aid | -1,2720692 | 0,203349 | 1 |
| q20 | Administrative - Health aid | -0,7243904 | 0,468826 | 1 |
| q20 | Doctor - Health aid | -0,421999 | 0,673026 | 1 |
| q20 | Academic/research - Nurse | -1,178661 | 0,238533 | 1 |
| q20 | Administrative - Nurse | -0,1929792 | 0,846975 | 1 |
| q20 | Doctor - Nurse | 0,5921802 | 0,55373 | 1 |
| q20 | Health aid - Nurse | 0,6851331 | 0,49326 | 1 |
| q20 | Academic/research - Others | 1,0623694 | 0,288068 | 1 |
| q20 | Administrative - Others | 1,4591655 | 0,14452 | 1 |
| q20 | Doctor - Others | 2,4313654 | 0,015042 | 0,5415133 |
| q20 | Health aid - Others | 1,869054 | 0,061615 | 1 |
| q20 | Nurse - Others | 2,02214 | 0,043162 | 1 |
| q20 | Academic/research - Paramedic/Emergency | -2,551989 | 0,010711 | 0,3855956 |
| q20 | Administrative - Paramedic/Emergency | -1,7578148 | 0,078779 | 1 |
| q20 | Doctor - Paramedic/Emergency | -1,6229819 | 0,104593 | 1 |
| q20 | Health aid - Paramedic/Emergency | -0,760879 | 0,446729 | 1 |
| q20 | Nurse - Paramedic/Emergency | -1,9239643 | 0,054359 | 1 |
| q20 | Others - Paramedic/Emergency | -3,0629321 | 0,002192 | 0,0789047 |
| q20 | Academic/research - Pharmacist | -1,8975721 | 0,057752 | 1 |
| q20 | Administrative - Pharmacist | -0,7918994 | 0,428419 | 1 |
| q20 | Doctor - Pharmacist | -0,3664109 | 0,714058 | 1 |
| q20 | Health aid - Pharmacist | 0,2367046 | 0,812886 | 1 |
| q20 | Nurse - Pharmacist | -0,8873002 | 0,374917 | 1 |
| q20 | Others - Pharmacist | -2,5613974 | 0,010425 | 0,3753073 |
| q20 | Paramedic/Emergency - Pharmacist | 1,3607707 | 0,173586 | 1 |
| q20 | Academic/research - Technician | 0,6399641 | 0,522196 | 1 |
| q20 | Administrative - Technician | 1,1084411 | 0,267671 | 1 |
| q20 | Doctor - Technician | 2,03363 | 0,041989 | 1 |
| q20 | Health aid - Technician | 1,596662 | 0,110341 | 1 |
| q20 | Nurse - Technician | 1,6119214 | 0,106979 | 1 |
| q20 | Others - Technician | -0,3886311 | 0,697549 | 1 |
| q20 | Paramedic/Emergency - Technician | 2,7803049 | 0,005431 | 0,1955084 |
| q20 | Pharmacist - Technician | 2,1838682 | 0,028972 | 1 |

## 10.4 Group comparisons – Workplace

| Kruskal-Wallis | | | | |
|---|---|---|---|---|
| discrete variable | tested variables | Test_Statistic | Degrees_of_Freedom | P_Value |
| workplace | q1 | 0,30879676 | 3 | 0,958365646 |

| | | | | |
|---|---|---|---|---|
| workplace | q2 | 3,685621245 | 3 | 0,297473541 |
| workplace | q3 | 1,350622277 | 3 | 0,717148836 |
| workplace | q4 | 5,3761083 | 3 | 0,146239379 |
| workplace | q5 | 3,373211607 | 3 | 0,337582245 |
| workplace | q6 | 5,836042489 | 3 | 0,11986537 |
| workplace | q7 | 5,730061604 | 3 | 0,125507902 |
| workplace | q8 | 0,460269336 | 3 | 0,927529227 |
| workplace | q9 | 0,03937006 | 3 | 0,997946739 |
| workplace | q10 | 7,069940759 | 3 | 0,06970162 |
| workplace | q11 | 5,817661597 | 3 | 0,12082634 |
| workplace | q12 | 0,905556201 | 3 | 0,824086767 |
| workplace | q13 | 0,503984688 | 3 | 0,918015125 |
| workplace | q14 | 1,502301991 | 3 | 0,681739134 |
| workplace | q15 | 4,01934799 | 3 | 0,259382462 |
| workplace | q16 | 4,844259074 | 3 | 0,183562989 |
| workplace | q17 | 0,202488232 | 3 | 0,977186616 |
| workplace | q18 | 2,0617424 | 3 | 0,559691224 |
| workplace | q19 | 0,85917419 | 3 | 0,835267128 |
| workplace | q20 | 1,112747868 | 3 | 0,773997623 |
| workplace | q21 | 1,51915828 | 3 | 0,677855721 |
| workplace | q22 | 2,434030465 | 3 | 0,487331301 |

## 10.5 Group comparisons – type of region

| Kruskal-Wallis | | | | |
|---|---|---|---|---|
| discrete variable | tested variables | Test_Statistic | Degrees_of_Freedom | P_Value |
| Type_region | q1 | 0,31906987 | 2 | 0,85 |
| Type_region | q2 | 0,40492161 | 2 | 0,82 |
| Type_region | q3 | 0,36923753 | 2 | 0,83 |
| Type_region | q4 | 0,07889797 | 2 | 0,96 |
| Type_region | q5 | 0,47486715 | 2 | 0,79 |
| Type_region | q6 | 0,11526061 | 2 | 0,94 |
| Type_region | q7 | 1,01787482 | 2 | 0,60 |
| Type_region | q8 | 0,10131652 | 2 | 0,95 |
| Type_region | q9 | 0,13248965 | 2 | 0,94 |
| Type_region | q10 | 2,51204479 | 2 | 0,28 |
| Type_region | q11 | 3,33394182 | 2 | 0,19 |
| Type_region | q12 | 0,14779089 | 2 | 0,93 |
| Type_region | q13 | 1,99831186 | 2 | 0,37 |
| Type_region | q14 | 0,56622407 | 2 | 0,75 |
| Type_region | q15 | 2,60942619 | 2 | 0,27 |
| Type_region | q16 | 3,85876634 | 2 | 0,15 |
| Type_region | q17 | 0,75633572 | 2 | 0,69 |
| Type_region | q18 | 0,89806354 | 2 | 0,64 |
| Type_region | q19 | 1,70146717 | 2 | 0,43 |
| Type_region | q20 | 4,20790747 | 2 | 0,12 |
| Type_region | q21 | 6,62073367 | 2 | 0,04 |
| Type_region | q22 | 3,88681943 | 2 | 0,14 |

**Post hoc:**

| Post-Hoc test | Dunntest on relevant variables | | | bonferroni method |
|---|---|---|---|---|
| tested variables | Comparison | Z | P,unadj | P,adj |

| | | | | |
|---|---|---|---|---|
| q21 | Rural - Suburban | -0,09 | 0,93 | 1,00 |
| | Rural - Urban | 1,69 | 0,09 | 0,27 |
| | Suburban - Urban | 2,06 | 0,04 | 0,12 |

## References


[1] R. Kellermann, T. Biehle, and L. Fischer, 'Drones for parcel and passenger transportation: A literature review', *Transp Res Interdiscip Perspect*, vol. 4, p. 100088, Mar. 2020, doi: 10.1016/J.TRIP.2019.100088.

[2] E. Frachtenberg, 'Practical Drone Delivery', *Computer (Long Beach Calif)*, vol. 52, no. 12, pp. 53–57, 2019, doi: 10.1109/MC.2019.2942290.

[3] S.-H. Cho and M. Kim, 'Assessment of the environmental impact and policy responses for urban air mobility: A case study of Seoul metropolitan area', *J Clean Prod*, vol. 360, p. 132139, 2022, doi: https://doi.org/10.1016/j.jclepro.2022.132139.

[4] S. Melo, 'Fundamental emerging concepts and trends for environmentally friendly urban goods distribution systems', *International Encyclopedia of Transportation*, pp. 320–323, 2021.

[5] A. Straubinger, R. Rothfeld, M. Shamiyeh, K. D. Büchter, J. Kaiser, and K. O. Plötner, 'An overview of current research and developments in urban air mobility – Setting the scene for UAM introduction', *J Air Transp Manag*, vol. 87, p. 101852, Aug. 2020, doi: 10.1016/J.JAIRTRAMAN.2020.101852.

[6] F. Becker and K. W. Axhausen, 'Literature review on surveys investigating the acceptance of automated vehicles', *Transportation (Amst)*, vol. 44, no. 6, pp. 1293–1306, Nov. 2017, doi: 10.1007/S11116-017-9808-9/TABLES/6.

[7] R. Rodrigues, F. Moura, A. Bastos Silva, and Á. Seco, 'The determinants of Portuguese preference for vehicle automation: A descriptive and explanatory study', *Transp Res Part F Traffic Psychol Behav*, vol. 76, pp. 121–138, Jan. 2021, doi: 10.1016/J.TRF.2020.10.009.

[8] S. M. Castritius, X. Y. Lu, C. Bernhard, M. Liebherr, P. Schubert, and H. Hecht, 'Public acceptance of semi-automated truck platoon driving. A comparison between Germany and California', *Transp Res Part F Traffic Psychol Behav*, vol. 74, pp. 361–374, Oct. 2020, doi: 10.1016/J.TRF.2020.08.013.

[9] ASSURED-UAM, 'UAM Foresight scenarios. Knowledge guidance.', 2023. doi: https://doi.org/10.5281/zenodo.7870428.

[10] McKinsey & Company and EASA, 'Study on the societal acceptance of Urban Air Mobility in Europe', May 2021.

[11] E. Ackerman and E. Strickland, 'Medical delivery drones take flight in east africa', *IEEE Spectr*, vol. 55, no. 1, pp. 34–35, 2018, doi: 10.1109/MSPEC.2018.8241731.

[12] McCall B. Sub-Saharan Africa leads the way in medical drones. Lancet. 2019. doi: 10.1016/S0140-6736(18)33253-7.

[13] J. Park, S. Kim, and K. Suh, 'A Comparative Analysis of the Environmental Benefits of Drone-Based Delivery Services in Urban and Rural Areas', *Sustainability 2018, Vol. 10, Page 888*, vol. 10, no. 3, p. 888, Mar. 2018, doi: 10.3390/SU10030888.

[14] R. Rothfeld, A. Straubinger, M. Fu, C. Al Haddad, and C. Antoniou, 'Urban air mobility', *Demand for Emerging Transportation Systems: Modeling Adoption, Satisfaction, and Mobility Patterns*, pp. 267–284, Jan. 2020, doi: 10.1016/B978-0-12-815018-4.00013-9.

[15] ASSURED-UAM, 'Assured-uam', 2022. https://assured-uam.eu/ (accessed Jan. 06, 2023).

[16] A. T. Silva, S. P. Duarte, S. Melo, A. Witkowska-Konieczny, M. Giannuzzi, and A. Lobo, 'Attitudes towards Urban Air Mobility for E-Commerce Deliveries: An Exploratory Survey Comparing European Regions', *Aerospace*, vol. 10, no. 6, p. 536, 2023. https://doi.org/10.3390/aerospace10060536

[17] G. Ling and N. Draghic, 'Aerial drones for blood delivery', *Transfusion (Paris)*, vol. 59, no. S2, pp. 1608–1611, Apr. 2019, doi: 10.1111/TRF.15195.

[18] A. A. Nyaaba and M. Ayamga, 'Intricacies of medical drones in healthcare delivery: Implications for Africa', *Technol Soc*, vol. 66, p. 101624, Aug. 2021, doi: 10.1016/J.TECHSOC.2021.101624.

[19] A. Rejeb, K. Rejeb, S. Simske, and H. Treiblmaier, 'Humanitarian Drones: A Review and Research Agenda', *Internet of Things*, vol. 16, p. 100434, Dec. 2021, doi: 10.1016/J.IOT.2021.100434.

[20] A. Claesson,, A. Bäckman, M. Ringh,, L. Svensson, P. Nordberg, T. Djärv, 'Time to Delivery of an Automated External Defibrillator Using a Drone for Simulated Out-of-Hospital Cardiac Arrests vs Emergency Medical Services', *JAMA*, vol. 317, no. 22, pp. 2332–2334, Jun. 2017, doi: 10.1001/jama.2017.3957.

[21] V. Puri, A. Nayyar, and L. Raja, 'Agriculture drones: A modern breakthrough in precision agriculture', *Journal of Statistics and Management Systems*, vol. 20, no. 4, pp. 507–518, Jul. 2017, doi: 10.1080/09720510.2017.1395171.

[22] J. Seo, L. Duque, and J. Wacker, 'Drone-enabled bridge inspection methodology and application', *Autom Constr*, vol. 94, pp. 112–126, Oct. 2018, doi: 10.1016/J.AUTCON.2018.06.006.

[23] J. Pons-Prats, T. Živojinović, and J. Kuljanin, 'On the understanding of the current status of urban air mobility development and its future prospects: Commuting in a flying vehicle as a new paradigm', *Transp Res E Logist Transp Rev*, vol. 166, p. 102868, Oct. 2022, doi: 10.1016/J.TRE.2022.102868.

[24] W. J. Yun, S. Jung, J. Kim, and J. H. Kim, 'Distributed deep reinforcement learning for autonomous aerial eVTOL mobility in drone taxi applications', *ICT Express*, vol. 7, no. 1, pp. 1–4, Mar. 2021, doi: 10.1016/J.ICTE.2021.01.005.

[25] A. Bauranov and J. Rakas, 'Designing airspace for urban air mobility: A review of concepts and approaches', *Progress in Aerospace Sciences*, vol. 125, p. 100726, Aug. 2021, doi: 10.1016/J.PAEROSCI.2021.100726.

[26] B. Sah, R. Gupta, and D. Bani-Hani, 'Analysis of barriers to implement drone logistics', *International Journal of Logistics Research and Applications*, vol. 24, no. 6, pp. 531–550, Nov. 2021, doi: 10.1080/13675567.2020.1782862.

[27] H. Sabino, R.V.S. Almeida, L.B. de Moraes, W.P. da Silva, R. Guerra, C. Malcher, D. Passos, F.G.O. Passos., 'A systematic literature review on the main factors for public acceptance of drones', *Technol Soc*, vol. 71, p. 102097, Nov. 2022, doi: 10.1016/J.TECHSOC.2022.102097.

[28] P. Yedavalli and J. Mooberry, 'An assessment of public perception of urban air mobility (UAM)', *Airbus UTM: Defining Future Skies*, pp. 1580045281–2046738072, 2019.

[29] H. Eißfeldt, V. Vogelpohl, M. Stolz, A. Papenfuß, M. Biella, J. Belz, D. Kügler, 'The acceptance of civil drones in Germany', *CEAS Aeronaut J*, vol. 11, no. 3, pp. 665–676, Sep. 2020, doi: 10.1007/S13272-020-00447-W/TABLES/5.

[30] J. Chamata, 'A Proposal for the Adoption of Unmanned Aerial Technology in Malaysia', in *4th Borneo Research Education Conference, BREC*, 2016.

[31] C. Del-Real and A. M. Díaz-Fernández, 'Lifeguards in the sky: Examining the public acceptance of beach-rescue drones', *Technol Soc*, vol. 64, p. 101502, Feb. 2021, doi: 10.1016/J.TECHSOC.2020.101502.

[32] C. Al Haddad, E. Chaniotakis, A. Straubinger, K. Plötner, and C. Antoniou, 'Factors affecting the adoption and use of urban air mobility', *Transp Res Part A Policy Pract*, vol. 132, pp. 696–712, Feb. 2020, doi: 10.1016/J.TRA.2019.12.020.

[33] A. P. Cohen, S. A. Shaheen, and E. M. Farrar, 'Urban Air Mobility: History, Ecosystem, Market Potential, and Challenges', *IEEE Transactions on Intelligent Transportation Systems*, vol. 22, no. 9, pp. 6074–6087, 2021, doi: 10.1109/TITS.2021.3082767.

[34] U. Eker, G. Fountas, P. C. Anastasopoulos, and S. E. Still, 'An exploratory investigation of public perceptions towards key benefits and concerns from the future use of flying cars', *Travel Behav Soc*, vol. 19, pp. 54–66, Apr. 2020, doi: 10.1016/J.TBS.2019.07.003.

[35] S. Leon, C. Chen, and A. Ratcliffe, 'Consumers' perceptions of last mile drone delivery', *International Journal of Logistics Research and Applications*, pp. 1–20, Jul. 2021, doi: 10.1080/13675567.2021.1957803.

[36] V. Yavas and Ö. Yavaş Tez, 'Consumer intention over upcoming utopia: Urban air mobility', *J Air Transp Manag*, vol. 107, p. 102336, 2023, doi: https://doi.org/10.1016/j.jairtraman.2022.102336.

[37] S. Kalakou, C. Marques, D. Prazeres, and V. Agouridas, 'Citizens' attitudes towards technological innovations: The case of urban air mobility', *Technol Forecast Soc Change*, vol. 187, p. 122200, 2023, doi: https://doi.org/10.1016/j.techfore.2022.122200.

[38] J. E. Scott and C. H. Scott, 'Drone Delivery Models for Healthcare', in *Proceedings of the 50th Hawaii International Conference on System Sciences*, 2017, pp. 3297–3304. [Online]. Available: http://hdl.handle.net/10125/41557

[39] P.L. Nedelea, T.O. Popa, E. Manolescu, C. Bouros, G. Grigorasi, D. Andritoi, C. Pascale, A. Andrei, D.C. Cimpoesu, 'Telemedicine System Applicability Using Drones in Pandemic Emergency Medical Situations', *Electronics 2022, Vol. 11, Page 2160*, vol. 11, no. 14, p. 2160, Jul. 2022, doi: 10.3390/ELECTRONICS11142160.

[40] B. Purahong, T. Anuwongpinit, A. Juhong, I. Kanjanasurat, and C. Pintaviooj, 'Medical Drone Managing System for Automated External Defibrillator Delivery Service', *Drones 2022, Vol. 6, Page 93*, vol. 6, no. 4, p. 93, Apr. 2022, doi: 10.3390/DRONES6040093.

[41] S. Schierbeck, J. Hollenberg, A. Nord, L. Svensson, P. Nordberg, M. Ringh, S. Forsberg, P. Lundgren, C. Axelsson, A. Claesson, 'Automated external defibrillators delivered by drones to patients with suspected out-of-hospital cardiac arrest', *Eur Heart J*, vol. 43, no. 15, pp. 1478–1487, Apr. 2022, doi: 10.1093/EURHEARTJ/EHAB498.

[42] W. Zhu, A. Oakey, P.G. Royall, T.P. Waters, T. Cherrett, K. Theobald, et al., 'Investigating the influence of drone flight on the stability of cancer medicines', *PLoS One*, vol. 18, no. 1, Jan. 2023, doi: 10.1371/JOURNAL.PONE.0278873.

[43] M. J. van Veelen, M. Kaufmann, H. Brugger, and G. Strapazzon, 'Drone delivery of AED's and personal protective equipment in the era of SARS-CoV-2', *Resuscitation*, vol. 152, p. 1, Jul. 2020, doi: 10.1016/J.RESUSCITATION.2020.04.038.

[44] M. C. Baumgarten, J. Röper, K. Hahnenkamp, and K. C. Thies, 'Drones delivering automated external defibrillators—Integrating unmanned aerial systems into the chain of survival: A simulation study in rural Germany', *Resuscitation*, vol. 172, pp. 139–145, Mar. 2022, doi: 10.1016/J.RESUSCITATION.2021.12.025.

[45] I. Quintanilla Garcia, N. Vera Velez, P. Alcaraz Martinez, J. Vidal Ull and B. Fernandez Gallo, 'A Quickly Deployed and UAS-Based Logistics Network for Delivery of Critical Medical Goods during Healthcare System Stress Periods: A Real Use Case in Valencia (Spain)', *Drones 2021, Vol. 5, Page 13*, vol. 5, no. 1, p. 13, Feb. 2021, doi: 10.3390/DRONES5010013.

[46] R. Goyal and A. Cohen, 'Advanced Air Mobility: Opportunities and Challenges Deploying eVTOLs for Air Ambulance Service', *Applied Sciences*, vol. 12, no. 3, p. 1183, 2022.

[47] J. Euchi, 'Do drones have a realistic place in a pandemic fight for delivering medical supplies in healthcare systems problems?', *Chinese Journal of Aeronautics*, vol. 34, no. 2, pp. 182–190, Feb. 2021, doi: 10.1016/J.CJA.2020.06.006.

[48] S. Truog, L. Maxim, C. Matemba, C. Blauvelt, H. Ngwira, A. Makaya, et al., 'Insights Before Flights: How Community Perceptions Can Make or Break Medical Drone Deliveries', *Drones 2020, Vol. 4, Page 51*, vol. 4, no. 3, p. 51, Aug. 2020, doi: 10.3390/DRONES4030051.

[49] R. Sham *et al.*, 'Drone Usage for Medicine and Vaccine Delivery during the COVID-19 Pandemic: Attitude of Health Care Workers in Rural Medical Centres', *Drones*, vol. 6, no. 5, p. 109, May 2022, doi: 10.3390/DRONES6050109/S1.

[50] M. Ayamga, S. Akaba, and A. A. Nyaaba, 'Multifaceted applicability of drones: A review', *Technol Forecast Soc Change*, vol. 167, p. 120677, Jun. 2021, doi: 10.1016/J.TECHFORE.2021.120677.

[51] V. Jain and N. Luthra, 'Medical Assistance Using Drones for Remote Areas', *Advances in Intelligent Systems and Computing*, vol. 1164, pp. 471–479, 2021, doi: 10.1007/978-981-15-4992-2_44/FIGURES/6.

[52] Z. Ghelichi, M. Gentili, and P. B. Mirchandani, 'Logistics for a fleet of drones for medical item delivery: A case study for Louisville, KY', *Comput Oper Res*, vol. 135, p. 105443, Nov. 2021, doi: 10.1016/J.COR.2021.105443.

[53] K. Flemons *et al.*, 'The use of drones for the delivery of diagnostic test kits and medical supplies to remote First Nations communities during Covid-19', *Am J Infect Control*, vol. 50, no. 8, pp. 849–856, Aug. 2022, doi: 10.1016/J.AJIC.2022.03.004.

[54] J. L. Duncan, B. M. Josiam, Y. H. Kim, and A. C. Kalldin, 'Using factor-cluster analysis to segment patrons of casual dining establishments in the United States', *British Food*

*Journal*, vol. 117, no. 4, pp. 1377–1398, Apr. 2015, doi: 10.1108/BFJ-04-2014-0142/FULL/PDF.

[55] E. Schubert and P. J. Rousseeuw, 'Fast and eager k-medoids clustering: O(k) runtime improvement of the PAM, CLARA, and CLARANS algorithms', *Inf Syst*, vol. 101, p. 101804, Nov. 2021, doi: 10.1016/J.IS.2021.101804.

[56] T. Filaire, 'Clustering on mixed type data. A proposed approach using R ', *Towards Data Science*, Jul. 16, 2018. https://towardsdatascience.com/clustering-on-mixed-type-data-8bbd0a2569c3.

[57] J. C. Gower, 'A General Coefficient of Similarity and Some of Its Properties', *Biometrics*, vol. 27, no. 4, p. 857, Dec. 1971, doi: 10.2307/2528823.

[58] R Core Team, 'R: A language and environment for statistical computing', *R Foundation for Statistical Computing*. https://www.r-project.org/ (accessed May 30, 2023).

[59] N. J. Gogtay and U. M. Thatte, 'Principles of correlation analysis', *Journal of the Association of Physicians of India*, vol. 65, no. 3, pp. 78–81, 2017.

[60] C. Mircioiu and J. Atkinson, 'A comparison of parametric and non-parametric methods applied to a Likert scale', *Pharmacy*, vol. 5, no. 2, p. 26, 2017.

[61] R. Likert, 'A technique for the measurement of attitudes.', *Archives of Psychology*, vol. 22 140, p. 55, 1932.

[62] J. Murray, 'Likert data: what to use, parametric or non-parametric?', *International Journal of Business and Social Science*, vol. 4, no. 11, 2013.

[63] C. Spearman, 'The proof and measurement of association between two things', *Am J Psychol*, vol. 100, no. 3/4, pp. 441–471, 1987.

[64] J. H. Zar, 'Spearman rank correlation', *Encyclopedia of biostatistics*, vol. 7, 2005.

[65] M. G. Kendall, 'Rank correlation methods.' *Griffin*, 1948.

[66] Y. Dodge, *The concise encyclopedia of statistics*. Springer Science & Business Media, 2008.

[67] W. H. Kruskal and W. A. Wallis, 'Use of ranks in one-criterion variance analysis', *J Am Stat Assoc*, vol. 47, no. 260, pp. 583–621, 1952.

[68] P. E. McKight and J. Najab, 'Kruskal-wallis test', *The corsini encyclopedia of psychology*, p. 1, 2010.

[69] A. Dinno, 'Nonparametric pairwise multiple comparisons in independent groups using Dunn's test', *Stata J*, vol. 15, no. 1, pp. 292–300, 2015.

[70] L. Patrício and R. P. Fisk, 'Creating new services', *Serving Customers: Global Services*, 2013.

[71] L. Patrício, R. P. Fisk, J. Falcão e Cunha, and L. Constantine, 'Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting', *J Serv Res*, vol. 14, no. 2, pp. 180–200, Mar. 2011, doi: 10.1177/1094670511401901.

[72] P. C. Verhoef, K. N. Lemon, A. Parasuraman, A. Roggeveen, M. Tsiros, and L. A. Schlesinger, 'Customer experience creation: Determinants, dynamics and management strategies', *Journal of retailing*, vol. 85, no. 1, pp. 31–41, 2009.

[73] L. Becker and E. Jaakkola, 'Customer experience: fundamental premises and implications for research', *J Acad Mark Sci*, vol. 48, pp. 630–648, 2020.

[74] J. Chen, 'The using of mind map in concept design', in *2008 9th International Conference on Computer-Aided Industrial Design and Conceptual Design*, IEEE, 2008, pp. 1034–1037.

[75] C. Eden and F. Ackermann, *Making strategy: The journey of strategic management*. Sage, 1998.

[76] D. Ahsan and S. Pedersen, 'The influence of stakeholder groups in operation and maintenance services of offshore wind farms: Lesson from Denmark', *Renew Energy*, vol. 125, pp. 819–828, 2018, doi: https://doi.org/10.1016/j.renene.2017.12.098.

[77] M. Slabá, 'Stakeholder power-interest matrix and stakeholder-responsibility matrix in corporate social responsibility', *Proceeding of 8th International Days of Statistics and Economics*, pp. 1366–1374, 2014.

[78] S. P. Duarte, J. P. de Sousa, and J. F. de Sousa, 'Rethinking technology-based services to promote citizen participation in urban mobility', *International Journal of Decision Support System Technology (IJDSST)*, vol. 15, no. 2, pp. 1–20, 2022.

[79] E. Chinyio and P. Olomolaiye, *Construction stakeholder management*. John Wiley & Sons, 2009.

[80] ASSURED - UAM, 'Financing and public acceptance (D2.4)', Nov. 30, 2021. https://assured-uam.eu/ASSURED-UAM_Recommendations_portugues.pdf

[81] S. Soares, A. Lobo, S. Ferreira, L. Cunha, and A. Couto, 'Takeover performance evaluation using driving simulation: a systematic review and meta-analysis', *European Transport Research Review*, vol. 13, no. 1, pp. 1–18, Dec. 2021, doi: 10.1186/S12544-021-00505-2/TABLES/6.

[82] W. Yoo, E. Yu, and J. Jung, 'Drone delivery: Factors affecting the public's attitude and intention to adopt', *Telematics and Informatics*, vol. 35, no. 6, pp. 1687–1700, Sep. 2018, doi: 10.1016/J.TELE.2018.04.014.

[83] R. Goyal *et al.*, 'Urban air mobility (UAM) market study', *NASA,* 2018, https://ntrs.nasa.gov/citations/20190001472

[84] F. Frattini, M. Bianchi, A. De Massis, and U. Sikimic, 'The role of early adopters in the diffusion of new products: differences between platform and nonplatform innovations', *Journal of Product Innovation Management*, vol. 31, no. 3, pp. 466–488, 2014.

[85] S. De Silvestri, M. Pagliarani, F. Tomasello, D. Trojaniello, and A. Sanna, 'Design of a Service for Hospital Internal Transport of Urgent Pharmaceuticals via Drones', *Drones*, vol. 6, no. 3, p. 70, Mar. 2022, doi: 10.3390/DRONES6030070/S1.