Social Acceptability of Urban Air Mobility by Aircraft Category and Autonomous Phases

By

PARK, Sun Wook

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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Professor Joo,Yu Min, Supervisor

Professor Cho, Yoon Cheong

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ABSTRACT

Social Acceptability of Urban Air Mobility by Aircraft Category and Autonomous Phases: A Seoul Metropolitan Area Case Study

By

Sunwook Park

Thanks to technology development, air taxis are attracting attention as an opportunity to create a new industry and a solution to traffic congestion in urban areas. Specifically, unmanned, electronic, and autonomous vehicles (AVs) are highlighted as key to modern urban air mobility (UAM). However, some hesitate to use UAM services due to resistance to new technology. Therefore, this study investigated publics' and experts' willingness to use UAM services as divided into four phases: traditional helicopters, electric vertical and take-off landing (eVTOL), remotely piloted aviation systems (RPAS), and a fully autonomous system. Results showed public willingness to use was at average 4.6–4.7 points in phases 1–2 and decreases to 3.7–3.8 points in phases 3–4, when using a seven-point Likert scale. Meanwhile, experts' willingness to use was at average 4.5 points in phase 1, increasing to 5.2–5.7 points in phases 2–4. The differences are statistically significant when using the ANOVA test. Moreover, the independent t-test provided evidence of a gap between experts and the public in willingness to use UAM. Based on the survey, I constructed the regression models based on each phase. Across-phase influential factors were the willingness to pay over 50,000 KRW and the belief that air taxis could be solution to traffic congestion. At phases 1–2, curiosity about the new transportation mode and preference for taking airplane were significant, but they did not affect phases 3–4 due to resistance. The influential factors identified in phases 3–4 were personality as an early adopter and interest in or understanding of the technology. In addition, females were less likely to use UAM due to hesitation to using autonomous system. Based on the analysis results, I interviewed experts in the fields of UAM policy, aviation, and autonomous vehicles. Generally,

experts thought it necessary to offer positive information about UAM, increase opportunities to see/learn about UAM, reduce user costs, demonstrate safety, and so forth.

ACKNOWLEDGEMENTS

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I. INTRODUCTION

1-1. BACKGROUND & RESEARCH PROBLEM

Seeing flying cars in our city skies may no longer be a far-fetched dream. The technology has already been developing, and we are moving into the age of urban air mobility (UAM). UAM refers to an urban transportation system that moves people and cargo by air via on-demand, highly automated vehicles. It includes not only manufacturers but also air traffic systems and operations. UAM promises to offer invaluable transportation services, especially in heavily congested urban areas. Instead of an internal combustion engine, which is prone to noise and environmental pollution, UAM currently employs vertical take-off landing (VTOL), allowing electrification and autonomization. As a result, we are currently one step closer to enabling efficient and environmentally friendly door-to-door air mobility services in our cities.

Uber, for example, is preparing its UAM service—Uber Air. Uber has been a pioneer in mobility as a service (MaaS), which is an integrated transport service system that brings together various transportation modes, ridesharing, and personal mobility via one platform. Uber tries to be an all-around mobility provider by expanding services. For instance, Uber added bike and scooter sharing services to its existing ridesharing service (Laura, 2018), and is currently looking into integrating ground and air travel with its ambitious Uber Air. Uber Air uses electric vertical and take-off landing (eVTOL) with a non-piloted autonomous system. In its preparations to operate Uber Air in the near future, Uber has been engaged in testing and operating a service known as UberCopter, which utilizes helicopters as airport shuttles, on-demand service, and sightseeing service in megacities such as New York, USA and San Paulo, Brazil. However, helicopters have a number of drawbacks including noise and environmental pollution and high fares due to the need to hire pilots. For wide commercialization, UAM

services inevitably need to be autonomous and electrified. Accordingly, Uber is already pursuing future business by signing a memorandum of understanding (MOU) with manufacturing companies, such as Hyundai, to produce eVTOL aircraft. While Hyundai has established itself primarily as an automobile manufacturer, it, along with a number of other companies—with its expertise in producing electric vehicles and autonomous technologies in the automobile industry—is venturing into this new market promising to overcome the limitations of ground urban mobility (Kim, 2020). Unlike the existing aviation market, which is dominated by a couple of giant companies, namely, Boeing and Airbus, the nascent eVTOL market, which requires new technologies, is attracting many start-up companies such as Ehang and Volocopter, as well as new entrants into the aircraft manufacturing industry, e.g., Hyundai.

Private companies such as Uber are not the only ones pursuing UAM. Several political leaders, including governors and mayors of key metropolitan cities, are showing keen interest in UAM services that could not only potentially solve urban congestion problems but also highlight their cities' technological prowess and enable them to achieve new economic competitiveness. For instance, Paris has a plan to operate UAM services during the 2024 summer Olympics, and Coventry, a British city, announced its plan to construct Urban AirPort (Woodyatt, 2019; Coventry City Council, 2021). Other uses that the governments are interested in pursuing with UAM include emergency medical services, intercity passenger services, and others.

Despite manufacturers, potential operators, and governments keen interest in progressing UAM, there needs to be positive public perception and acceptance to succeed in the penetrating the transportation market. Indeed, the National Aeronautics and Space Administration (NASA) selected "community integration" as one of the five key factors for success in introducing this new transportation mode. One of the projects under the community integration category is

public acceptance. (NASA, 2019) Public perception and acceptance will be particularly critical for UAM, which uses autonomous, unmanned, and electric small-scale air vehicles. In fact, in the case of the automobile sector, public perception and acceptability were found to have a significant role in the adoption of autonomous vehicles (AVs) (Penmetsa, Adanu, Aood, Wang, & Jones, 2019). Accordingly, it is necessary to evaluate public perception and acceptability of UAM service for a successful market entrance. However, as UAM is a nascent issue, relatively little research has been published on the issue, with a few exceptions (Edwards & Price, 2020; Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen, 2018; Al Haddad, Chaniotakis, Plötner & Antoniou, 2020; Yedavalli & Mooberry, 2019; Garrow, Mokhtarian, German & Boddupalli, 2020; Binder & Garrow, 2018; Winter, Rice & Lamb, 2020). Public acceptability could also vary by nationality and cultural background, so governments considering introducing novel UAM services should first study their population's perceptions on UAM. In South Korea, the government is considering introducing UAM in the Seoul metropolitan area (SMA) first (MOLIT, 2020). Research is needed to examine how Seoul citizens perceive UAM in SMA; hence, Ministry of Land, Infrastructure and Transport(MOLIT) has been providing funding for and conducting an R&D project for developing an eVTOL and service operation plan, of which this paper is a result.

1-2. RESEARCH PURPOSE & RESEARCH QUESTIONS

This study aims to evaluate how social acceptability of UAM services in SMA varies across different levels of autonomous phases and transportation mode. The public and experts' willingness to use the UAM service are examined according to the four different development phases: traditional helicopters, electric vertical and take-off landing (eVTOL), remotely-piloted aviation systems (RPAS), and a fully autonomous system. UAM is expected to first start entering the market as eVTOL. As aforementioned, eVTOL represents an enormous

technological advancement; it produces less noise and environmental pollution and is also considered to be safer than a traditional helicopter. The next stage is RPAS, which utilizes pilots on the ground who take control during emergencies. This phase could allow passengers to get accustomed to not having a pilot on board. The final goal of UAM is to reach a fully autonomous stage.

Dealing with public perception is critical when introducing such a new transport mode of small-scale autonomous air vehicles. Yet, to know how to address the public perception, there should be an understanding of how the public currently perceives and views the UAM concept first. What factors influence the public's willingness to use UAM service at different phases of development? This thesis uses a stated preference (SP) survey to examine the influential factors and the public's willingness to use UAM as potential users. Furthermore, the gap between experts and the public regarding the acceptability of UAM could potentially lead to ill-conceived policies for UAM. Hence, this thesis also seeks to understand willingness to use UAM between the public and the UAM experts differs. Finally, it explores how acceptability of UAM services can be enhanced, and with what policies. Overall, guided by these research questions, I expect this research to provide useful insights for policymakers and operators of UAM in their preparations to introduce UAM in the market.

1-3. STRUCTURE OF THE THESIS

Section 1 provides the background on UAM and confirms the necessity of researching public acceptability to understand any gap of willingness to use UAM between the public and experts. Hence, the following research questions are defined: 1) What factors influence the general public's willingness to use UAM services? 2) Is there a difference between the willingness to

use UAM services between the public and experts? 3) How can the acceptability of UAM services be enhanced? Section 2 consists of a literature review of why acceptability research is needed and what methods are used in the previous studies. For instance, I searched for what independent and dependent variables were defined as affecting willingness to use UAM services as influential factors and what methods are used for confirming statistically significant differences between two groups. Section 3 establishes hypotheses for finding answers to the research questions. However, according to the research question, how to enhance the acceptability, there is no assumption because the methods should be drawn by interviewing the experts. Therefore, except for this research question, research questions employ quantitative methods. Section 4 explains the quantitative and qualitative methods. First, in the quantitative method section, the SP survey design for obtaining quantitative data is explained, including a description of analysis for variance (ANOVA), independent t-test, and regression analysis for each hypothesis. ANOVA is used to test hypotheses about whether the willingness to use UAM among phases differ between the public and experts as a research question. Independent t-test is for testing hypotheses about whether there is a difference between the willingness to use UAM between the public and experts in each phase as a research question. Regression analysis is for testing the hypothesis about whether influential factors exist on the public's willingness to use UAM. Next, the qualitative method section explains the open questions of the SP survey and in-depth interviews. The reasoning behind method selection is explained, as well as how to define the interviewee target and interview processes. Section 5 describes the data survey result by comparing the public and experts, and shows the result of testing hypotheses, i.e., which hypotheses are accepted or rejected and result of the analysis of open questions and experts' interviews. Section 6 discusses research implications by analyzing the quantitative and qualitative results together, mainly regarding the results and implications of changes of potential users' acceptability with electrification or autonomy, influential factors to willingness

to use, perception gaps between the public and UAM experts, and methods for enhancing the acceptability. Section 7 presents the conclusion of this paper and the need for further research.

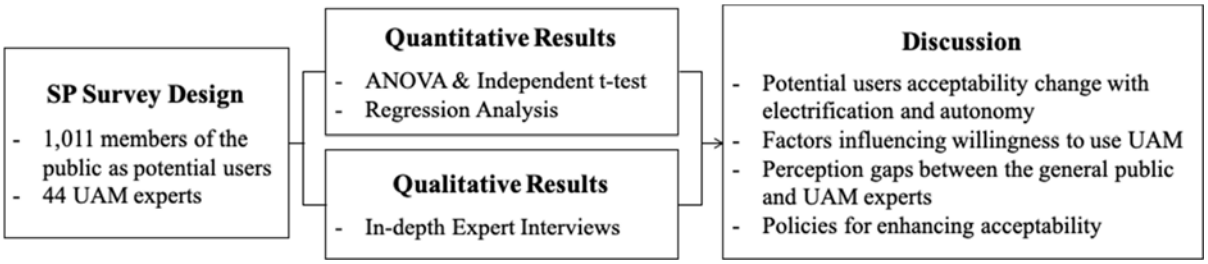

Figure 1. Main structure of the thesis

II. LITERATURE REVIEW

Research on UAM acceptability was initiated from actively discussing acceptability in the field of autonomous vehicles. Acceptability of new technology and innovations has been progressively studied; specifically, in the case of AVs, research has been ongoing, triggered as an extension of what is known as the trolley problem (a situation in which a bystander must choose to passively let five people die or pull a lever and actively kill one person). The trolley problem in the AVs field concerns the morality of the potential users who unlike a manual driver should be pre-selected one outcome using an uncontrolled and active collision avoidance system that potentially kills the one careless pedestrian (Maurer, 2016). Bonefon, Shariff and Rahwan (2016) conducted a survey that asked participants about several trolley problems. They found respondents approve of the AVs saving the pedestrians and sacrificing the driver or passengers, while stating they preferred not to ride in these AVs. Based on this result, they drew the morality conundrums raised from AVs and collected decisions with participants from 233 countries and territories through online quizzes (Maxmen, 2018). These morality problems of AVs attracted the public's attention due to their relationship with the Fourth Industrial Revolution, which has produced advancements such as artificial intelligence (AI), block chains, etc. Finally, the morality acceptance problem extends to whether the public chooses to accept or reject the goods or services, spurring the need for broad public acceptance research. Eventually, public acceptance is necessary to implement the social benefit through AVs (Yuen, Wang, Ma & Li 2020).

As UAM is a relatively new concept, there are only few studies on the public perception of UAM. These studies target the USA, Mexico, New Zealand, and Europe, and no studies focus on the SMA or South Korea. Existing research on public perception or acceptability has

focused on finding the influential factors in adopting UAM services. Demographic characteristics and personality are set as the common influential factors. The demographic characteristics, including gender, age, income, and education levels, significantly differ by target nation or city. Moreover, males feel more comfortable using UAM service than the females (Al Haddad, Chaniotakis, Plötner & Antoniou, 2020; Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen, 2018). However, Fu, Rothfeld and Antoniou (2019) found that gender does not affect the adoption of UAM. Al Haddad, Chaniotakis, Straubinger, Plötner and Antoniou (2020) targeted Europe, Latin America, the US, and the Middle East and discovered that Germans are likely to be less willing to adopt UAM services. These results demonstrate that acceptability and perception differ by nationality or cultural background. Similarly, research by Yedavalli and Moobery (2019), who surveyed Mexico City, New Zealand, Los Angeles, and Switzerland, showed that residents of Mexico City and Los Angeles have a more positive initial reaction and perceived safety to the low-altitude scenario than other areas. The level of concern of Mexico City and Los Angeles is similar to the New Zealand and Switzerland. Results indicated that Mexico City and Los Angeles respondents believe UAM services will be adopted sooner in their city rather than other areas due to the high population density and the volume. Daniel and Axcel (2019) mentioned that culture is a limitation of their research targeting Germans, specifically because acceptance, preference, and willingness to pay vary by country and Germans are known as being conservative in their approach to new technology. Therefore, it is difficult to generalize their research outcome. In addition, acceptability differences among countries or cities can be found from the AVs' morality acceptance problem. According to the Rahwan team, most people have a tendency to save people rather than pets and save the group rather than one person. However, there was variation in decisions according to government power or economic level in each country (Maxmen, 2018). Therefore, the cities

or countries considering the introduction of the UAM should check their populations' specific willingness to use or affinity for UAM.

Apart from the demographic characteristics (e.g., individuals with high-income or high-education are more willing to use UAM services), existing trip characteristics were found to be significant. According to Garrow, Mokhtarian, German and Boddupalli (2020), whether or not drivers experience traffic congestion or not in their commutes and having fewer constraints of travel budgets are influential factors. Hence, this research sets the demographic characteristics of gender, age, and income, and existing trip characteristics (purpose and modes) as variables. The variables also involve the personalities that are usually influential factors in previous research in common. The early adopter and pro-environment personalities are significant to the adoption of not only UAM but also AVs, hybrid cars, and electric cars (Garrow, Mokhtarian, German & Boddupalli, 2020; Ozaki & Sevastyanova, 2011; Schuitema, Anable, Skippon & Kinnear, 2013; Haboucha, Ishaq & Shiftan, 2017). In addition, transportation mode preferences are added due to their high possibility of being influential. Among them, according to research by Garrow, Mokhtarian, German and Boddupalli (2020), who clustered the samples based on enthusiasm and concern for air taxis, the particular preference for utilizing air transport is significantly meaningful to the adoption of UAM. However, this research also used the belief that air taxis could be a solution to traffic congestion as a variable. Most of the previous studies do not have a standard of samples excluding the demographics. Still, Garrow, Mokhtarian, German and Boddupalli (2020) and Binder & Garrow (2018) used the high-income commuters as samples because they think air taxi fare must be expensive. This research does not exclude participants based on income, but rather targets people who have traveled more than one hour within SMA in the one-week period prior to taking the survey, since few people consider air taxi when travelling short distances.

The questions about the adoption of air taxis vary, e.g., which year air taxis will be used after introducing, willingness to use air taxi services when changing the level of autonomy, and whether the presence of a flight attendant would change the decision. In addition, choice of transport mode affects the outcome of the modal split (Fu, Rothfeld & Antoniou, 2019; Binder & Garrow, 2018). This research asked about willingness to use air taxi service benchmarking the automation degree from five scenarios (piloted, remotely piloted with a flight attendant on board, remotely piloted without a flight attendant on board, automated with a flight attendant on board, and automated without a flight attendant on board) proposed by Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen (2018). The five scenarios focused on automation and presence/absence of a flight attendant, but this study adopted an automation degree and ignore the presence/absence of the flight attendant in all scenarios. It seems difficult to hire flight attendants when considering the cost and operation of air taxis and using eVTOL for a maximum of 4–5 people aboard. Moreover, the situation of using a helicopter is unfamiliar because it is not a typical daily commute transportation mode. Hence, this research constructs four phases of UAM service based on aircraft and autonomous changes.

Various methodologies exist for drawing the influential factors to adoption of air taxis. Al Haddad, Chaniotakis, Plötner and Antoniou (2020) asked how many years after introducing the UAM service the participants would use the service. Hence, they draw the influential factors using the multinomial logit and ordered logit models. The multinomial logit model can be used when there are several dependent variables, and the ordered logit model can be used when the dependent variable is an ordinal scale. Further, Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando and Shaheen (2018) used the ordered logit regression to determine influential factors and found that age, gender, and familiarity with the UAM concept are

significant. They set willingness to use UAM as the dependent variable and investigated it using a five-point Likert scale: strongly agree, agree, neutral, disagree, and strongly disagree. However, there is much debate about whether the Likert scale is an ordinal scale or interval scale (Bishop & Herron, 2015, Allen & Seaman, 2007, Mircioiu & Atkinson, 2017). According to the categorization as either an ordinal scale or an interval scale, the analysis method can be fixed. Generally, when the dependent variable is an ordinal scale, nonparametric statistical tests are used. The Mann-Whitney U-test is used to determine a difference between two groups, and the ordered logit model is for identifying influential factors. The Mann-Whitney U-test and ordered logit model are included in nonparametric statistical tests. Given the dependent variable is an interval scale, assumed that the data satisfy a normally distribution condition, ANOVA is used to determine the difference among groups, or the T-test is used to find the difference between two groups. Regression analysis is used for drawing influential factors. According to the number of independent variables, we can use simple regression analysis or multiple regression analysis. Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando, and Shaheen (2018) used the ordered logit model by evaluating the willingness to use UAM service via a five-point Likert scale as an ordinal scale. On the contrary, Winter, Rice and Lamb (2020) construct a linear regression equation by considering the intention to use UAM service with a seven-point Likert scale as an interval scale. However, as UAM adoption research is in the initial stage, finding studies examining the willingness to use gaps among groups is difficult. Hence, when referring to the AV studies, there is research analyzing the general opinion gap using a Likert scale using the Mann-Whitney U-test or Kruskal Wallis H test (Lijiamo, Liimatainen & Pöllänen, 2018). In addition, there is research using ANOVA for analyzing differences among groups. Eventually, researchers differ in how they classify the Likert scale. In this research, willingness to use UAM service is investigated using a seven-point Likert scale and treated as an interval scale because there is a possibility of omitting information when

analyzing by treating the Likert scale as an ordinal scale (Mircioiu & Atkinson, 2017). Besides, as the sample size is more than 30, using parametric statistics is possible. Therefore, regression analysis is used for drawing influential factors, and ANOVA or t-test for determining differences of willingness to use UAM service among groups.

The studies of Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando, and Shaheen (2018) treat certain aspects as important for drawing results of UAM perception apart from setting scenarios and analysis method. To obtain insights into potential social barriers, a focus group interview (FGI) is performed. Particularly, the focus group is divided into users and non-users to determine perceptions about safety, privacy, sharing, etc. Yedavalli and Mooberry (2019) interviewed experts, primarily to identify possible concerns, UAM development strategies, and survey design and development. Similarly, Edwards and Price (2020) interviewed technology experts, people members of helicopter operator websites, and those with operational knowledge to elicit possible concerns. This research surveyed experts in the UAM field and then conducted expert interviews to draw policies for enhancing acceptability, but excluded non-user perceptions because they are not the targets of this research.

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III. HYPOTHESIS DEVELOPMENT

3-1. QUANTITATIVE HYPOTHESIS

Hypotheses are established to find answers to the research questions of this paper. The research questions used for quantitative method are as follows:

- Does the public's willingness to use UAM services change when services change to using electric, autonomous, or unmanned vehicles?
- Do the public and experts differ in their willingness to use UAM services?
- What factors affect the public's willingness to use UAM services?

Before establishing the hypotheses, four phases of UAM service relating to electric, autonomous, and unmanned vehicles are defined: phase 1 is using a traditional helicopter, phase 2 is using an eVTOL, phase 3 is using an RPAS system with eVTOL, and phase 4 is using a fully autonomous system with eVTOL. Particular focus is paid to the changes, electrification change from phase 1 to 2, unmanned vehicle change from phase 2 to 3, and autonomous degree change from phase 3 to 4. Then, I establish the hypotheses a1 and a2 related to a research question, whether the public's willingness to use UAM service changes when services change using electric, autonomous, or unmanned vehicles. Each hypothesis is set to determine statistically significant differences among the four phases of UAM services. The groups are divided into the public and experts; hence, hypotheses are established for each group.

- Ha1: The public's willingness to use UAM services differs by phase.
- Ha2: Experts' willingness to use UAM services differs by phase.

I establish hypotheses b1–b4 to find answers to the research question of whether the public and experts differ in their willingness to use UAM services. Hypotheses are set to determine if such differences exist and if, so, in which phases this occurs.

- Hb1: There is a difference in willingness to use phase 1 of UAM services between the public and experts.
- Hb2: There is a difference in willingness to use phase 2 of UAM services between the public and experts.
- Hb3: There is a difference in willingness to use phase 3 of UAM services between the public and experts.
- Hb4: There is a difference in willingness to use phase 4 of UAM services between the public and experts.

Hypotheses c1–c4 are established to determine factors that influence willingness to use UAM services. Before identifying influential factors, it should be clarified whether such influential factors exist. Therefore, I establish the hypotheses to involve at least one influential factor among several variables. Since UAM service has been broken down into four phases, there are four hypotheses.

- Hc1: There is at least one influential factor to willingness to use phase 1 of UAM service among several independent variables.
- Hc2: There is at least one influential factor to willingness to use phase 2 of UAM service among several independent variables.
- Hc3: There is at least one influential factor to willingness to use phase 3 of UAM service among several independent variables.
- Hc4: There is at least one influential factor to willingness to use phase 4 of UAM service among several independent variables.

3-2. QUALITATIVE HYPOTHESIS

The research question for finding the answer through the qualitative method is what method or policy can enhance acceptability. For this research question, as we have seen in previous

research, it is necessary to derive results by approaching qualitative research rather than quantitative research. Unlike the quantitative method, the qualitative method does not require a hypothesis.

IV. METHODOLOGY

4-1. QUANTITATIVE METHODS

4-1-1. SP SURVEY DESIGN

The Stated Preference (SP) survey was designed to gauge the level of willingness to use UAM services, collect demographic characteristics, existing travel mode, and personalities assumed the introduction of UAM services to test hypotheses a1 to c4. The SP survey designated two groups, the public as potential users and experts, as the survey target to identify any differences in willingness to use UAM services. The general public survey targets people who have traveled more than one hour within SMA in the last week at the time of survey. This condition considers the role of a trunk line in the transportation systems and flight range of eVTOL. The general public survey is composed in two parts. Part 1 includes questions about demographics, existing trip characteristics, personalities, etc. Concerning the demographic characteristics, questions included gender, age, income, and numbers of cars for personal use. In the case of existing transportation mode, participants were asked to identify the transportation mode used for a trip over one hour within SMA as well as the trip purpose. A total of 13 personality variables were selected as significant in common or important based on previous studies about the influential factors to adopt UAM. Specifically, personality questions considering daily life environment, the value for cost, privacy concerns (Al Haddad, Chaniotakis, Straubinger, Plötner & Antoniou, 2020) were included. In addition, preference to use airplane transportation, preference to choose to transfer in the situation of traffic congestion, tendency to use a smartphone, tendency to have characteristics of the early adopter (Garrow, Mokhtarian, German & Boddupalli, 2020) were evaluated. Some questions about respondents' curiosity about the new transportation modes and whether or not respondents enjoy adventures were added. Because the helicopter is not a typical daily commute transportation mode, many people

are unfamiliar with the UAM concept. The familiarity with the concept of UAM (Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen, 2018) changed whether they had heard about UAM. Helicopter experience is also asked. For the personality questions, I used a seven-point Likert scale from 1=*strongly disagree* to 7=*strongly agree*.

Table 1. Example of personality questions in part 1

Personality Questions	Strongly Disagree			Neutral			Strongly Agree
1. Air taxis could be a solution to traffic congestion.	1	2	3	4	5	6	7
2. I prefer faster modes of transport despite the higher cost.	1	2	3	4	5	6	7
3. I prefer riding an airplane.	1	2	3	4	5	6	7
4. I feel nervous taking an airplane.	1	2	3	4	5	6	7
5. I am curious about new modes of transportation.	1	2	3	4	5	6	7
6. I do not use a smart phone for long periods in my daily routine.	1	2	3	4	5	6	7
7. I consider environment pollution in my daily routine.	1	2	3	4	5	6	7
8. I have concerns about privacy problems from technology development.	1	2	3	4	5	6	7
9. I enjoy adventures.	1	2	3	4	5	6	7
10. I prefer buying goods after reading reviews.	1	2	3	4	5	6	7
11. I prefer using only one mode of transport despite the longer travel time.	1	2	3	4	5	6	7
12. I like to introduce new trends or goods to my neighbors.	1	2	3	4	5	6	7
13. I hesitate to use electric cars or scooters.	1	2	3	4	5	6	7

Part 2 asks about the willingness to adopt the UAM service in four phases using a seven-point Likert scale, as shown in Figure 2. To understand the UAM service concept, before starting part 2 of the survey, respondents watched the UAM service video from Uber. The UAM service is divided into four phases corresponding to the changes in aircraft category and autonomous

technology: phase 1 uses a helicopter with a pilot; phase 2 uses eVTOL with a pilot; phase 3 uses an unmanned eVTOL with an RPAS system; and phase 4 uses an unmanned eVTOL with a fully autonomous system.

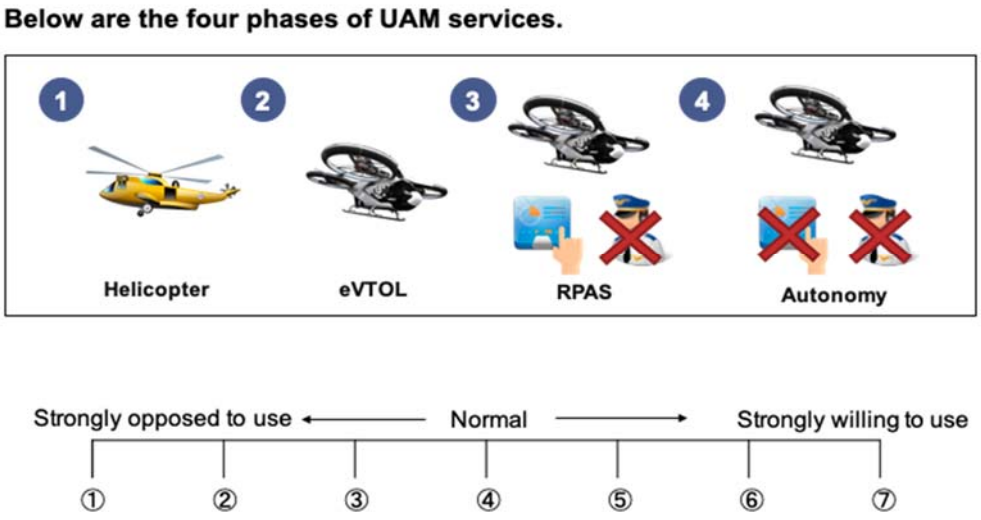


Figure 2. Example of willingness to use UAM service question in part 2

In the case of the expert survey, it was unnecessary to elicit influential factors for willingness to use UAM services. Therefore, it is possible to use only part 2 of the survey to determine differences in willingness in each phase. Hence, part 1 excludes questions about the demographic characteristics and existing transportation mode and only include personality questions. Two personality questions were altered to elicit clear perspectives on new aircraft and simplify questions for the expert: “I hesitate to use electric cars and scooters” was changed to “I think electric aircraft are safe.” Moreover, there is an issue that connecting to the internet using a smartphone is difficult while riding UAM. Hence, to confirm the relationship, I changed “I do not use a cellphone for long periods in my daily routine” to “It is important/inseparable to use a smartphone in my daily routine.”

4-1-2. ANOVA & INDEPENDENT T-TEST

ANOVA is a test for variances that simultaneously compares several means to determine if they came from equal populations. The data used should follow a normal distribution and be an interval scale. (Aaker, Kumar & Day, 2001). As mentioned in a literature review, I analyze the Likert scale data as an interval scale. Therefore, I use the ANOVA test for testing hypotheses a1–a2 and the t-test for testing hypotheses b1–b4.

The willingness to use each phase of UAM service can be expressed as follows:

- μ_1: means willingness to use phase 1 of UAM service.
- μ_2: means willingness to use phase 2 of UAM service.
- μ_3: means willingness to use phase 3 of UAM service.
- μ_4: means willingness to use phase 4 of UAM service.

In other words, Hypothesis b1 can be expressed as that, at least, two means are different among μ_1, μ_2, μ_3, and μ_4, of the public. Additionally, Hypothesis b2 can be expressed as that, at least, two means are different among μ_1, μ_2, μ_3, and μ_4, of experts.

When the research hypothesis is accepted by ANOVA analysis, which means differ can be determined through post hoc. The methods for post hoc analysis are Tukey, Duncan, Scheffe, and Bonferroni, etc. In this paper, the Tukey method is used due to comparing means based on the same sample (McHugh, 2011; Lee & Lee, 2018). Suppose the p-value of post hoc analysis is smaller than 0.05. In that case, the alternative hypothesis, that is, two means are different is accepted. Alternatively, if the p-value is larger than 0.05, the alternative hypothesis is rejected. Hence, it can be seen which groups generate differences among several groups through post hoc t-test analysis.

The independent t-test is used for testing hypotheses b1–b4 to determine whether there is a difference between the willingness to use UAM services of experts and the public. The independent t-test can be used to compare the means of two groups. When the sample size is larger than 30, a t-test can be used. Since, the general public sample consisted of 1,011 individuals, and there were 44 experts; using the t-test was deemed appropriate. The t-test is a method of comparing only two groups, by which it is hoped that the difference generated, and at which phases can be known so that hypotheses are accepted or rejected for each phase. Before conducting the t-test, Levene's test should be conducted to check homogeneity. The null hypothesis is that the variances of the two groups are equal. The independent t-test can be conducted assuming the variances are equal or not. Hence, the independent t-test was analyzed after conducting Levene's test (Lind, Marchal & Wathen, 2018; Albright, Winston & Zappe, 2002). The null hypothesis of the independent t-test is that the means of the two groups are equal. Hence, the p-value is smaller than 0.05; the null hypothesis is rejected, and the research hypotheses (b1–b4) are accepted.

4-1-3. REGRESSION ANALYSIS

Regression analysis was used for testing hypotheses c1–c4. Based on hypothesis c1, the willingness to use phase 1 of UAM service was set as an dependent variable. In addition, demographic characteristics, existing used mode characteristics, and personality characteristics from survey part 1 are set as independent variables. In this case, there are several independent variables, so a multinomial regression equation was constructed. For constructing the model, the nominal scale data was transferred to the dummy variable form with 0 or 1.

- Gender: Male (0), Female (1)
- Income: Under 5 million KRW/month or no regular income (0), above 5 million won/month (1)
- Trip purpose: none-business trips (0), business trip (1)

- Transportation mode: all transportation mode except for public transportation (0), public transportation including subway and bus (1)

The general linear regression equation is defined as:

$$Y = \beta_0 + \beta_1 x \quad (1)$$

In this paper, several independent and dummy variables were used, so use multiple linear regression analysis was set as:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_n x_n + \beta_{n+1} D_1 + \beta_{n+2} D_2 + \cdots \quad (2)$$

where Y means the dependent variable, X means the independent variable, D means the dummy variable, and β means parameter.

Generally, R square and adjusted R square are measures of how well regression lines fit the data. Adjusted R square is an adjusted measure for solving problems when the number of independent variables increases, R square close to 1. When the coefficient's p-value is smaller than 0.05, it can be judged that the independent variable is significant. In addition, if a p-value of the F statistics is lower than 0.05, the null hypothesis, where the null hypothesis is that the whole coefficient is zero, can be rejected. In the case of multiple regression analysis, multicollinearity should be checked to determine whether the independent variables have a strong correlation or not. The multicollinearity has a negative effect on the outcome and reliability of coefficients. By analyzing correlation analysis or variance inflation factor (VIF), multicollinearity can be assessed. Correlation analysis is a method for determining the relationship between two variables, and the value is in a range of -1 to 1. If the value is less than 0, it means a negative relationship, whereas if the value is more than 0, it is a positive relationship. The 0 value means there is no relationship, and if the value is closer to 1 or -1,

there is a strong relationship. The VIF was larger than 10, which means there is multicollinearity (Lind, Marchal & Wathen, 2018).

4-2. QUALITATIVE METHOD

4-2-1. EXPERT SURVEY DESIGN & WORD CLOUD

Open questions related to acceptability were added to the SP survey for experts. The questions are about social barriers or concerns and the public and private sectors' roles. Before discussing enhancing acceptability, it is necessary to ascertain the worries about and social barriers to UAM. For the same reason, Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando and Shaheen (2018) also investigated social barriers. Questions about social barriers were posed twice: from both the view of an expert and a potential user. Specifically, I asked what factors experts believe make commercialization of UAM difficult and what aspects make potential users reluctant to use UAM services. Questions about private and public sector roles were added to determine how many methods for enhancing acceptability should be done and by what sector. Additionally, before interviewing experts, what experts need in each sector was examined. The answers to these questions were analyzed with a focus on which words were mentioned a lot and visualized using word cloud.

4-2-2. IN-DEPTH INTERVIEW

In-depth interviews are a method to understand personal accounts of human experiences and perspectives that would be impossible to obtain via a survey. Survey and analysis can find which factors affect the willingness to use UAM services and gaps in willingness between the public and experts. Still, the analysis results acquired from the quantitative method alone are insufficient to enhance acceptability. Hence, in-depth interviews, one of the qualitative methods, were used to find policy strategies to enhance acceptability based on experts'

experience and insights. The in-depth interview has strengths in that interviewees can express their opinions comfortably and asked additional questions based on their positions.

I conducted interviews with five experts; one UAM policymaker, three aviation experts, and one AVs expert. The UAM policymaker has been listening to various opinions from various stakeholders and experts and trying to laying the groundwork for UAM. For the aviation experts, I selected three individuals from a expert pool. This pool consists of experts from academia and research institutes without directly related to UAM introduction. For instance, someone who develops eVTOL or operates a UAM service in the future may not objectively consider acceptability due to being absorbed with fulfilling his or her goals. In the case of AVs, the unmanned and autonomous issues are similar to UAM. In particular, I expect to benchmark the AVs prepared in advance of UAM cases in many areas, including ethnic guidelines in the legal systems for practical introduction, etc. All five experts were interviewed through online meetings for approximately one hour during the period January 12–15, 2021. They were mainly asked their opinions on the survey and analysis results and how to enhance acceptability. The presented results are gaps in willingness to use UAM services between experts and the public, factors that influence UAM service, and a word cloud analysis, including barriers in the view of experts and users, and role of public and private sectors. Participants were asked what policies are necessary when considering the survey and analysis results and which policies are the most important between enhancing acceptability from the negative perception group and strengthening acceptability from the positive group. In addition, the UAM policymaker was asked to identify any obstacles and which influential factors could be used when making policies. The AVs experts were also similarly queried on issues in AVs and benchmarking the policies.

V. DATA ANALYSIS

5-1. QUANTITATIVE DATA ANALYSIS

5-1-1. SURVEY DATA RESULT

A total of 1,011 general members of the public as potential passengers of UAM and 44 experts were interviewed. The surveys targeting the public were conducted twice, during the periods April 16–20 and April 29–May 7, 2020. Two periods were used to check appropriateness; after the first survey was analyzed, the second survey was performed. The first and second surveys had 219 and 792 responses, respectively. A quota was placed on each age group, similar to the SMA Census. Online panels were used in the case of the public survey, and UAM expert surveys were conducted in an offline meeting on October 28, 2020. Table 2 shows the essential characteristics of the public sample. Most of the respondents are male because males seem to be more interested in new transport modes and technologies. The majority of respondents were in their 30s, followed by 40s and 20s. The most common trip purpose was commute at 46.4%, and the used transportation mode was private car (52.5%) and public transportation (43.6%). The sample proportion is not the same as the SMA Census, but an attempt was made to collect samples similar to the SMA Census to establish representativeness; hence, minimal quota was used. However, it was not possible to obtain responses from teenagers and the proportion of males was higher than that of the proportion of SMA census. Nevertheless, it is hard to treat this sample as not having representativeness, but representativeness could be decrease. Despite the female proportion is smaller than the census, but the sample numbers are adequately large because use quota. Responses from teenagers could not obtained, but they could be non-potential user when considering the high cost.

Table 2. Summary of the public sample's characteristics

		Sample Proportion	SMA Census
Gender	Male	74.0%	49.9 %
	Female	26.0%	50.1 %
Age	20–29	16.1%	14.3 %
	30–39	36.3%	15.3 %
	40–49	22.4%	16.6 %
	50–59	15.9%	16.5 %
	>59	9.3%	21.2 %
Occupation	Professionals	14.2%	13.2 %
	Service Workers	5.7%	5.6 %
	Sales Workers	4.8%	6.4 %
	Managers & Clerks	47.5%	11.4 %
	Skilled Agricultural, Forestry, and Fishery Workers	0.5%	0.8 %
	Equipment, Machine Operating, and Assembly Workers/Elementary Workers	6.5%	15.9 %
	Homemakers	5.7%	-
	Unemployed Individuals & Students	10.6%	31.2 %
	Others (Armed Forces, etc.)	4.4%	-
Trip Purpose	Commute	46.2%	45.8 %
	Business (work)	11.1%	14.3 %
	Exercise/Sightseeing/Leisure	12.7%	20.4 %
	Visiting others	10.3%	-
	Shopping	9.6%	15.1 %
	Other	10.2%	4.3 %
Transport Mode Used	Car (drive myself)	52.5%	24.4 %
	Car-sharing	0.8%	-
	Public Transportation (bus/metro)	43.6%	65.1 %
`	Taxi	2.4%	6.3 %
	Others	0.7%	4.1 %

Note: SMA Census about the trip purpose only includes the Seoul metropolitan area and excludes Gyeong-gi Province and Incheon.

Source: KOSIS (2020A); KOSIS (2020B); Seoul Metropolitan City (2020)

In the expert survey, the condition of having traveled within SMA for more than one hour in the past week and demographic characteristics were not related to the survey. The survey pool was composed of experts in government, public institutions, industry, academy, and research fields. All of the experts belong to a council entitled UAM Team Korea. Thirteen experts were

from public institutes, nine were experts in the industry, eight were experts in research institutes, ten were experts in government, and four were academy experts (See Table 3).

Table 3. Summary of expert sample's characteristics

Category	Organization	No. of Samples	Proportion
Public Institute	Subtotal	12	27.9 %
	Korea Agency for Infrastructure Technology Advancement	1	2.3 %
	Incheon International Airport Corporation	2	4.7 %
	Korea Airport Corporation	3	7.0 %
	Korea Transportation Safety Authority	1	2.3 %
	Korea Land and Geospatial Informatix Corporation	1	2.3 %
	Korea Expressway Corporation	1	2.3 %
	The Korea Development Bank	1	2.3 %
	Korea Institute of Aviation Safety Technology	3	7.0 %
Industry	Subtotal	9	20.9 %
	Korean Airlines	1	2.3 %
	Korea Aerospace Industries	1	2.3 %
	Hanwha Systems	3	7.0 %
	Hyundai Engineering & Construction Company	1	2.3 %
	Hyundai Motor Company	1	2.3 %
	KT	1	2.3 %
	SK Telecom	1	2.3 %
Research Institutes	Subtotal	7	16.3 %
	Korea Aerospace Research Institute	4	9.3 %
	Korea Transport Institute	3	7.0 %
Government	Subtotal	10	23.3 %
Central Department	Ministry of Land, Infrastructure, and Transport	1	2.3 %
	ROK Army headquarters	1	2.3 %
	Korea Aviation Meteorological Agency	1	2.3 %
Local Government	Sejong Metropolitan Autonomous City	1	2.3 %
	Ulsan Metropolitan City	2	4.7 %
	Incheon Metropolitan City	1	2.3 %
	Jeollanam-do Provincial Government	2	4.7 %
	Provincial Office	1	2.3 %
Academy	Subtotal	4	9.3 %
	Konkuk University	1	2.3 %
	Hanseo University	2	4.7 %
	Korea Aerospace University	1	2.3 %
Total		43	100.0 %

Figure 3 shows the result of the personalities of experts. Among them, helicopter experience is a dummy variable, where 0=do not have experience taking a helicopter and 1=have experience taking a helicopter. A total of 28.3% and 38.5% of the public passengers and experts had

experienced taking a helicopter, respectively. Having heard about air taxis is also a dummy variable, where 0=have not been heard about air taxis and 1=have heard about air taxis. Results indicated 48.8% of public passengers have heard about air taxis. As a result, the general personalities about "enjoy adventure," "has concerns about privacy problems from technology development," "prefers buying goods after reading reviews," and "prefers using only one mode of transport despite the longer travel time," are similar between the public and experts. The above personalities had an average score of 4–4.5 points, which means "normal." However, experts have more positive personalities than the public. Experts were more likely to believe air taxis could be a solution to congestion, be curious about new transport modes, prefers taking airplanes, and prefer faster modes of transport despite higher costs than the public. After surveying the public, the expert survey was performed. One question about pattern of smartphone usage was changed because, considering the reason for choosing this personality, it was considered more appropriate to ask how important smartphones are than asking about how long participants do not use their smartphones. Hence, the question about smartphone usage was changed. Experts were likely to agree that they cannot be separated and using a smartphone is important. In contrast, the public responded at average score about 4 points that they do not use a smartphone for long periods in the daily routine. Experts seem more frequently use a smartphone for business in daily life than the public. Moreover, to ascertain experts' direct thought about eVOTL, I changed the question from "hesitates to use electric cars or scooter" to "thinks that eVTOL is safe." Experts tend to believe that eVTOL is safe as the mean score was over 5 points. In the public's case, they tend not to hesitate to use electric cars or scooters, as the mean score was 3.45 points.

Figure 3. Summary of the personalities by experts and the public

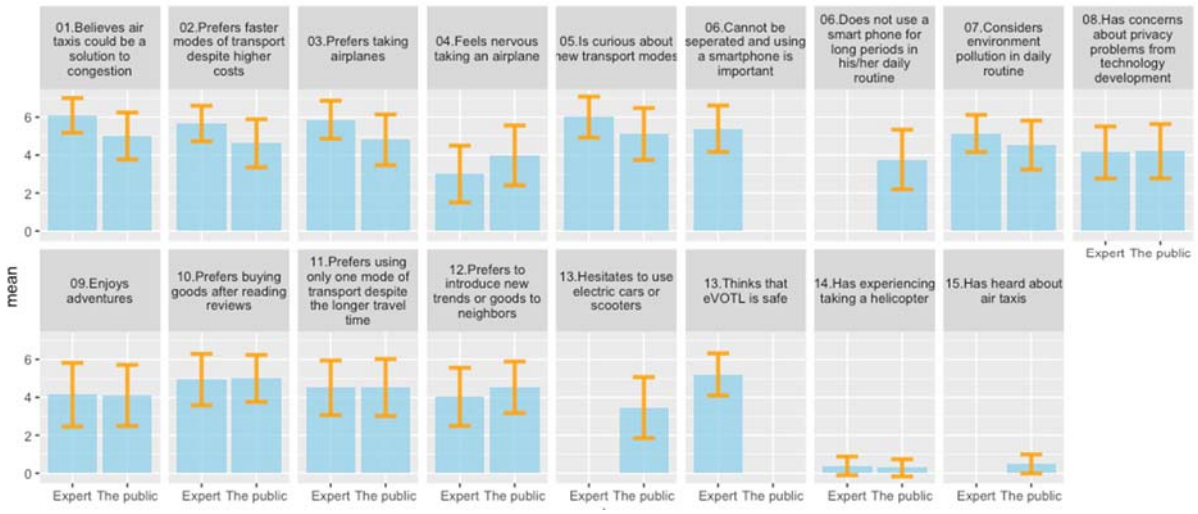
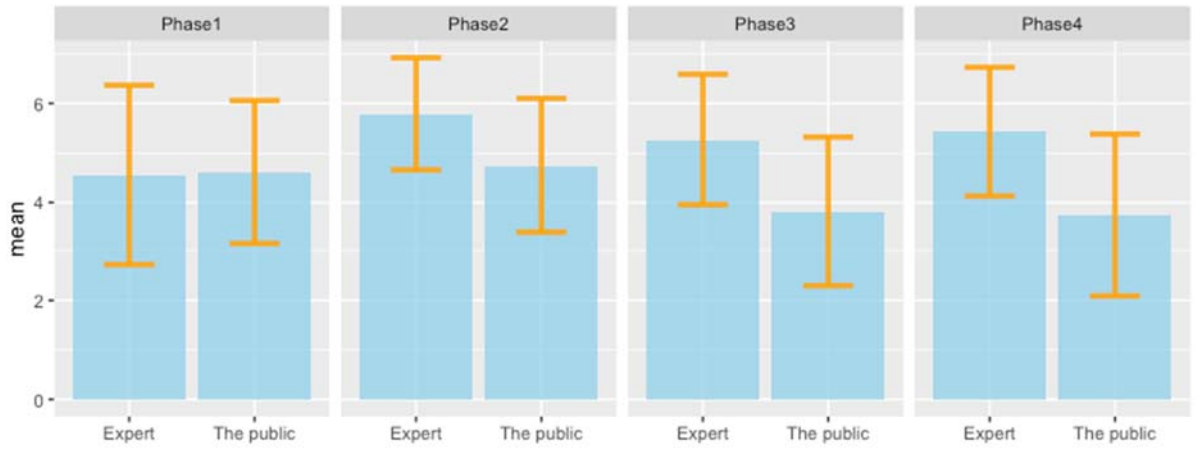


Figure 4 shows the results of willingness to adopt by UAM service phase. In phase 1, the willingness to adopt is similar between experts and the public. However, the standard deviation of experts is higher than the passengers, as experts who know helicopter technology well are aware of the dangers of taking a helicopter. When examining the willingness to use UAM service by phase from phases 2–4, experts were found to be more favorable towards UAM services than the passengers were. In addition, in the case experts, willingness to use in phases 2–4 is higher than in phase 1, while willingness to use in phases 3–4 is lower than in the initial phases (1–2) in the case of public, suggesting that experts are more prepared to use UAM services. In the public's case, the standard deviation increases as the phases increase. In contrast, the standard deviation of willingness to adopt in phase 1 is more considerable in the expert group and the standard deviation in phases 2–4 is smaller than in phase 1. It is possible the large standard deviation stems from some experts increased awareness of helicopters' dangers than ordinary people.

Figure 4. Experts and the publics' willingness to use in four phases of UAM service



5-1-2. ANOVA & INDEPENDENT T-TEST RESULTS

To test Hypothesis a1, ANOVA analysis was conducted. Table 4 shows descriptive data, Table 5 shows ANOVA results, and Table 6 indicates the post hoc analysis result. The p-value of ANOVA is smaller than 0.05; therefore, research hypothesis a1 that the public's willingness to use UAM service differs by phase is accepted. As a result of the post hoc test, the p-value of phases 1–2 and phases 3–4 are larger than 0.05. Therefore, there is a difference between the two groups and the alternative hypothesis is rejected. That means the willingness to use UAM service is the same in both phases 1 and 2. In addition, phases 3 and 4 show no difference. However, the p-value of phases 2–3 is smaller than 0.05, which means there is a difference in willingness to use UAM service. Therefore, hypothesis a1 is accepted due to the difference between phases 2 and 3.

Table 4. Hypothesis a1 - Descriptive data

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
1	1,011	4.60	1.454	.046	4.51	4.69	1	7
2	1,011	4.74	1.362	.043	4.65	4.82	1	7

3	1,011	3.81	1.516	.048	3.72	3.91	1	7
4	1,011	3.74	1.651	.052	3.64	3.84	1	7
Total	4,044	4.22	1.565	.025	4.17	4.27	1	7

Table 5. Hypothesis a1 – ANOVA result

	Df	**Sum of Squares**	**Mean of Squares**	**F value**	**p-value**
Adoption	3	824	274.66	122.2	<0.001
Residuals	4,040	9083	2.25	-	-

Table 6. Hypothesis a1 – Post Hoc Pairwise t-test result (Tukey method)

	Phase 1	**Phase 2**	**Phase 3**
Phase 2	0.176	-	-
Phase 3	<0.001	<0.001	-
Phase 4	<0.001	<0.001	0.682

Because of ANOVA analysis for testing hypothesis a2, the p-value was smaller than 0.05; hence hypothesis a2 is accepted and experts' willingness to use UAM service differs by phase. As seen in Table 9, the p-value of the t-test between phases 1 and 2 is smaller than 0.05; there is a difference between willingness to use phases 1 and 2. The p-value is larger than 0.05 in phases 2–3 and phases 3–4; therefore, the alternative hypotheses are rejected and H2 is accepted due to the difference in willingness to use between phases 1 and 2 (See Tables 7, 8 and 9).

Table 7. Hypothesis a2 - Descriptive data

	N	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Min**	**Max**
					Lower Bound	**Upper Bound**		
1	44	4.55	1.823	.275	3.99	5.10	1	7
2	44	5.80	1.133	.171	5.45	6.14	2	7
3	44	5.27	1.318	.199	4.87	5.67	1	7
4	44	5.43	1.301	.196	5.04	5.83	2	7
Total	176	5.26	1.477	.111	5.04	5.48	1	7

Table 8. Hypothesis a2 – ANOVA result

	Df	Sum of Squares	Mean of Squares	F value	p-value
Adoption	3	36.4	12.129	6.036	<0.001
Residuals	172	345.6	2.009	-	-

Table 9. Hypothesis a2 – Post Hoc Pairwise t-test result (Tukey method)

	Phase 1	Phase 2	Phase 3
Phase 2	<0.001	-	-
Phase 3	0.0798	0.3115	-
Phase 4	0.0197	0.6256	0.9526

The result of the independent t-test for testing hypothesis b1 is shown in Table 11. Table 10 shows Levene's test result that the p-value is 0.005, so the two groups have no equal variance, and an alternative hypothesis is accepted. Hence, the independent t-test was conducted assuming the two groups' variance is not equal. The p-value is 0.836; thus, the research hypothesis b1 is rejected and there is no difference in willingness to use UAM services in phase 1 between the public and experts.

Table 10. Hypothesis b1 – Levene's Test result

	Df	F value	p-value
Group	1	7.742	0.005
	1053	-	-

Table 11. Hypothesis b1 – Independent t-test result

t	Df	p-value	95% Confidence Interval		Sample Estimates	
			Lower	Upper	The public	Experts
0.20785	45.413	0.836	-0.503	0.619	4.603	4.545

To test hypothesis b2, the p-value of Levene's test is 0.102 (See table 12). Hence, the two group's variances are equal. Therefore, the independent t-test was performed assuming the two groups' variances are equal. The p-value in Table 13 is lower than 0.001; hence, the research hypothesis b2 is accepted and there is a difference in willingness to use UAM services in phase 2 between the public and experts.

Table 12. Hypothesis b2 – Levene's Test result

	Df	**F value**	**p-value**
Group	1	2.685	0.102
	1053	-	-

Table 13. Hypothesis b2 – Independent t-test result

t	**Df**	**p-value**	**95% Confidence Interval**		**Sample Estimates**	
			Lower	**Upper**	**The public**	**Experts**
-5.070	1053	<0.001	-1.466	-0.648	4.739	5.795

To test hypothesis b3, Levene's test was conducted. The p-value in table 14 is 0.333; the variances of the two groups are equal. The result of the independent t-test assuming that the variances are equal is shown in Table 15. The p-value is smaller than 0.001, so hypothesis b3 is accepted and there is a difference in willingness to use UAM services in phase 3 between the public and experts.

Table 14. Hypothesis b3 – Levene's Test result

	Df	**F value**	**p-value**
Group	1	0.938	0.333
	1053	-	-

Table 15. Hypothesis b3 – Independent t-test result

t	Df	p-value	95% Confidence Interval		Sample Estimates	
			Lower	Upper	The public	Expert
-6.2864	1053	<0.001	-1.917	-1.005	3.812	5.273

Levene's test and the independent t-test were conducted to test hypothesis b4. Because of Levene's test, the p-value was 0.064; hence, the two groups' variances are equal. As the result of the independent t-test supposing that the two groups' variances are equal, the p-value is lower than 0.001, and the research hypothesis b4 is accepted. To test hypothesis b4, Levene's test was conducted. The p-value in Table 16 is 0.064; the variances of the two groups are not equal. The result of the independent t-test assuming that the variances are equal is shown in Table 17. The p-value is smaller than 0.001, so hypothesis b4 is accepted and there is a difference in willingness to use UAM services in phase 4 between the public and experts.

Table 16. Hypothesis b4 – Levene's Test result

	Df	F value	p-value
Group	1	3.450	0.064
	1053	-	-

Table 17. Hypothesis b4 – Independent t-test

t	Df	p-value	95% Confidence Interval		Sample Estimates	
			Lower	Upper	The public	Experts
-6.7163	1053	<0.001	-2.189	-1.199	3.738	5.432

The only rejected hypothesis is Hb1 among Ha1–Hb4. The others are accepted. Results indicated the public's willingness to use UAM services changes when switching phases (Ha1); specifically, when changing from phase 2 to 3, where there is no longer a pilot in the vehicle, willingness to use decreases. In the case of experts, willingness to use UAM services changed

among the phases (Ha2); there is a difference when phase 1 changes to phase 2 using eVTOL as new aircraft. Public and expert willingness to use UAM services are equal in phase 1, but differ in phases 2–4. People can use the UAM service using a helicopter (phase 1) in other countries or for other purposes, and helicopters exist now; hence willingness to use of the public and experts are equal (Hb1 is rejected). However, when eVTOL and unmanned systems are implemented, there are differences in willingness, with experts being more likely to use.

5-1-3. REGRESSION ANALYSIS RESULT

Before constructing multiple regression models for Hc1–Hc4, correlation analysis was conducted. Figure 5 shows the correlation among personality variables. The whole values range from -0.5 to 0.5. This means there are weak relationships among the variables, and excluding some variables is not necessary.

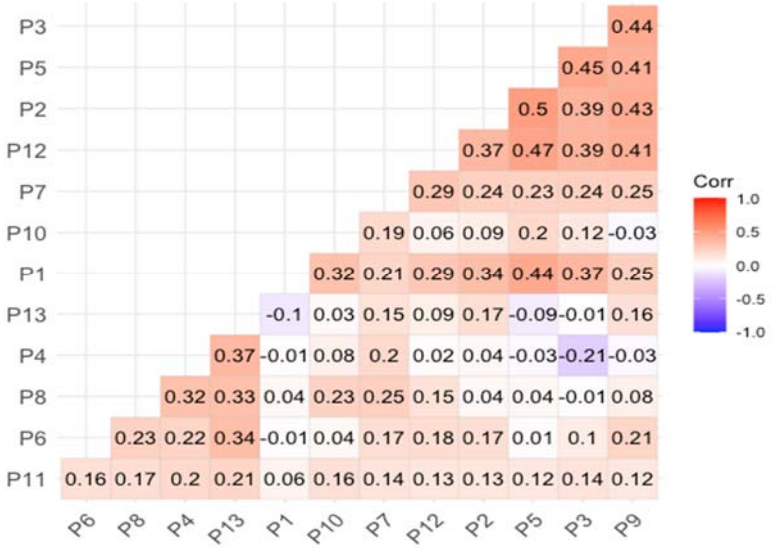


Figure 5. Correlation among personality variables

Multiple regression analysis was conducted using backward elimination. The result of regression analysis is shown in Tables 18 and 19 for testing Hc1. The significant independent variables are willing to pay over 50,000 KRW(WTP), belief that air taxis solve the traffic congestion in the city (p1), preference for fast mode even though expensive (p2), preference

for taking an airplane (p3), and having curiosity about new transport mode (p5). The whole coefficients have positive values, thus the effect is positive in willingness to use UAM services in phase 1. VIF is checked, and the total values are under 10; hence, there is no multicollinearity. The R-square is 0.225, and the adjusted R square is 0.220, so the explanation of this model is not high, but no issue was found in drawing the influential factors. F statistics is F(6, 1004) = 48.57, and the p-value is smaller than 0.05. Therefore, this regression equation is significant statistically and research hypothesis c1 is accepted.

Table 18. Hypothesis c1 – Coefficients

Variables	B	Std. Error	t value	Pr(>|t|)	VIF
Constant	1.422	0.217	6.553	<0.001	-
Transport Mode	0.246	0.084	2.930	0.003	1.067
WTP	0.721	0.129	5.597	<0.001	1.101
P1	0.117	0.037	3.128	0.002	1.318
P2	0.109	0.038	2.838	0.005	1.457
P3	0.217	0.035	6.151	<0.001	1.367
P5	0.166	0.037	4.457	<0.001	1.597

Table 19. Hypothesis c1 – Summary of the regression analysis

R-squared	Adjusted R-squared	Df	F-statistic	p-value
0.225	0.220	6,1004	48.57	<0.001

The result of testing Hc2 is shown in Tables 20 and 21. Willingness to pay over 50,000 KRW(WTP), belief that air taxis can solve the traffic congestion problem in the city (p1), preference for taking an airplane (p3), curiosity about new transportation modes (p5), concerns about privacy due to technology development (p8), enjoying adventure (p9), tendency to introduce new trends and goods to neighbors (p12), and hesitating to use an electric car or scooter (p13) are significant influential factors to willingness to use UAM service in phase 2.

Hesitating to use an electric car or scooter (p13) and having concerns about privacy due to technology development (p8) have a negative coefficient, so a person who has these personality aspects is less likely to use UAM services. The other influential factors' coefficients are positive, and they are significant as the p-value is lower than 0.05, so they positively affect willingness to use. The whole VIF is lower than 10; hence, there is no multicollinearity. The R-square of the regression model is 0.2834, and the adjusted R-square is 0.277. The explanation and forecasting are poor, but there is no problem drawing out the influential factors. F statistics is F(8, 1002) = 34.23, and the p-value is smaller than 0.05; Hence, this regression equation is statistically significant and Hc2 is accepted.

Table 20. Hypothesis c2 – Coefficients

Variables	B	Std. Error	t value	Pr(>|t|)	VIF
Constant	1.880	0.219	8.582	<0.001	-
WTP	0.495	0.113	4.370	<0.001	1.048
P1	0.211	0.034	6.248	<0.001	1.321
P3	0.140	0.033	4.207	<0.001	1.492
P5	0.153	0.034	4.462	<0.001	1.655
P8	-0.063	0.027	-2.298	0.022	1.154
P9	0.077	0.027	2.821	0.005	1.461
P12	0.098	0.033	3.024	0.003	1.468
P13	-0.060	0.025	-2.423	0.016	1.200

Table 21. Hypothesis c2- Summary of the regression analysis

R-squared	Adjusted R-squared	Df	F-statistic	p-value
0.2834	0.277	8,1002	49.54	<0.001

The result of Hc3 is shown in Tables 22 and 23. Like Hc1 and Hc2, willingness to pay over 50,000 KRW(WTP) and belief that air taxis can solve the traffic congestion in the city(p1) are

influential factors of willingness to use UAM services in phase 3. Preference for fast mode even though it is expensive (p2), not using a smartphone for a long period daily (p6), enjoying adventure (p9), and preference for buying goods or services after reading reviews (p10) are significant. Preference for buying goods or services after finding reviews (p10) have a negative coefficient, that means a person who prefer for buying goods or services at first without waiting and finding reviews is more likely to use UAM services. In addition to personality aspects, gender was found to be significant; females are less likely to use phase 3 of UAM services. VIFs of all independent variables are under 10; there is no multicollinearity. R-square is 0.193, and adjusted R-square is 0.187. F statistics is F(7,1003) =34.23, and the p-value is smaller than 0.05; hence this regression model is statistically significant and Hc3 is accepted.

Table 22. Hypothesis c3 – Coefficients

Variables	B	Std. Error	t value	Pr(>|t|)	VIF
Constant	2.142	0.263	8.144	<0.001	-
Gender	-0.272	0.099	-2.740	0.006	1.019
WTP	0.498	0.135	3.704	<0.001	1.059
P1	0.151	0.040	3.818	<0.001	1.306
P2	0.194	0.040	4.899	<0.001	1.363
P6	0.071	0.028	2.507	0.012	1.072
P9	0.174	0.031	5.680	<0.001	1.315
P10	-0.192	0.037	-5.143	<0.001	1.142

Table 23. Hypothesis c3 - Summary of the regression analysis

R-squared	Adjusted R-squared	Df	F-statistic	p-value
0.193	0.187	7, 1003	34.23	<0.001

Tables 24 and 25 show the result of Hc4. Willingness to pay (WTP) and belief that air taxis can solve traffic congestion in the city (p1) are significant, as seen in phases 1–3. Preference for fast mode even though expensive (p2), enjoying adventure (p9), and preference for buying

goods or services after finding reviews (p10) are significant. Preference for buying goods or services after finding reviews (p10) have a negative coefficient, so a person who has these personality aspects is less likely to use UAM services. Like phase 3, females are less likely to use UAM services. The total VIFs are under 10; there is no multicollinearity. R-square is 0.195, and adjusted R-square is 0.190. F statistics is F(7, 1003) = 34.79, and the p-value is smaller than 0.05; therefore, this regression equation is statistically significant and Hc4 is accepted.

Table 24. Hypothesis c4 – Coefficients

Variables	B	Std. Error	t value	Pr(>|t|)	VIF
Constant	2.340	0.275	8.519	<0.001	-
Gender	-0.395	0.108	-3.643	<0.001	1.035
Heard	0.302	0.097	3.096	0.002	1.086
WTP	0.376	0.157	2.573	0.010	1.061
P1	0.091	0.043	2.122	0.034	1.291
P2	0.205	0.043	4.781	<0.001	1.354
P9	0.216	0.033	6.512	<0.001	1.306
P10	-0.196	0.040	-4.860	<0.001	1.138

Table 25. Hypothesis c4 – Summary of the regression analysis

R-squared	Adjusted R-squared	Df	F-statistic	p-value
0.195	0.190	7,1003	34.79	<0.001

When considering that the public's willingness to use UAM services is same in phases 1–2 and phase 3–4, the influential factors can be categorized into reduplicated factors at phases 1–2, reduplicated factors at phases 3–4, and reduplicated factors for all phases. Despite gaps between willingness to use in phases 1–2 and 3–4, the influential factors for all phases are willingness to pay over 50,000 KRW and the belief that air taxis solve the traffic congestion in the city. When considering the characteristics of UAM except for electric, autonomous, and unmanned systems, those factors are significant due to the perception that UAM is an expensive

mode and possible to not move on the ground. The common factors of phases 1–2 are curiosity about the new transportation mode and preference for taking an airplane; those factors are significant because flying in the sky is similar to existing airplanes, and UAM is a new transport mode that has not been introduced before in the SMA. The common factors of phases 3–4 are enjoying adventure, preference for fast mode even though expensive, and preference for buying goods or service at first without waiting and finding reviews. In addition, men are more likely to use UAM services than women are. A pilot is not aboard an aircraft in phases 3–4; hence, enjoying adventure affects willingness to use. Moreover, the preference for buying goods or services without checking reviews reflects the personality of the early adopter, who is more open to innovative goods or technology; hence, this personality aspect affects use in phases 3–4. Gender does not affect willingness to use in phases 1–2. However, after changing to phases 3–4, females are less likely to use UAM because interest in technology is low and safety-oriented personalities are common, in general. In addition, some variables are not reduplicated in phases 1–2 or phases 3–4. However, these factors are not important but rather common factors.

5-2. QUALITATIVE DATA ANALYSIS

5-2-1. SURVEY DATA RESULT

I used open questions to elicit factors experts consider when making policies to enhance acceptability: the barrier to commercializing UAM service as an expert view, the barrier to using air taxi services as a potential user view, and the roles of private and public sectors for UAM. The barriers can differ depending on the expert or potential user aspects, the roles were divided. Due to the nature of open questions, some words mentioned are duplicated.

Specifically, in the view of a user, experts were more likely to mention safety. Specifically, experts mentioned safety (23 times), cost (12 times), air space (10 times), acceptability (8 times), legal/regulation (8 times), and infrastructure (7 times) as barriers for commercializing UAM. In the view of users, the highest mentioned word was also safety (34 times), followed by cost (14 times), and infrastructure (9 times). (These response numbers include duplicates.) When they are users, they primarily mentioned safety, cost, and infrastructure, but several factors should be solved for commercializing UAM in the view of experts (See figure 6).

Figure 6. Barriers mentioned by the view of experts and users (R: experts, L: users)

Figure 7 shows the frequency of word mentioned concerning the role of public and private sectors. Safety and infrastructure were selected as the most significant roles for the public sector. It is also necessary to provide subsidies, win-win cooperation with the private sector, secure acceptance, and advertise about the UAM to the public. The private sector mostly focused on aircraft and technology development. In addition, the platform's operation, safety guarantee, securing acceptance, and guarantee of business possibilities were mentioned as prerequisites for a profitable market.

Figure 7. Role of the public and private sector (R: public, L: private)

The barriers among potential users are mainly safety, costs, and infrastructure, while the barriers among experts vary. Air space, which the public does not know well and that experts think should be solved for progress in UAM services is mentioned. For instance, flying following along the Han River corridor is possible, but other areas are not permitted in SMA. Therefore, before constructing UAM infrastructure, the air space issue should be solved. As for the public and private sector roles, experts expect roles to be more public rather than private. Experts expect aircraft or technology development and operating service mainly in the private sector, while they mentioned many roles in the public sector such as securing safety, constructing infrastructure, securing acceptability, advertising, etc. Because the UAM is a new industry, it requires much support from the government to enter the transportation market successfully. Preparation policies are necessary to consider these kinds of expectations and barriers.

5-2-2. EXPERT INTERVIEW RESULT

Through expert interviews, willingness to use UAM services and influential factors and policies to enhance acceptability were examined. Concerning the survey and analysis results,

experts evaluated those as reasonable. However, opinions differed regarding gaps of willingness to use UAM services between experts and the public. Three interviewees said that a more positive willingness to use from experts is reflected in goal orientation, while other interviewees stated that it reflected a strong understanding of technology. Duplicated mentions about policies to enhance acceptability and essential parts related to the public sector's roles from the survey were selected for analysis.

1) To offer information about UAM. (UAM expert, Aviation expert 1, AVs expert)

   Due to it being a new concept, people could not understand the gaps in aircraft and autonomous systems changes. In other words, when the aircraft type is changed, users lacked knowledge on the different parts of UAM services. Therefore, it is necessary to provide information on these changes and to inform people about the benefits of using UAM services. For instance, benefits such as reduced the trip time or the fact that costs can be reduced in the future after commercializing such services although it is expensive right now could encourage users to be comfortable using UAM. In addition, it was suggested that if a series of trip chain scenarios were created and presented, the public's general understanding of services and potential benefits could be improved.

2) Exposure through UAM experience (UAM expert, Aviation expert 1, AVs expert)

   Experience is strongly linked to willingness to use new technology. As one expert mentioned, "I had no idea before using the self-driving cruise mode, but after using it, I thought it was convenient." Therefore, it is essential to increase exposure opportunities for technology through pilot operation or simulator experience. It is also necessary to be able to encounter it frequently in daily life; for example, license plates used for electric vehicles could be adjusted so that they turn blue, enabling observers recognize that a particular car is an electric vehicle.

3) Cost reduction (UAM expert, Aviation experts 1, 2 & 3, AVs expert)

Since, apart from safety, cost is the most important factor from a user's point of view, a policy that reduces usage fees can be useful. In that respect, subsidy payment policies can also be an option. In the future, if acceptance is secured and the number of people using UAM services increases, resulting in economies of scale and increasing the size of the market itself, rates can be lowered.

4) Secure safety (UAM expert, Aviation experts 1, 2 & 3, AVs expert)

Experts all agreed that safety is the most important aspect because it is directly related to preserving life. Therefore, it is necessary to construct aircraft that meet industry safety standards, and the aviation authorities must create a standard that can be commercialized while ensuring technical safety. In addition, even after introducing the service, safety management should be thoroughly executed, and authorities should regularly check how well the operator performs safety management even after airworthiness certification. Further, it is necessary to hold a safety demonstration event so that users can recognize that such vehicles are indeed safe.

5) Policy support for initial market formation (UAM expert, AVs expert)

From the existing UAM Uber promotional video, it seems that it is available to everyone, but there is a concern that if the user fee is too high only a specific economic class will be able to afford it. While admittedly, it may be expensive initially, opening the initial market is very important. How UAM is presented to the market can determine whether economy of scale can be accomplished in the future. Therefore, market opening strategies, such as focusing on “business trips” in the early stage, or using it for cargo service, public service obligation (PSO), and emergency medical use are needed. As costs are linked to demand, and demand is linked to supply, subsidies or incentives may be required to engage private businesses in the market

in the early stages. For example, the concept of an “air ambulance” could induce private companies to participate by giving a monetary advantage from the government.

6) Preparation of solutions to conflict-causing elements (Aviation expert 2)

Unlike the U.S., in South Korea, there are few charters or helicopters, so users may be unaware of the situation in which noise or privacy problems occur when an actual air taxi is introduced and frequently flies around their house or above roads. However, these kinds of noise and privacy problems are factors that can cause significant conflict. For instance, complaints occur due to the air ambulance's noise even though it is for the public interest. Therefore, it is necessary to design equipment that can solve conflict-causing elements and think in advance about how to prevent or ameliorate such conflicts.

7) Perform acceptability study continuously (Aviation expert 1, AVs expert)

While the UAM researches about acceptability is like an early stage of AVs acceptance studies, and it is thought that the acceptability and service phases will be more concrete in the future. It began with ethical acceptance in the early days of the AVs market and then materialized into technical and social acceptance. Moreover, the service phases were subdivided into level 0, levels 1–2, levels 3–4, and level 5, which users can feel the differences between each level. In the process of market formation, as technology advances and systems are prepared, players' perceptions change, it is necessary to track acceptability. In addition, as experts are more willing to use UAM services than the public, there is a possibility that experts have high willingness to adopt due to high motivation for introducing services successfully. Therefore, it is necessary to prepare the policies and services that take into account the acceptability of the public through continuous acceptability surveys.

VI. DISCUSSION

Overall, experts are more positive and willing to use UAM services compared to the public. This result reflects the experts' characteristics such as a better understanding of autonomous and electric technology and expectation to achieve related goals. The point of the result is acknowledging the possibility that the public cannot accept UAM services or policies due to the gap between experts and the average person. Thus, regular studies about acceptability that are mentioned by experts as one of the methods to enhance acceptability are needed to narrow the gap. In addition, it was found that experts' willingness to use UAM increases when changing aircraft from helicopter to eVTOL, while the public's willingness remains the same because it lacks information regarding aircraft differences. Experts know that the eVTOL is safer than a helicopter and more comfortable because it generates less noise. However, there is no general public resistance because people have already seen and heard about electrification after the introduction of electric cars. On the other hand, while experts' willingness to use does not fall when changing to unmanned vehicles, the public's willingness decreases. The public hesitates to use services without a pilot because of safety perceptions and a lack of understanding regarding the technology. After using eVTOL without a pilot, changing from RPAS to a fully autonomous system is no different in terms of willingness of experts and the general public because there is no perception about autonomy. The AVs expert said the autonomous systems were not sufficiently classified to recognize the difference in levels. In the case of AVs, the willingness to use increases when using fully autonomous systems because people more likely to hesitate to use imperfect technology. Still, the autonomous systems of UAM have been developing, so the willingness to use RPAS to fully autonomous systems remain unchanged due to abstract concepts. Therefore, regular studies about perception and acceptability are necessary while preparing UAM services and developing related technologies.

For potential users, safety, cost, and infrastructure are the main barriers. Most of all, enhancing acceptability about safety is essential. A process that ensures safety is necessary, as experts mentioned, for creating a positive perception of UAM and convincing the public. Through a pilot test; for example, the safety of UAM should be revealed directly. Likewise, establishing government systems that manage UAM safety and defining standards are critical. Regarding cost, willingness to pay over 50,000 KRW affects willingness of us for all phases (1–4) of UAM services, as does the preference for a fast, although expensive mode, except for phase 2. Eventually, given safety concerns are addressed, potential users would mainly consider the cost. Cost is related to not only users' acceptability but also directly connected to demand, which in turn affects supply. Hence, experts pointed out that offering a subsidy is needed to reduce the fare. This supporting method is also mentioned in terms of AVs (Ozaki & Sevastyanova, 2011). When considering using high technology for systems and the eVTOL, this supporting method should be discuss at greater length the amount of subsidy, beneficiaries, and adequacy. When considering that phase 2 of UAM services will be introduced in the SMA initially, the influential factors of phase 2 can be considered to create appropriate policies for initial market activation. As already mentioned, willingness to pay is important; hence, designing service models like subscriptions for groups with high willingness to pay, such as entrepreneurs or celebrities, would be beneficial. In addition, preference for taking airplanes has a positive effect; hence, a service model linked to international flights could be considered. One of the UAM roles mentioned is the airport shuttle, and peer-to-peer (P2P) operation has the possibility to offer additional supply for growing market scale (Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen, 2018). Finally, after phase 2, for operating UAM service phases 3–4 using eVTOL with a fully autonomous system, influential factors such as early adopter personalities should be considered. Preference for being the first to buy goods or services and

enjoying adventure can be classified as aspects of an early adopter personality. This personality is also significant in new transportation modes using new technology such as AVs or electric cars (Berliner, Hardman & Tal, 2019; Liljamo, Liimatainen & Pöllänen, 2018). Hence, Berliner, Hardman, and Tal (2019) researched the willingness to buy the AVs targeting individuals who bought electric cars in the early days when they first became available on the market. Because the buyers have early-adopter personalities, some believe they will also be willing to purchase AVs. Positive perception of UAM as influential factors of all phases and having heard about air taxis, as the influential factor of phase 4, are eventually related to the importance of informing and exposure to UAM, as mentioned by the experts. This result is similar to Winter, Rice and Lamb (2020), who found familiarity and wariness of new technology affect autonomous air taxis. Chen (2019) also discovered that perceived usefulness affects attitude, and attitude affects intention to use in AVs having similar issues with UAM. Finally, policymakers should inform the public on UAM, what technologies are used, and what social benefits may be derived from using UAM service through school education, advertisements, and trial service offers to accustom users to the experience. Most of all, citizens should be exposed regularly to UAM to perceive its existence.

UAM is still in the initial stage of preparing for its introduction to the market. Hence, several aspects should be discussed. For instance, experts said that the government should proactively prepare solutions to potential conflict-causing elements, but specific cases have not yet been discussed. Therefore, it is necessary to derive situations in which conflict may occur in the future and study people's acceptability of such situations. This research divides UAM services into four phases; however, it is not a general agreement on phase division within the UAM field. There is no yet a general agreement. Therefore, other service phases could be embodied

in the future, after which definitions of the exact concept for each phase would be produced, and acceptability should be further studied.

VII. CONCLUSION

This research explored the public and experts' willingness to use UAM service by phase that reflect electric, unmanned, and autonomous changes in aircrafts. The influential factors of the public's willingness to use UAM services and methods for enhancing acceptability are elicited by interviewing a number of experts.

The SP survey results indicate influential factors and willingness to use UAM services in each of four phases (phase 1 is using a traditional helicopter, phase 2 is using an eVTOL, phase 3 is using an RPAS system with eVTOL, and phase 4 is using a fully autonomous system with eVTOL) for members of the public who had traveled over one hour in SMA in the previous week. The willingness to use UAM services is the same in phases 1–2 and phases 3–4, but decreases when shifting from phase 2 to 3, indicating that willingness drops when using an unmanned vehicle due to safety concerns, and that the general public tends not to feel the gaps at other phase changes. The influential factors of all phases are affinity for UAM and willingness to pay. Cost eventually becomes the second important factor after the safety, and people who think UAM can be an alternative transport mode in the SMA are more likely to use this service. These results are similar to the outcome of Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando, and Shaheen (2018), who found familiarity with the UAM concept is significant. Additionally, at phases 3–4, females are less likely to use UAM; this outcome is similar with the result by Al haddad, Chaniotakis, Plötner, and Antoniou (2020). Moreover, early adopters are more likely to use UAM; this tendency is shown at the initial stage when AVs is adopted. However, U.S cases (Garrow, Mokhtarian, German & Boddupalli, 2020; Reiche, Goyal, Cohen, Serrao, Kimmel, Fernando & Shaheen, 2018) or cases in other countries, including Europe (Al haddad, Chaniotakis, Plötner & Antoniou, 2020), show that young people or high-income

groups are more likely to use UAM; in this research those factors are not significant because SMA is a smaller region than other countries or cities studied, has good infrastructure for public transportation, and taxi fare is relatively cheap. Income does not affect willingness to use UAM services at phases 3–4; due to safety concerns, most the respondents tend not to want to ride UAM. One limitation is that in the case of age, teenagers were not included in the survey, which may have affected the research outcome.

In the case of experts, willingness to use UAM service is the same with the public at phase 1. Moreover, experts are more likely to use UAM in phases 2–4. Experts did not feel significant gaps in the shift to unmanned, and autonomous vehicles; in other words, they are not afraid of these changes. Eventually, experts are more optimistic; hence, there is a possibility of introducing UAM service hopefully considering not the public acceptance exactly. Therefore, as noted in the expert interviews, tracing the public's willingness to use UAM and finding out how to enhance acceptability by conducting acceptability studies continuously is recommended. Particularly, many experts think that improving acceptability is one of the public's roles. They select the most significant factor is safety and then cost; hence, the government's effort to prove the safety of UAM is paramount in enhancing acceptability. The next important policy is creating demand by reducing costs, such as by offering a subsidy or giving incentives, considering willingness to pay is significant throughout all phases of UAM service. Moreover, early adopter personality and positive perceptions about UAM positively affect willingness to use; therefore, experts mentioned that informing the public about the UAM through education or events and providing opportunities for listening and learning about the UAM are needed.

As the research is one of few initial studies about acceptability in preparing for the introduction of UAM, this study determined willingness to use UAM services at each stage and influential factors to the public in SMA. Moreover, it demonstrated the necessity of tracing the public's acceptability and preparing for the introduction of UAM, considering acceptability due to experts makes the public look on UAM services more favorably. The influential factors provide implications on what factors should be considered for enhancing acceptability. Additionally, willingness to use and influential factors are found, while necessary methods for enhancing acceptability are suggested from interviews with relevant experts. Most of the methods are policies that should be performed by the government; hence, policymakers related to UAM and the person(s) in charge of UAM in public companies should consider these suggested policies for a successful introduction. That said, the policies are just items for enhancing acceptability; further investigation and development of each policy is needed. Remarkably, when considering the public's willingness to use UAM service decreases at phases 3–4, there is resistance to unmanned and autonomous systems; hence, their willingness to use and affinity for UAM with an autonomous system should be increased for successful future UAM service. Continuously informing the public on UAM through advertisements, education, and practical experience for understanding and affinity is needed, and we should look for whether willingness to use increases or not in the future. In this process, specific situations, including noise level, booking process, or ID checking method, are first suggested and then the public's acceptability should be investigated later.

UAM service is not yet introduced; I use SP survey assumed four phases of UAM services. This method is commonly used for knowing future demand and intention but systematically has limitations because respondents should imagine the situations. Therefore, in further research, specific situations should be explained and then investigated the adoption given the

service model like airport shuttle or on-demand service. In this research, the target of the public was potential users, but some pedestrians can be affected by UAM service; hence their acceptability should be investigated later for introducing UAM services.

APPENDIX 1. SUMMARY OF INTERVIEW RESULT

ID	**1**	**2**	**3**	**4**	**5**
Field	**UAM**	**Aviation**	**Aviation**	**Aviation**	**Autonomous Vehicles**
Thinking about the quantitative results	I think the outcome of Booz Allen Hamilton is reconfirmed in this study.		This outcome seems to be a predictable result.	It is a reasonable outcome.	This is a convincing result.
- **Gaps of willingness to use UAM service between experts and the general public**	Experts understand the technologies well and hold a conviction that the UAM is feasible.	Experts' high willingness to use UAM service seems to reveal goal-oriented thinking, not real intention to use as a potential user.	The degree of understanding is different, so it is reasonable, but I think commercializing UAM service is far from now due to the technology development level of now. Hence, I believe the experts' willingness to use UAM service includes hopefulness.		It seems it is because the public's understanding of UAM is low.
Opinions about social barriers or concerns in the view of experts or potential users	Safety is the most important thing. The demonstration events are needed for showing and giving proof that UAM is safe technically.	Declarative something like a demonstration show is needed to show UAM is safe. The events like UAM policymaker riding the UAM should be shown to the public. In the case of the cost, the cost is expensive at the beginning market, so private sectors	Naturally, safety is the biggest concern. Policies for guaranteeing safety are needed. The authorities must manage safety thoroughly, verify airworthiness, and supervise the operators' safety problems. If the cost is prohibitive, only a specific group will use this mode. Then, it is tough to find	Decreasing the cost is right. Supporting operators or deducting taxes would be effective policies.	Safety must be our top priority. It is important to find standards that are both safe and commercially available. It is vital to match the level at which the developer can develop and the safety level that the public can understand. It is essential to make guidelines before institutionalization or to set the direction of the legal system well.

	Aviation space, law, and regulation are difficult parts. There are several parts needed cooperation.	cannot enter the market. Therefore, for encouraging participants, giving incentives or subsidies are needed. Maybe, related to airspace, there is a problem with the low altitude because no aircraft has yet flown at a low altitude in the SMA before. Aircraft can only fly above the Han River corridor in SMA, and government must solve this problem.	social consensus. Finally, the cost has a significant impact on the market's success. If the government has a will, they can solve the airspace problem. They have to make related regulations.		
Policies or methods for enhancing the acceptability - **Considering concerns or social barriers**	For sending messages that these futures are coming true, advertisements, demonstrations, and events have occurred. Continuous advertising and sharing the plan are needed.	It is necessary not only to listen to the experts' opinions but also to look for the public's perception. It is needed to make policies to increase the understanding level to the public. For instance, demonstration, pilot test, the simulator would be the right solution. Additionally, frequently showing the technology is	It is needed to find out the point of the necessity of UAM and promote it. Before introducing the UAM service, the government should think about what factors raise conflicts and how to solve it. People make complaints related to noise even if the air ambulance is for the public interest.	It matters whether I can ride when I want. Eventually, it should be accessible.	Understanding about UAM is needed, so advertisements or explanations to make it user friendly would be significant. The field should do acceptability research continuously. UAM acceptability studies are like an initial stage of acceptability studies about AVs. It is expected to be concretely detailed gradually. The proposed scenario

		necessary like having a blue electronic vehicle registration plate. Like Air ambulance, urging participation from private operators is necessary by giving financial benefits.			can also be further specified. After safety, the cost is inevitably important. You can also consider the policy to reduce fares, such as giving subsidies. However, it is necessary to consider whether there is a policy validity. If all people ride, economies of scale will grow, and then the cost will decrease.
What is the focus of the high acceptability group or the low acceptability group?	Enhancing the acceptability from the low acceptability group is important. I think the high acceptability group will follow the plan without special treatment.	I think it is to enhance acceptability in the high acceptability group quickly.	If the purpose is to expand service, enhancing the acceptability of low acceptability group is more necessary. To them, at least, giving the perception that UAM is an essential mode is critical. Like an air ambulance, UAM service is used for public service obligation (PSO) routes or ambulances for good perception.	Increasing acceptability of the low acceptability group is essential because the increasing degree is high. Social benefits should be emphasized. Showing how much time and cost savings and then safety should be secured.	Both methods are right, but I will select the high acceptability group if I have to choose one thing because at least they have a willingness to use UAM service, but it is too early to divide into two groups and discuss each.
Others	The aviation groundwork of South Korea is weak compared to the U.S. and the EU. We need to keep up with		RPAS is highly affected by camera performance. In addition, if it is sensor-based, sufficient infrastructure	I guess UAM is a more difficult problem than autonomous vehicles.	It tends to decrease acceptability to imperfect technologies. Introducing UAM service systematically

	foreign countries. Opening the initial market is very critical. In the future, we should achieve the economy of scale, but at first, considering specific influential factors like willingness to pay is needed.		installation is required. Even though remote control began in the 1980s, the civil aircraft itself has never been officially operated.	Autonomous vehicles can take over controls in an emergency at a specific stage, but UAM cannot grant control to non-pilot passengers.	following the phases presented in this paper is depends on the user's acceptability.

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