# Public Opinion Concerning the Siting of Vertiports

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Vertiports, also known as vertical takeoff and landing (VTOL) ports, are emerging facilities that serve as hubs for Advanced Air Mobility (AAM). They accommodate the landing and takeoff of electric vertical takeoff and landing (eVTOL) aircraft. As interest in urban air transport solutions grows, vertiports have gained substantial potential significance in revolutionizing urban transportation systems. Vertiports possess the potential to address several transportation challenges, providing efficient aerial connectivity within cities and surrounding areas. Moreover, their integration into urban landscapes has the potential to transform the way people commute, facilitating faster and more sustainable transportation options. However, implementing this transformation necessitates understanding the potential effects on public acceptance of this shift in paradigm (Chancey & Politowicz, 2020). More specifically, understanding public opinions and concerns related to vertiport locations plays a crucial role for policymakers, city planners, and stakeholders involved in developing and implementing advanced air mobility plans. Thus, the primary objective of this study was to explore and analyze public sentiment and preferences regarding the location of vertiports (Shaheen et al., 2018; Yedavalli & Mooberry, 2019).

## Literature Review

It has long been recognized that public acceptance of civic projects is critical to its successful implementation. As such, public participation in airport development has been extensively studied, with case studies being a common approach. Early studies focused on the role of power in decision-making and the importance of active community involvement. Studies have focused on conflicts over airport noise, community engagement during airport expansion, and ways to improve and protect community quality. It has been found that it is not uncommon that socio-environmental conflict between airports and surrounding communities can stem from a lack of trust, disparate opportunities for civil society, and difficulty accessing information. Open dialog among all stakeholders has been determined to be essential for successfully integrating air service ports in and around communities (Chancey & Politowicz, 2020; Shaheen et al., 2018; Yedavalli & Mooberry, 2019).

Sedlin et al. (2020) explored the role of local residents in airport planning and operational decisions, highlighting the importance of active consideration of these communities in airport planning. Researchers found that airports often follow consultation requirements but do not fully incorporate interactive engagement, which could increase public trust and reduce resistance. Several cases were presented as exemplars. An airport project in Mexico City failed due to top-down decision-making and disputed importance of public participation. Munich Airport's third runway project also faced communication failures, leading to strong,

unresolved conflicts between the public and the airport. In the case of the New Beijing Airport, inconsistencies between policymakers' and developers' objectives of public participation created a disjointed relationship among participants. They concluded that comprehensive information and broad consultation could not guarantee meaningful participation if they were not linked to a careful selection process (Sedlin et al., 2020).

A recent example of failed community engagement and its impact on airport site selection occurred in the Puget Sound region near Seattle, Washington. The commission appointed by the state legislature to study options for a major new airport in Washington has formally disbanded after submitting its final report without recommending a preferred location. The commission's goal was stymied by public backlash last year to its shortlist of proposed new airport sites. The report concluded that Washington needs a new airport and likely will not have one before 2050. The report states that Washington will only be able to meet future commercial aviation needs by developing a greenfield site on undeveloped land, which has yet to be found. A survey of the commission's 16 members found that a new primary commercial aviation facility will take until 2050 or beyond to be complete and functional (Gates, 2023).

Much like airports, a range of public concerns are associated with vertiport locations. Besides addressing the more commonly recognized factors such as noise, safety, and pollution, it also encompasses additional critical aspects such as hours of operation, proximity, real estate values, and convenience. Opinion studies about drone activities can garner some insight into public acceptance of AAM.

Awareness of drones is between 93% and 97% in North American and European countries. This high level of awareness can be attributed to the extensive media coverage and the increasing visibility of drones in everyday life. As a result, public opinion on drones has become more nuanced, with some individuals embracing their potential benefits while others express concerns about privacy and safety issues. The growing interest and awareness surrounding drones have sparked meaningful discussions and debates about their impact on society.

Support for drones increases with the level of awareness among the population. People who are more informed about the various applications of drones, such as aerial photography, search and rescue operations, and delivery services, are more likely to view them positively. However, there are still segments of the population who remain skeptical or even fearful of drones due to their association with military use and potential misuse by individuals or organizations.

Support for air taxis has steadily increased, around 40–60%. This growing support can be attributed to the potential benefits of air taxis, such as reducing

traffic congestion and providing faster transportation options. However, there are still concerns regarding the safety and reliability of air taxis, which need to be addressed in order to gain wider acceptance among the population.

Public perception plays a crucial role in the widespread adoption of any new technology. It is essential for companies and organizations involved in the development of air taxis to actively engage with the public, address their concerns, and provide transparent information about safety measures and reliability. Additionally, collaboration with regulatory bodies and industry experts can help establish standards and regulations that further enhance the safety and reliability of air taxis, ultimately boosting public confidence in this mode of transportation (Tepylo et al., 2023).

Public concerns about drone operations are primarily focused on safety, environment, privacy, and noise. Some of the identified societal concerns such as noise impact, environmental concerns, safety concerns, fairness, and economy. Some of the concerns about the impacts of AAM have been proposed to be countered by mitigation strategies such as alterations to flight trajectory, noise-limiting hover time, flying direct routes, alternate paths, avoiding certain areas, limiting speeds, and restrictions on hours of operation. Mitigations can be classified as "tools and technologies," such as artificial intelligence or new materials. Low-noise propeller drones can increase minimum altitude noise mitigation. Future developments can help avoid unexpected encounters at any speed (Çetin et al., 2022).

Available research underscores that public perception of AAM will definitively impact the acceptance and adoption of such services. Community engagement is also crucial for AAM service success, leading to NASA and FAA making efforts to understand the potential disturbance of eVTOL operation in communities through demonstration projects. Recent studies have used survey instruments and econometrics modeling to estimate potential AAM demand and study near-term and long-term market size under competition with traditional ground transportation and ground autonomous vehicles. Most respondents recognized time-saving benefits and safety as primary concerns. Factors such as age, gender, income level, educational background, and daily driving habits were found to be statistically significant.

Safety concerns were the most critical factors influencing adoption, followed by cost, trip duration, on-time reliability, and operation characteristics. A meta-analysis of urban mode choice factors from 52 studies from 1980 to 2017 identified demand and acceptance drivers for AAM. A simulation tool was developed to integrate AAM service into existing transportation systems. A well-

designed ground infrastructure system is essential for AAM operation, and optimal vertiport locations must be identified to serve potential users and support eVTOL operations (Wu & Zhang, 2021).

Various causes have fueled interest in AAM, but the rapid urbanization and reliance on automobiles have caused gridlock and inefficiency in cities worldwide, leading to delays, vehicular emissions, increased stress levels, noise, and vibration, which have seemingly caused a sense of urgency in adoption. Urban skies remain an untapped resource for local transport. Historically, innovations to combat congestion have focused on increasing transportation supply for the automobile, such as building more roads or increasing lanes on highways. However, these efforts have often been futile and counterproductive, leading to more significant congestion, worse equity outcomes, and wasted resources. Alternatives include providing incentives for behavioral changes in mobility, replacing trips with telecommuting, and offering accessible transportation alternatives. It has been proposed that AAM can fill the mid-to-long distance gap that current transport modes are not efficiently addressing, reducing travel times and reducing environmental degradation, energy costs, and infrastructure costs (Rothfeld et al., 2020; Yedavalli & Mooberry, 2019).

Yedavalli and Mooberry (2019) surveyed groups of participants in Los Angeles, Mexico City, New Zealand, and Switzerland better to understand the acceptance of AAM in different regions. The survey included psychographic, scenario-based, general, and demographic questions. The psychographic questions tested attributes such as tech dependence, savviness, trust, professional and personal aspirations, preferences about lifestyle, privacy, openness, understanding others, desire for efficiency, and general life satisfaction. The scenario-based questions provided five scenarios about an aerial taxi, each with randomized values for the time of day, passengers, sound frequency, duration, visibility, riders, landing location, and flight altitude. The survey aimed to understand the factors affecting people's future acceptance of AAM in their communities.

The study revealed that the most impactful perception factors about aircraft were noise, altitude, frequency, flight time, and distance from home. The highest average concern was the aircraft having a sound like a helicopter, flying at a low altitude, and high-frequency operations (100 flights per hour). Overall, most respondents were concerned about the safety of the individuals on the ground. The duration of noise and visibility of the aircraft were the next group of parameters generating less concern. The landing location of the aircraft was the least concerning at a statistically significant level (Keeler et al., 2021; Yedavalli & Mooberry, 2019).

The noise pollution associated with eVTOLs, particularly near vertiports, is a concern, and the potential nuisances may threaten the adoption of the technology within existing land use. Understanding NIMBYism is crucial for the development of AAM infrastructure, particularly within sensitive land uses. For example, residential communities may be more at odds with vertiport infrastructure than commercial or industrial zones (Hall, 2023).

Hall (2023) specifically explored the public perception of vertiports in residential neighborhoods and whether the distance from a vertiport influences the willingness of the public to accept vertiports for AAM services. Participants identified their sentiments about the acceptability of potential services, including package delivery, food delivery, medical supply delivery, photography, hobby flights, emergency support, infrastructure monitoring, and entertainment (Hall, 2023). It has been recommended that vertiports be located in isolated areas with few air and ground risks but close to transportation hubs for economic reasons. Using rooftop locations could mitigate nuisance but increase flight risk (Hall, 2023; Shaheen et al., 2018).

A survey was conducted to understand the willingness of future AAM users to travel to vertiports, which are designated landing/takeoff locations for AAM aircraft. The survey asked respondents about their willingness to travel, the cost of travel, and the time they would spend there. The preferred transportation mode was also explored. Approximately half of the respondents were willing to travel on AAM aircraft, while one-third indicated they might be willing. Women were more hesitant to travel to vertiports, with a slightly higher proportion being unwilling and more women suggesting they might. Most respondents were unwilling to travel more than 20-30 minutes and not willing to pay more than $10 to reach a vertiport (Shaheen et al., 2018).

AAM has the potential to change urban skies significantly, but it faces challenges such as noise, third-party risk, privacy, and security. New traffic operating close to people's homes and workplaces could increase noise complaints. To manage these issues, new technologies must outperform conventional alternatives and provide a safer alternative. Privacy is also a concern, as AAM services rely on heavy data communication between vehicles, infrastructure, and passengers. Addressing privacy issues could lead to undesired airspace restrictions and minimum altitudes. Public acceptance of AAM depends on factors such as noise, third-party risk, privacy, security, and perceived benefits. Services with clear societal benefits, such as emergency response helicopters, are viewed differently from those without. Culture also plays a significant role in public acceptance of

new technology, with some regions being more open to introducing AAM than others (Roosien & Bussink, 2019).

Under a contract with NASA, Maven Consulting embarked on a study to identify optimal locations for vertiports. The study focused on how close participants felt a vertiport should be from work and home. Additionally, the respondents were asked about their biggest concerns about having a proximate vertiport. Safety, noise, traffic, and congestion topped the list. Respondents stated that they want a location that is convenient to their home, perhaps within 20 minutes, yet not in their neighborhood or near schools or parks. They also stated that the vertiport should be close enough to their workplace for easy access. An overarching sentiment was that the vertiport should be close enough to be convenient, but its operations should be out of sight with minimal noise impacts (Nordstrom, 2022).

As has been noted in various studies, favorable public opinion and the subsequent acceptance of AAM have been determined to be critical to the success of the new transportation paradigm (Chancey & Politowicz, 2020). Even in light of this fact, there is a limited amount of research on the siting of vertiports from the perspective of the public. Therefore, as Sedlin et al. (2020) recommended, the proper evaluation and consideration of public sentiment are paramount for a more seamless and welcoming adoption of new air transit port projects. This study aimed to augment the understanding of public opinion related to the sitting of vertiports.

## Methods

This study employed an electronically disseminated mixed-methods survey. The survey aimed to identify what persons living in the United States thought about the siting of vertiports in their communities. Areas of interest included reasonable proximity to one's home, noise, sight pollution (number of flights and aircraft altitude), hours of operation, and generalized concerns. Demographic questions were also included.

### Participants

The target population was the United States public population. According to the National Institutes of Health, a representative sample with a 95% confidence level and a 3% margin of error is just over 1,000 responses. The survey was available only to respondents who lived in the United States. The survey remained accessible until the threshold of 1,000 responses was surpassed (Martinez-Mesa et al., 2014). At the closure of the survey, a total of 1,041 responses were collected. Participants for the study were recruited using the Amazon crowdsourcing platform Mechanical Turk (MTurk). This platform facilitates a link between those who wish to participate in studies and the researchers conducting such studies. Prior research

has indicated that the data obtained by MTurk exhibits comparable reliability to conventional laboratory findings (Buhrmester et al., 2011; Rice et al., 2017). Also, the demographic attributes of MTurk participants closely mirror U.S. Census data with the exception of age, as MTurk samples tend to be younger than the general population (Moss & Litman, 2023).

**Instrument**

The survey was adapted from that used by Yedavalli and Mooberry (2019). In addition, survey questions were cross-referenced with surveys used by both Nordstrom (2022) and Shaheen et al. (2018) to verify validity. The demographic questions were derived from the measures utilized by the U.S. Census Bureau (2022). A panel of survey and AAM experts conducted additional evaluations of survey validity. The draft survey was then placed in an online format and piloted to 100 respondents. Feedback from the pilot process and the expert panel was integrated into a revised version used in the final distribution to the public. The final instrument comprised 49 questions, of which 48 were quantitative and one was qualitative. Some quantitative questions provided "other" as a response with a box for open-ended responses. Reliability analysis across sub-scales resulted in a range of Cronbach's $\alpha$ of .908 to .967 with a mean $\alpha = .929$, considered by exigent literature to be excellent (Gliem & Gliem, 2003).

**Procedure**

The MTurk request linked to the survey was posted for users to access and was left open for 16 days. Upon accepting the request, respondents were directed to a landing page describing the survey topic. Individuals were informed about the voluntary nature of their participation and that they could discontinue at any time. Respondents were also informed that the survey was anonymous and that no electronic tracking was utilized. If the respondents agreed to participate, they were directed to a page that defined what a vertiport is and various use cases for which they may be used. An artist's rendition of a vertiport with a terminal, vertipad, and eVTOL was also provided. On the next page, respondents were then directed through the survey questions. The survey consisted of Likert-type scale questions, numerical selection questions utilizing a slider bar, multiple-choice questions, an open-ended question, and demographic measurement questions. Since this study was exploratory, no statistical analysis was planned.

## Results

During the data collection period, there were 1,286 potential respondents, meaning visitors to the survey, and the total number of responses was 1,041. Using the American Association for Public Opinion Research (AAPOR) Outcome Rate Calculator Version 4.1 (2023), the calculated response rate was 89.9%. For the sake

of simplicity, the survey results are grouped into seven sections: personal impacts of a vertiport, community impacts of a vertiport, acceptable proximity of a vertiport, benefits of and concerns about a vertiport, flight operations to and from a vertiport, open-ended comments, and demographics.

**Personal Impacts of a Vertiport**

Questions on how a vertiport impacts an individual used a five-point Likert-type scale. Respondents were asked how they might respond to hearing that a vertiport was being constructed near their home. Specifically, respondents were asked about their excitement, happiness, concern, or agreement levels. Across this series of questions, the mean score was 3.59 ($s$ = 1.029), which indicates that respondents feel slightly optimistic about the prospect of a proximate vertiport. A breakdown of the responses to individual questions is shown in Table 1.

**Community Impacts of a Vertiport**

Respondent opinion on the impact of a vertiport on the local community was assessed using a Likert-type scale consisting of five points. The participants were asked about their prospective reactions upon learning about constructing a vertiport within their neighborhood. The participants were queried on their respective degrees of agreement with statements about the potential local impacts of a vertiport. The mean score was 3.70 ($s$ = 0.98), suggesting that the respondents have a somewhat positive outlook on the impact of a vertiport on their locale. Table 2 presents a summary of the replies received for each question.

**Acceptable Proximity of a Vertiport**

Next, individuals were asked what distance between their home and a vertiport might be acceptable using different reference scales. When respondents were asked how close they would accept a vertiport to their home in minutes of walking, the mean was 5.95 minutes ($s$ = 2.39). Individuals were next asked how few city blocks would be acceptable between their home and a vertiport. The average response was 6.15 city blocks ($s$ = 2.28). The survey then asked how many feet would be reasonable between one's home and a vertiport. The mean among respondents was 4,086 feet ($s$ = 3,107) or just over three-quarters of a mile. Lastly, individuals were asked to scale the closest a vertiport should be to their home in miles. The mean value was 2.37 miles ($s$ = 1.94).

Comparing responses on a standard scale of feet and miles, the closest value was for walking, which translated to 1,487 feet or 0.28 miles. The furthest distance provided was 12,513 feet for the 2.37 miles provided in the mileage scale question. An average across scales resulted in 6,800 feet or 1.29 miles.

**Table 1**

*Personal Impacts From a Nearby Vertiport*

| Question | Mean | Std. Dev. | Scale |
|---|---|---|---|
| What is your initial reaction to a vertiport being located near your home? You would be... | 3.22 | 1.09 | 1 = Very concerned<br>5 = Not very concerned |
| Upon hearing about a new vertiport being constructed near your home, you would be... | 3.72 | 0.94 | 1 = Very angry<br>5 = Very happy |
| I would support the construction of a vertiport near my home. | 3.64 | 1.03 | 1 = Strongly disagree<br>5 = Strongly agree |
| I would like to have a vertiport near my home. | 3.66 | 1.05 | 1 = Strongly disagree<br>5 = Strongly agree |
| Having a vertiport near my home will make my life better. | 3.61 | 1.03 | One = Strongly disagree<br>5 = Strongly agree |
| I am/would be excited about having a vertiport near my home. | 3.66 | 1.03 | 1 = Strongly disagree<br>5 = Strongly agree |

**Table 2**

*Potential Community Impacts From a Nearby Vertiport*

| Question | Mean | St. Dev. | Scale |
|---|---|---|---|
| Having a vertiport near my home will increase its real estate value. | 3.72 | 0.98 | 1 = Strongly disagree<br>5 = Strongly agree |
| Having a vertiport near my home will make it easier to travel within my local area or city. | 3.72 | 0.95 | 1 = Strongly disagree<br>5 = Strongly agree |
| I think vertiports will be important parts of a city's transportation system. | 3.70 | 0.99 | 1 = Strongly disagree<br>5 = Strongly agree |
| I think vertiports will be important to the future of my home town/city. | 3.67 | 0.97 | 1 = Strongly disagree<br>5 = Strongly agree |

**Benefits of and Concerns About a Vertiport**

The following set of questions asked respondents to indicate what possible benefits might be incurred from a vertiport. For the first question, respondents could select as many benefits as they seemed appropriate. A summary of responses is shown in Table 3. An open-ended answer was asked of those who selected "other," with the two most common responses being no benefits and faster emergency response. When asked to identify the primary benefit of having the vertiport, persons replied (in rank order): save time, access to transit, reduced congestion, flexibility, and economic impact. Again, there was a minority of responses indicating there would be no benefits and that there would be faster emergency response.

**Table 3**

*Percentage of Respondents Indicating Benefit Types From a Local Vertiport*

| Benefit | % of respondents |
|---|---|
| Save time | 60.14% |
| Reduce local congestion/traffic | 45.80% |
| Access to transit | 46.21% |
| Flexibility | 35.96% |
| Economic impact on the local area | 20.18% |
| Other | 1.02% |

Next, respondents were asked to indicate their concerns about a nearby vertiport. Firstly, respondents could select as many concerns as they seemed appropriate. A summary of responses is shown in Table 4. An open-ended answer was asked of those who selected "other," which resulted in a diverse mix of answers. The most common "other" concern was that eVTOLs might crash into the respondents' homes. Additional responses included environmental impact on wildlife, privacy, decreasing property values, electromagnetic interference, taking resources away from more accessible and practical forms of transit such as public transit, increased traffic or congestion, and cost. When asked to identify the primary concern about having the vertiport, persons replied (in rank order) safety, noise, air pollution, light pollution, visually distracting/disturbing, and "other." The distribution of responses among safety, noise, and air pollution were comparatively similar. Among "other" open-ended responses were concerns about the vertiport not being used, increased taxes, negative impacts on public transit, and increased traffic/congestion.

**Table 4**

*Percentage of Respondents Indicating Types of Concern Regarding a Local Vertiport*

| Concern | % of respondents |
|---|---|
| Safety | 55.02% |
| Noise | 54.82% |
| Air pollution | 48.67% |
| Light pollution | 27.66% |
| Visually distracting/disturbing | 18.44% |
| Other | 1.74% |

**Flight Operations to and from a Vertiport**

Individuals were subsequently asked how many eVTOL flights they could hear or see in a given day would be acceptable. Answers ranged from 0 to 50, with a mean of 25.1. The largest percentage of responses (13.5%) indicated that 35-40 daily flights would be tolerable.

Survey respondents were presented with images showing an eVTOL flying overhead at various altitudes. For each image, they were asked about their comfort level with the proximity of the vehicle to them and their home. All answered leaned towards being comfortable; however, only in cases when aircraft were flying at 1,000 feet were respondents solidly "comfortable." A summary of this set of questions is shown in Table 5.

**Table 5**

*Level of Concern About eVTOL Proximity During an Overflight*

| Hypothetical altitude of eVTOL | Mean |
|---|---|
| 50 feet | 3.46 |
| 100 feet | 3.63 |
| 200 feet | 3.82 |
| 500 feet | 3.94 |
| 1000 feet | 4.05 |

*Note.* Scale for questions used emojis: ☹ (1) = not comfortable at all, 😊 (5) = very comfortable

Next, individuals were asked about the hours of operation of a nearby vertiport that they would find acceptable. The opening time mean was 0700 am and, the mode was 0900 am, and the mean closing time was 0745 pm while the mode was 0900 pm.

**Open-Ended Comments**

The final vertiport-related question was a request for any comments about eVTOLs or vertiports being located close to the respondent's residence. Responses

to this question were not required; only 47.8% of surveys included qualitative responses. Responses were analyzed using Voyant Tools (n.d.) and Taguette (n.d.) qualitative analysis tools. The most frequently used word was "good," as in the existence of a local vertiport was considered a good thing. There appeared to be two primary categories of responses: positive and negative. Under positive, there were two sub-categories: utility and excitement. Utility comments focus on the efficiency and efficacy of an eVTOL network, while excitement comments indicate a positive emotional response. See Table 6 for the given comments in each sub-category.

**Table 6**

*Positive Comments From an Open-Ended Question*

| **Positive** | |
|---|---|
| ***Utility*** | ***Excitement*** |
| It's really useful | I feel very happy about vertiport is near to my home |
| Facilitating the movement of people and goods more rapidly and efficiently | Would be interesting |
| Speed and safety of evtols | I will love it |
| I don't have a car and I live in a food desert. 2 miles from the closest grocery store. 2 miles to the nearest bus stop too. I would use this often. | I think this would be a great idea if it was widespread. |
| I would like it to be near my house | It would be wonderful. |
| Faster deliveries, reduced traffic, and environmental gains, contributing to a sustainable future | I have a small heliport 3 blocks away and it's awesome. The key to making it acceptable at close distance is to have limited hours |
| I would definitely be interested in using them to get around, and I think they would be a valuable addition to our transportation network. | I embrace the future, but hope for quiet evtol motors. |
| Major metropolitans this would be great as another option to mass transit. Less attractive for populations under 1 million | We are happy at the same and concern about our safety |
| Vertiports will be a reducing the time to travel and i think it is efficient | I have never heard off them before, I'm actually quite intrigued by them! |
| Very good and travel time maintain quick easy | I think it would be kind of neat |
| | Good |

*Note.* Codes used to classify remarks into designated groups are underlined.


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Under negative, there were three sub-categories: annoyance, fear, and skepticism. Annoyance comments describe noise, congestion, pollution, and similar concerns. Fear comments indicate being scared of vertiport operations for various reasons. Skepticism comments convey doubt that vertiports will become a reality anytime soon, if ever. Comments provided for each sub-category are shown in Table 7.

**Table 7**

*Negative Comments From Open-Ended Question*

| **Negative** | | |
|---|---|---|
| ***Annoyance*** | ***Fear*** | ***Skepticism*** |
| I just do not like idea of any airport being near home. Between noise and traffic, not an ideal scenario in my mind | It scares me, but it will definitely happen in the future. So I need to get used to it. | This seems unlikely to me |
| I'm most concerned about a vertiport and VTOL activity disturbing the wildlife | I worry about the safety of passengers and those on the ground | Seems experimental at this point. |
| evtols increasing the amount of noise and traffic | Evtols being too close would cause me to fear for my own safety. | This is fiction, right? |
| We are rural and do want additional traffic in our area, any type of noise after dark, and aircraft flying at low altitudes over our homes. | Risks outweigh the benefits | It also services a much smaller amount of people than a traditional system such as a train |
| Not in my yard! | No wings means crash imminent | The reasons you won't be seeing an air taxi landing in the street in front of your house or apartment just yet include government regulations |

| ***Annoyance*** | ***Fear*** | ***Skepticism*** |
|---|---|---|
| Drawing people to the site would be added congestion and parking would be needed at the site. | I am very afraid of this thing crashing into my house or into me or into my car. People will obviously fly it drunk and high which makes things worse. I do not want an evtols above me or my house | |
| I would just hope they'd make them less noisy. | I'm really concerned about poor air traffic control… could potentially lead to risk of an air traffic incident with a private or commercial airline… I'm also curious what the safety of these evtols are compared to traditional helicopters. The last thing we need is a evtol going down in downtown | |
| Flight paths should be over roads or greenways, not houses or buildings when at all possible. | I am worried about the privacy as well. They might be able to see inside of our house. | |
| Potential to be obnoxious and disruptive, but that depends on how they are operated. | After the Kobe Bryant incident, I would not want helicopters or similar forms of transportation being used so close to me | |
| I greatly oppose any project that wants to place evtols in my city. I prefer money be spent for more practice and cost effective public transport such as busses. | | |

| *Annoyance* | *Fear* | *Skepticism* |
|---|---|---|
| I already have an air base nearby! Too much traffic and noise! | | |
| I wouldn't want them within 150 miles | | |
| My concern would be about the noise especially if it's over 10+ times in one day. | | |
| Air travel is already a massive source of pollution. Having evtols may contribute to local noise and air pollution. | | |
| I am not crazy about evtols flying or being placed near my home because… make too much noise and more people would drive closer to my house | | |
| I would not want to be constantly listening to it | | |
| I wouldn't be bothered by helicopter noise. Perhaps my neighbors would. | | |

*Note.* Codes used to classify remarks into designated groups are underlined.

**Demographics**

The survey also explored the demographic attributes of respondents using the same measures utilized by the U.S. Census Bureau. The respondents' ages were between 20 and 50, with the mean age being 38.6 ($s$ = 16.27). Most (58.8%) respondents were men, and 39.7% were women, with the remaining 1.5% being split between "prefer not to answer" and "other." The majority (90.1%) of respondents identified their race as white, followed, in order, by American Indian or Alaska Native (5.9%), Black or African American (4.38%), Native Hawaiian or Other Pacific Islander (4.3%), Prefer Not to Answer (3.5%), Asian (3.3%), Unknown (0.5%), and Other (0.5%). Note: These do not add up to 100% because persons could choose more than one ethnicity. Among respondents, 66.2% were not Hispanic, Latino, or of Spanish origin, while 26% identified as one of these descriptors,

and the remainder stated they preferred not to answer (7.8%). The highest level of education of survey takers is shown in Table 8.

**Table 8**

*The Highest Level of Education of Respondents*

| Highest Education Level | Percentage of Respondents |
|---|---|
| Bachelor's | 55.6% |
| High School, Diploma, or GED | 14.1% |
| Some college | 7.9% |
| Associate | 7.8% |
| Master's | 7.7% |
| Some High School, no Diploma | 2.8% |
| Trade/Technical/Vocational | 1.4% |
| Professional (e.g., MD, JD) | 1.3% |
| Doctorate | 0.5% |
| Other, None, Prefer not to Answer | 0.9% |

Respondents were overwhelmingly employed full-time (79.7%), and 13.7% were employed part-time or self-employed. The remaining 6.6% were not working, were students, were homemakers, were military personnel, retired, unable to work, or preferred not to answer. Most (82.7%) indicated they were married or in a domestic partnership, 13.6% were single, and 2.1% were divorced. The other 1.6% were separated, widowed, or preferred not to answer. Respondents most frequently (36%) reported having four household members, followed by three persons (29.8%), two persons (18.7%), five persons (6.9%), and one person (5.0%). The remainder of the sample (2.6%) indicated 6 or more persons, or they preferred not to answer.

Individuals were then asked to indicate their household income. Most (35.6%) indicated that they made $50,000 to 74,999, followed by 20.7% making $75,000 to 99,999 and 15.9% making $35,000 to 49,999. All income results are shown in Figure 1. Over half (55.2%) of persons described their place of residence as urban, while 24.8% stated they lived in a rural environment, and 19.5% indicated they were in a suburban area. The remaining respondents (0.5%) chose "other."

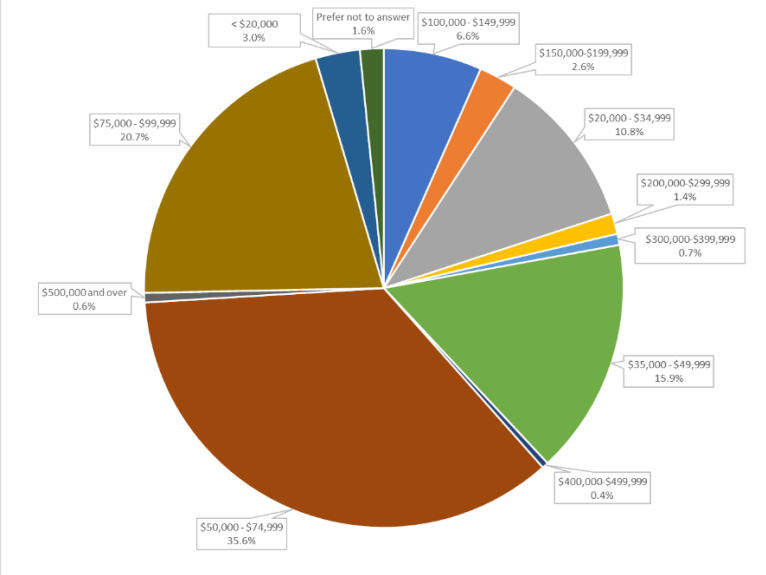
## Discussion

Upon examining the survey results, it was somewhat surprising how positive respondents were concerning eVTOL operations and the presence of a nearby vertiport. Regarding the personal impacts resulting from a neighboring vertiport, the mean of 3.59 indicated only a slight leaning toward the positive. The least enthusiasm was displayed among initial reactions to the news that a vertiport

was planned near a respondent's home, with mean concern scores close to a neutral position ($M$ = 3.22). This finding aligns with Nordstrom's (2022) results (approximate $M$ = 5.2 on a 10-point scale), indicating a primarily neutral sentiment towards having a vertiport close by. However, the happiness mean score was the highest ($M$ = 3.72) within personal impacts, indicating at least some positivity about having a vertiport nearby. Persons in rural areas ($M$ = 4.02) were the happiest about the prospect of a new vertiport, followed by urbanites ($M$ = 3.78) and then suburbanites ($M$ = 3.35). Perhaps the potential for improved access to transit is more appealing to those in remote and congested areas but less so in the suburbs.

**Figure 1**

*Income Ranges for Survey Respondents*




Respondents were also more positive than expected about the impacts of a vertiport on the local community ($M$ = 3.70). Results also showed a leaning towards agreement with the concepts that vertiports will make life easier, will be important to the future of one's community, and will become pivotal components of the local transit system. Positive community impacts were highest among urban residents ($M$ = 3.82), followed by rural ($M$ = 3.65) and suburban residents ($M$ = 3.52), respectively. Overall, the findings of this study are slightly more positive than the neutral responses reported in Nordstrom (2022).

Indications of how close to a vertiport an individual would find acceptable were, in some cases, surprising. For example, the mean walking time provided was about six minutes, which is undoubtedly convenient but also puts one's home closer

to vertiport operations. This seems arbitrarily low. It is surmised that this may be due to the unfamiliarity with relating walking time to the distance that would be traveled during that timeframe. The highest number of respondents stated their preferred walking time to be between 24 and 30 minutes. In Nordstrom (2022), the preferred walking time was 20 minutes, while Shaheen et al. (2018) reported that 80% of respondents would be willing to walk 6 to 30 minutes. Upon reflecting on these studies, a consensus would be around 20 minutes of walking time.

Examinations of vertiport proximity in terms of Imperial units yielded 1.29 miles in the current study and a preference for the location to be within approximately 1 mile in Shaheen et al. (2018) and within 2 miles in Nordstrom (2022). However, Nordstrom (2022) reported more support for vertiports the further they were from one's location, with the highest level reported for locations at or beyond 10 miles. It seems logical that the distance range between one and two miles was reported for those interested in using the vertiport and looking for convenience. On the contrary, those favoring locations beyond 2 miles most likely contested the vertiport due to higher levels of concern about noise, safety, congestion, and so forth.

The top three benefits of vertiports cited in this study were saving time, access to transit, and reduced traffic/congestion. The top two benefits were also noted in other studies in the same rank order (Roosien & Bussink, 2019; Shaheen et al., 2018; Wu & Zhang, 2021). Among concerns about vertiports, in this study, the top items were safety, noise, and air pollution. Safety and noise were most concerning in Nordstrom (2022) and Roosien and Bussink (2019). Respondents in Norstrom (2022) ranked concern about increased traffic and noise in the top three. Persons providing open-ended responses in this study expressed similar concerns, but only in a few instances.

When asked about the number of daily flights that would be tolerable, responses were concentrated between 15 and 40 flights, with an average of 25.1. This is far below the 100 daily flights level mentioned in other studies (Keeler et al., 2021; Yedavalli & Mooberry, 2019). The density of 25 flights per day seems reasonable, especially in light of the fact that even small commercial airports have over four times as many departures and arrivals (Jacksonville International Airport, 2023).

Next, survey takers were asked a series of questions using images of an eVTOL flying overhead at various altitudes. The author of this study is skeptical that individuals would find an overflight at an altitude of 50 feet on the comfortable side of neutral ($M$ = 3.46). It would seem, especially if this type of flight occurred frequently, it would be far from acceptable for most persons. For perspective, a

regional jet begins its landing flare (final maneuver before touching down) at 50 feet. Logically, the comfort level increased as the eVTOL's altitude increased, with respondents indicating they were comfortable when the aircraft was at 1,000 feet. This aligns with the flight parameters described in Roosien and Bussink (2019). Shaheen et al. (2018) noted that individuals wanted a minimum altitude requirement to reduce the noise and sight impacts of eVTOLs, but no specific value was mentioned. These findings reiterate the need to carefully plan eVTOL flight paths in all three dimensions to integrate harmoniously into the local environment.

As for hours of operation, respondents seemed to favor 7 a.m. to 745 p.m., yet the most frequently given recommendations were for an 8 a.m. to 8 p.m. operating window. This could certainly reduce displeasure due to seeing and hearing eVTOLs flying in the vicinity. This aligns with what was presented by Shaheen et al. (2018): people do not want flights taking place in the early mornings or evenings. This was echoed by at least one open-ended response from the present study.

The open-ended question asking for additional comments provided two major themes with several sub-themes. Comments were easily classified as either positive or negative. Positive responses fell into a utility or excitement subtheme. Words or phrases like useful, facilitating, use often, addition, another option, quick, and efficient were used to segregate comments into the positive-utility category. Words or phrases like very happy, interesting, great, wonderful, awesome, happy, neat, and intrigued were used to categorize responses as positive-excitement. Negative responses were placed into one of three subthemes: annoyance, fear, and skepticism. Annoyance comments included words like noise, traffic, disturbing, low altitude, congestion, obnoxious, disruptive, pollution, and waste of money. Fear-based comments used words like scare, worry, risk, crash, afraid, concerned, incident, and privacy. Skepticism comments included words or phrases like unlikely, experimental, fiction, and will not be seeing an air taxi.

Negative open-ended answers well outnumbered positive comments, with most worry centered on the potential for annoyance from vertiport activities. The issue of privacy emerged rather often in comments. While privacy has often been mentioned as a major concern in drone (UAS) operations, it rarely comes up when discussing commercial operations and perhaps occasionally surfaces related to helicopter operations, especially when operated by law enforcement. This will be another consideration for public outreach efforts, eVTOL operational parameters, and zoning.

Demographic data was compared to the attributes of the MTurk population, and some variations in certain categories were discovered (Moss & Litman, 2023).

The sample used in this study had a higher percentage of white respondents than both the MTurk and U.S. populations. The participation by American Indians or Alaska Natives and Native Hawaiians or other Pacific Islanders was higher than would be expected in the context of MTurk and U.S. populations. Also, there were more persons of Hispanic background than either population. The sample of the current study was also higher educated than the U.S. population. Approximately 64% of this sample had a bachelor's degree or higher vs. 33.7% of the U.S. population.

Gender distribution was in line with U.S. data but slightly skewed towards male in reference to the MTurk data. Approximately 80% of respondents in this study were employed full-time vs. 63% of the U.S. population. As is often the case in MTurk samples, the current sample was younger than the general population. The ages within the sample were concentrated in the 20 to 40 range.

Most respondents fell within the $35,000 to 99,999 range. This income distribution followed a similar pattern as the MTurk population, albeit at a higher concentration within the income range. The current sample clearly leaned towards lower-middle to middle-class incomes. Using the mode of income responses, used due to the use of income ranges rather than raw numbers, respondents favored $50,000 to 74,999 which aligns with the median income in the U.S. of $69,000.

In summary, the sample used in this study was primarily white, slightly more male than female, young, had an above-average education, and had a lower-middle to middle-class income. This distribution closely mimics the sample used in Shaheen et al. (2018), except that the NASA study used a fair number of students, which lowered the mean age to a greater degree than the current study. A more detailed exploration of the relationships among AAM-related responses and demographic information is beyond the scope of this study and will be addressed in a subsequent study.

**Limitations**

The use of MTurk samples resulted in some variance in demographics in relation to the U.S. population. This has been recognized frequently in previous studies. This sample was younger, mostly white and male, lived in city environments, married, and had low-to-mid-range incomes. It is reasonable to hypothesize that the sample in this study may resemble early adopters and thus have a more open perspective of neophyte technologies. It is also reasonable to recognize that the results of this study may not entirely represent the opinions of all persons in the US.

## Delimitations

The researcher chose to recruit participants from the MTurk platform based on the plethora of literature that has used MTurk to generate samples and those studies that support the efficacy and validity of MTurk samples compared to other types of data collection. The researcher chose not to dissect the demographic nature vis-à-vis other variables as it was posited that it was outside of the scope of this study and will be explored in a follow-up study. The study was also limited to persons who live in the U.S. since the data is intended to inform researchers and other stakeholders in the U.S.

## Conclusion

The analysis of the survey data unveiled an unexpected inclination towards eVTOL operations and the presence of vertiports in close proximity. The expected personal impact from a vertiport was mostly negative. The effects of a vertiport on the immediate community were found to be more favorable than initially anticipated, particularly among urban dwellers who expected the most pronounced beneficial outcomes. Most participants indicated a preference for a maximum walking duration to reach a vertiport ranging from 24 to 30 minutes. The research also revealed that respondents favored having a vertiport within a radius of around 1 to 2 miles. According to Nordstrom's (2022) findings, there was an increasing degree of support for vertiports as the distance from one's location increased.

The present study found that the perceived advantages associated with vertiports focused on time savings, enhanced transport accessibility, and traffic congestion alleviation. Several notable concerns are associated with establishing vertiports, including safety, noise levels, and air pollution. The research revealed that participants were apprehensive about the number of daily flight operations, settling on a reasonable average frequency of 25 flights per day. Not surprisingly, respondents were more comfortable when aircraft were at or above 1,000 feet if flying over their residences. This finding is consistent with other research conducted in this field. Respondents preferred a vertiport operating window from 8 am to 8 pm.

Negative open-ended replies outnumber the positive, with many participants expressing concerns about possible distress caused by vertiport activities. Positive comments concentrated on how vertiports could improve their lives, of which several expressed excitement about AAM.

The demographic data was analyzed in relation to the characteristics of the MTurk community and the U.S. population, revealing that the sample used in this study varied from the reference populations. The sample was predominantly white,

male, generally young in age, with educational attainment above the norm, and income levels ranging from lower-middle to middle-class.

In summary, this research sought to explore the opinions and attributes of U.S. residents in relation to vertiports. The study was able to achieve this goal. The findings underscore the complexity of where to site vertiports. This study shows that planners must look beyond simply looking for open or unused real estate, sites near multimodal hubs, or even existing zoning. This study outlines the importance of meticulous planning and thoughtful consideration of impacts on persons and communities under flight paths and near vertiports. It also highlights the sensitivities and concerns the public may have when the widespread construction of vertiports becomes a reality. This can help guide public outreach and education to mitigate resistance to the concept of AAM. By taking into account these critical factors, planners and vertiport stakeholders will be in the best position to ensure the success of eVTOL operations.

## Suggestions for Future Research

AAM is an area in need of a significant amount of additional research, in particular, how to choose locations for vertiports responsibly. As a result of the findings of this study, the data set will be further scrutinized in a future study to cross-reference demographic attributes with other survey variables. This will further inform stakeholders about how demographics may influence the acceptance of AAM in neighborhoods.

Another recommended study would be a review of all available literature on the siting of vertiports and public acceptance of AAM to consolidate the findings into a best practice model. Also, this study could be repeated in specific regions, counties, municipalities, or neighborhoods to pinpoint data on local sentiments about vertiports and eVTOL operations.

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