



Perspectives on drone delivery

From the first community in the U.S.
to experience residential package
delivery by drone

Executive summary

Public attitudes towards drone delivery will significantly influence the ultimate success of these programs in communities. Data on this topic is limited, however, and no study has evaluated how drone delivery is perceived in a community that has had first-hand experience with it. Researchers from Virginia Tech conducted such a survey in Christiansburg, Virginia (Va). Christiansburg is the site of the first service in the U.S. to deliver goods directly to residences on demand via drone, launched by drone-delivery company Wing in October 2019. Survey respondents ($n = 821$) answered demographic and psychographic questions and provided quantitative feedback on drone delivery including general sentiment, familiarity, and likelihood of use, and qualitative feedback on its perceived positive and negative attributes. In contrast to previous surveys, this study found a strongly positive attitude towards drone delivery, with 87% of respondents reporting positive sentiments and 89% stating that they were likely to use the service if it were available; 87% of respondents reported that they viewed the use of drones for package delivery on equal or more favorable terms than other uses of drones. These results suggest that communities may be significantly more receptive to drone delivery than earlier studies have suggested and have implications for policy and outreach on this topic, as well as for survey methodology.

Background

Over the last two years, several companies have earned permission from the FAA to deliver packages by drone. Small-scale trial services, usually with tight restrictions, are operating in a handful of communities around the country; maturing technology and regulatory shifts suggest that drone package delivery could become more commonplace over the next decade. Among potential commercial applications for drones (also known as UAS, or unmanned aircraft systems), package delivery is notable for its direct interaction with consumers and high degree of visibility in the community. Therefore, public receptiveness to this technology is highly salient to the regulatory agencies developing rules that will govern its use, companies evaluating new markets, and state and local governments considering whether to encourage drone delivery in their regions.

However, to date, these groups lack reliable gauges of public sentiment on which to base their decisions. The small number of previous studies of public opinion about UAS delivery have been marked by two flaws: first, they survey individuals who have no direct experience with drone delivery, and are therefore speculating about what such a service would be like. Second, most ask respondents about specific potential risks of the technology selected by the researchers in advance. Explicitly identifying possible risks may have framing effects, leading respondents to focus on hazards and arrive at a more negative overall sentiment than they would otherwise.

For these reasons, Virginia Tech conducted a public sentiment study in Christiansburg, Va., where the population has experienced UAS delivery for more than a year. In October 2019, Wing launched a drone-delivery trial in the town, a community of 22,163 people in the state’s New River Valley region that sits next to Blacksburg, Va (home of Virginia Tech), and 35 miles from Roanoke, Va., the nearest metropolitan region. This was the first service in the U.S. to deliver goods on-demand directly to residences via drone; it was also, and continues to be, the most sophisticated and robust program of its kind.



Figure 1. Christiansburg, a small town in southwest Virginia, has had an active drone delivery program since 2019. It is the first community in the U.S. where drones delivered goods to residences on demand, and therefore provides a unique opportunity to study public sentiment towards drone delivery in a community with direct experience with it.

Wing’s deliveries originate at a central operations site (a “Nest”) located in an industrial-commercial section of Christiansburg that serves several neighborhoods within a three-mile radius. This model much more closely resembles the likely future of drone delivery than any other ongoing programs, which typically have strict limits: operating between two fixed points, for example, or between different facilities within a single medical campus. The vast majority of Wing’s flights occur directly over buildings and homes in residential areas, with deliveries primarily to customers in quiet suburban neighborhoods, who must be home to receive deliveries. Wing operates five days per week, with occasional interruptions for weather, holidays, or other factors. Daily order volumes fluctuate, but 2020 data showed an average volume of 57 orders per week and peaks as high as 97 orders per day.

¹ Cobb, Michael D. “Framing Effects on Public Opinion about Nanotechnology.” *Science Communication* 2005, 27(2).

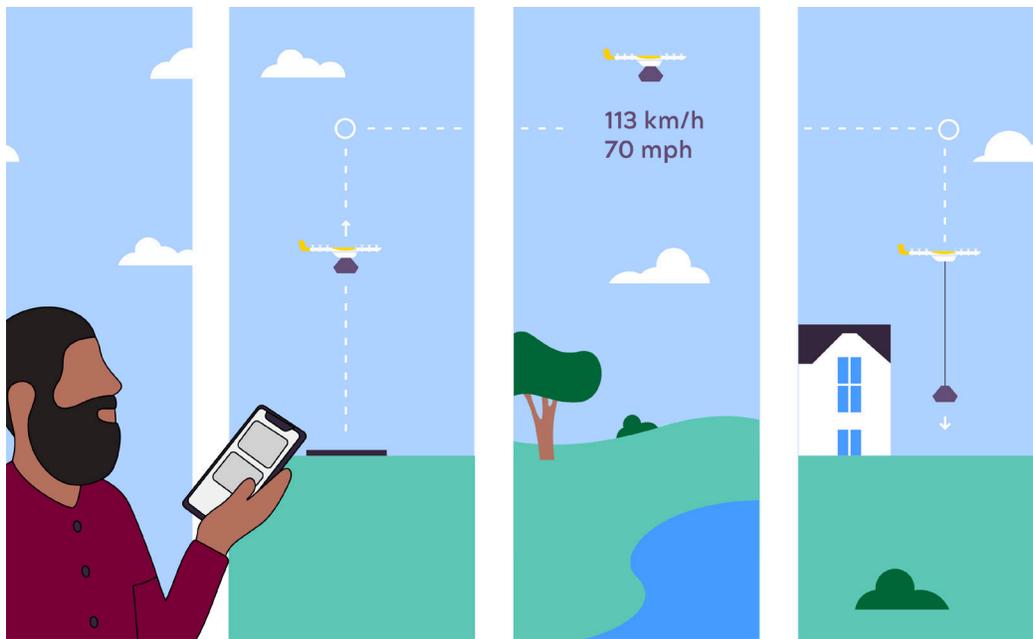


Figure 2. Each drone delivery is initiated when a user places an order through Wing's app. After the package is loaded at Wing's operations center, the drone flies autonomously to a predetermined drop-off site at the user's address and lowers the package to the ground. Customers must be home to receive their deliveries.

Wing launched the trial in collaboration with the Virginia Tech Mid-Atlantic Aviation Partnership (MAAP), an FAA-designated UAS test site that has worked with Wing on drone integration research projects since 2016. MAAP's research and testing supported Wing's application for Air Carrier certification from the FAA, which they received in April 2019 — the first drone company to earn the certificate, which allows commercial deliveries of goods on demand. The Christiansburg trial launched in October of that year. All this work unfolded under the UAS Integration Pilot Program (IPP), a federal drone-integration initiative that brought together state agencies, local governments, and companies to collaboratively develop strategies for expediting the rollout of UAS applications with significant benefits to communities. (The ongoing trial now falls under the umbrella of BEYOND, the successor program to the IPP.)

One of the central goals of the IPP was to understand community sentiment around the introduction of drone technology, understood by the FAA to be a key element guiding UAS integration from both commercial and regulatory perspectives. For this reason, community outreach was a major component of MAAP's work under the IPP, particularly for Wing's package delivery trial. Wing and MAAP conducted several months of outreach to local stakeholders and the general public prior to the launch of the service, which provided the opportunity to familiarize the community with the technology and understand and respond to any concerns.

However, because these outreach activities necessarily occurred prior to the launch of service, the community's feedback reflected speculation about what the service would be like rather than firsthand experience. Conducting a survey after the service had been operational for some time provided a unique opportunity to quantitatively assess public sentiment around drone delivery in a community that had actually experienced it.

Survey design and content

The research team comprised representatives from MAAP and an assistant professor in the Department of Science, Technology, and Society who is an expert on human responses to technological change. The primary goal of the survey was to capture public perceptions of drone delivery in this unique sample group without introducing potential bias. To identify possible correlations between sentiment about drone delivery and factors such as education, income, family composition, and general attitude towards technology, the survey began with a standard array of demographic questions and one psychographic question about adoption of new technology. These were followed by questions that asked respondents to rank their sentiment towards the idea of drone delivery and how likely they were to use it on Likert-type scales (e.g. like a great deal / like a moderate amount / *etc.*). In order to avoid priming respondents by suggesting specific positive or negative attributes of drone delivery, the survey instead posed the open qualitative questions, “What are the positive parts of drone delivery in your opinion?” and “What are the negative parts of drone delivery in your opinion?”

The survey also asked respondents if they were familiar with Wing’s service; if so, how they had heard about it (e.g. from a friend, in the media, interacting with Wing staff at an outreach event); and if their opinion of drone delivery in general had changed after learning about Wing. Answers to these questions will probe the influence of familiarity on sentiment in more detail and provide insights on outreach methods.

The survey was administered in the fall of 2020, well into the COVID-19 pandemic. This unique set of circumstances might be expected to increase the appeal of services that provided access to goods without human contact; accordingly, one survey question asked how and whether the pandemic had shaped the respondent’s perception of drone delivery.

Feedback received from the Christiansburg community during outreach events reinforced the observation that opinions about drone delivery are often influenced by opinions about other, more well-established uses for drones, in particular military and hobbyist applications. For this reason, the survey asked if respondents perceived delivery drones more positively or more negatively than drones for other purposes. (This question was deliberately placed at the end of the survey to avoid influencing responses to other survey questions.)

The survey content and data management plan were reviewed and approved by the Virginia Tech Institutional Review Board (IRB # 20-678). Funding for survey distribution was provided by Wing through an existing research contract with MAAP. Respondents were recruited (1) via a mailer sent to 13,774 households in Christiansburg the week of November 18 and again the week of November 25 and (2) via a geo-targeted Facebook ad which ran November 19 - 30. Virginia Tech invited survey respondents to participate in a drawing for small (\$25 - \$50) gift cards to local businesses. Eligibility was not contingent on responses to survey questions, and contact information collected for participation in the drawing was not connected in any way to an individual’s responses.

Primary Findings

The survey received 834 responses; 821 were considered suitable for inclusion in analysis. One response was excluded because the respondent was not over 18, and 12 were excluded because respondents lived outside of the target geographical area, restricted for simplicity to Montgomery County (most county residents are likely to do some of their shopping in Christiansburg, where the region’s major national retailers are located). Survey data was reviewed by two Virginia Tech statisticians for validity and precision. For all the values reported in this section, a 95% confidence interval bounds values no more than five percentage points in either direction from the stated value. (See Appendix for complete tables, including confidence intervals.)

Of 821 included respondents, 87% reported positive sentiments about the idea of drone delivery. The specific sentiment with the highest percentage of responses was “like a great deal” (53%) followed by “like a moderate amount” (26%) and “like a little” (8%). Only 7% reported negative sentiment across three categories of dislike (“dislike a great deal”; “dislike a moderate amount”; and “dislike a little”). Six percent of respondents reported neutral sentiments.

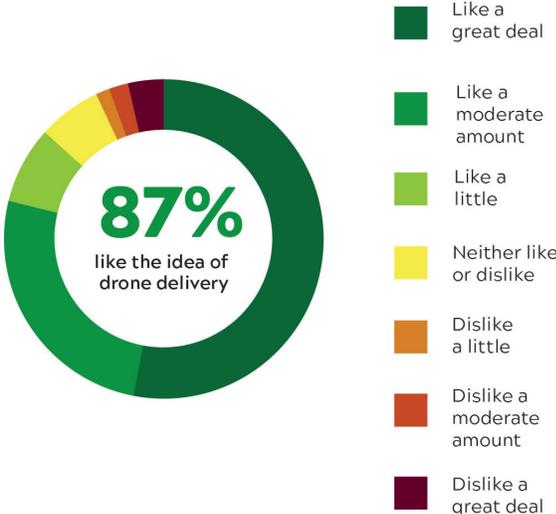


Figure 3. Respondents were asked to rate how much they liked the idea of drone delivery on a scale that included seven categories from “dislike a great deal” to “like a great deal.”

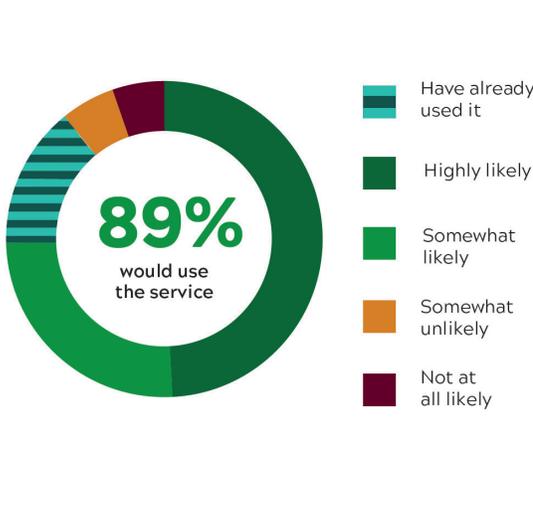


Figure 4. Respondents were asked how likely they were to use drone delivery if it were available to them. (Not all Christiansburg residents live within Wing’s delivery radius.) “I have already used it” was offered as an option, to distinguish current users (teal/green stripes) from the remainder of the group.

Of 821 included respondents, 89% had either already used the service or reported that they were likely to if it were available to them. The remaining 11% were evenly split between “somewhat unlikely” and “not at all likely.”

Responses to the qualitative question addressing the positive aspects of drone delivery largely focused on speed and convenience, with some respondents citing specific advantages for older adults, individuals with mobility challenges, or families with children. Other common responses included environmental benefits, reduced traffic, and contact-free delivery in the context of the COVID-19 pandemic.

In the set of responses addressing the negative aspects of drone delivery, noise was cited most frequently. Other common concerns were privacy, service limitations (e.g. delivery radius, package weight, item selection, and weather restrictions), potential job loss, impersonality in commerce, safety concerns (particularly with respect to other aircraft), and risk for delivery errors.

The majority of respondents (58%) reported that the COVID-19 pandemic had improved their opinion about drone delivery. Only 1% reported that their opinion had changed in a negative direction; 41% reported that the pandemic had not changed their opinion about drone delivery.

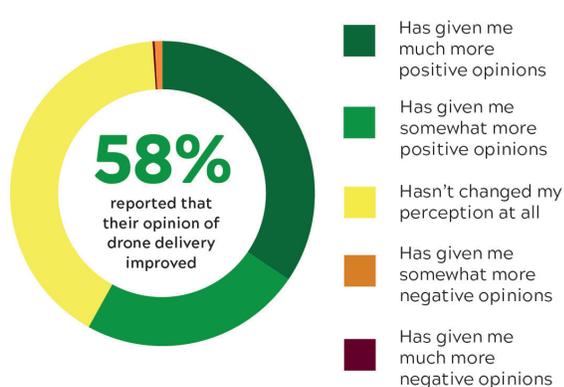


Figure 5. Respondents were asked how the COVID-19 pandemic had changed their perceptions of delivery drones.

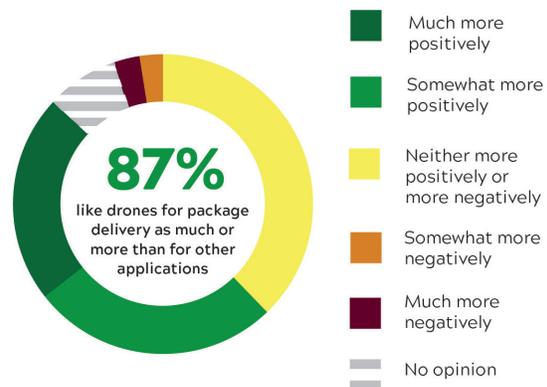


Figure 6. Respondents were asked if they perceived delivery drones more positively or more negatively than drones for other purposes. No purposes were specified in the question.

Regarding the appeal of drones used for package delivery versus other applications, 49% of respondents reported liking the idea of drones used for package delivery more than drones used for other purposes; 38% of respondents were neutral. Only 5% reported viewing delivery drones more negatively than drones used for other purposes (the remainder selected “no opinion”).

More detailed analysis, including correlations between demographic and psychographic factors and sentiment, will be forthcoming in later publications.

Discussion

Previous surveys^{2,3} conducted in the U.S. have found support for drone delivery hovering around 50%; support is lower in Europe and the U.K.^{4,5}, and delivery is a relatively unpopular application for drones when ranked against others. However, these surveys polled individuals who were almost certainly speculating about a technology they had not actually experienced. In Christiansburg, where drone delivery is an everyday reality for some residents and a familiar idea for many others, positive sentiment as measured by this survey was 87%. Similarly high percentages reported being likely to use the service, and feeling at least as positively about drone delivery as for other applications. These remarkably positive results suggest that sentiment towards drone delivery may be generally higher in communities that have experienced it. In fact, a long tradition of studies of innovation suggests that familiarity increases positive sentiment generally.⁶ Future research should interrogate this more specifically by surveying populations before and after a service launch.

It is important to note, however, that while a sample group uniquely familiar with drone delivery was a primary distinguishing feature of this survey, other major factors may be relevant. A high percentage of the survey respondents reported being generally receptive to new technology, which might be expected to include drone delivery. In addition, Christiansburg's proximity to Virginia Tech, a large university with a strong engineering program, may contribute to positive sentiment in two ways. First, the presence of the university boosts the average level of educational attainment in the population, a factor consistently correlated with early adoption of new technologies. (Among survey respondents, about 62% reported having a bachelor's degree or higher, in contrast to about 33% in the general U.S. population.⁷) Demographic data did not indicate a relationship between degree attainment and sentiment within this population; nevertheless, the university may have a more generalized effect. A significant fraction of Christiansburg residents are affiliated with Virginia Tech in some way: They are alumni or employees, have family members who fall into those categories, or follow the school's popular football team. The community may, therefore, have been



² "How Americans view drone safety and privacy." The Hawthorn Group, November 2019.

³ "Autonomous Delivery Systems: Consumer Awareness & Favorability Study." Consumer Technology Association, May 2020.

⁴ "Public Perceptions: Drones." Institution of Mechanical Engineers, 2019. (United Kingdom)

⁵ "Traffic solution or technical hype: Representative population survey on delivery drones and air taxis in Germany." Sky Limits, 2020.

⁶ Rogers, Everett. *Diffusion of Innovations*. Simon and Schuster, 1962.

⁷ "Educational Attainment in the United States: 2019." U.S. Census Bureau, Current Population Survey Annual Social and Economic Supplement.

predisposed to feel favorably about the drone delivery program because of its association with the university — highly visible since 2016, when Wing conducted their first public U.S. tests at Virginia Tech, and reinforced by the joint outreach program.

Second, the research team deliberately designed the flow and content of survey questions to avoid creating either positive or negative associations. Other recent surveys on this topic have asked questions with a strongly negative inherent bias. For example, one U.S. survey asked respondents how strongly they agreed with the statement “Commercial drones used for small scale and cargo deliveries will cause a serious accident sooner or later,” whether they thought using drones for neighborhood deliveries was “too dangerous,” and asked them to rank how concerned they were about safety²; a German study asked if respondents agreed that “drones should not be put to use for parcel deliveries at all as a matter of principle⁵. Several surveys have explicitly asked about specific concerns including privacy, national security, injuries to people and property, and disruption to air travel^{4,5}. While all of these concerns appeared in responses to the question “What are the negative parts of drone delivery in your opinion,” giving respondents the opportunity to offer their own answers, rather than priming responses by suggesting risks, may allow for a more accurate reflection of sentiment.

Conclusive findings on the effect of survey construction and content on reported sentiment is beyond the scope of this work. However, it is worth considering whether the deliberate neutrality of this survey may have contributed to more positive — and potentially more representative — reported sentiment. These issues should be considered in the development of future surveys on this topic.

Beyond implications for survey design, this research also contains suggestive findings for best practices around public outreach. Notably, when asked to select all the ways in which they had been exposed to the service, only 16% of respondents reported receiving a drone delivery and 16% reported interacting with Wing staff at outreach events. However, 77% reported having heard about the service through the media — by far the largest category. This underscores the importance



of conducting broad education and awareness campaigns that utilize a range of different channels, including local media. The qualitative responses about perceived positive and negative aspects of drone delivery are also a rich source of insight for future outreach efforts, indicating a community's potential needs and concerns and informing the development of effective messaging.

The COVID-19 pandemic sparked an increase in Wing's order numbers and new customer sign-ups. The company partnered with new local merchants, which expanded the options available to their customers and provided businesses with a valuable way to continue to earn revenue. Working with a local librarian, they began delivering books from the school library system. Anecdotal reports suggested that the community appreciated the availability of no-contact deliveries, access to some of their favorite foods, and the boost for local businesses. This hypothesis was borne out by the majority (58%) of respondents who indicated that their opinion of drone delivery had improved since the pandemic, as well as by the many responses to the open-ended question about benefits of drone delivery that referenced the pandemic, such as "contact free," "not having to go out for small items during covid [sic]," and "Hands off especially no contact in the midst of the pandemic." (Note that the question about the pandemic appeared later in the survey than this open-ended question, and could not have prompted COVID-related answers; these associations were offered spontaneously.) These results differ somewhat from those of another 2020 survey³, in which only 26% of respondents reported that their opinion of drone delivery had improved following the pandemic; 60% reported no change, and 14% reported that their opinion had deteriorated. The larger jump in positive opinion in the Christiansburg survey may be related to the respondents' observations — or direct experience of — of ways the technology had mitigated the impacts of the pandemic in their own communities.

Conclusion

This Virginia Tech survey provides the first known measure of public sentiment towards drone delivery in which the survey population was familiar with the service in their own community and, in some cases, had actually used it themselves. This offered a unique opportunity to estimate potential public response to a technology still in the nascent stages of commercial rollout but likely to become more widespread over the next five to ten years. In the survey, 87% of respondents reported positive overall sentiment, a similar number reported that they had already used the service or were likely to, and a large percentage reported feeling more positively about the use of drones for package delivery than for other applications. These results are all significantly more favorable than other recent studies on the same topic but whose survey populations had no firsthand experience. In addition to being a promising sign for the future of drone delivery in the U.S., the nature of these results has useful implications both for survey design and outreach strategies. Those insights, in addition to the primary survey outcomes, have the potential to shape the rollout of drone services by facilitating more accurate research and more effective public engagement — all of which will provide invaluable guidance for policymakers, communities, and governments as they work together to advance safe UAS integration to the benefit of the public.

Appendix

Table I. General sentiment towards drone delivery

Question: Please tell us how much you like the idea of drone delivery on the following scale.

| Response | Count | Probability | Lower confidence interval (CI) | Upper confidence interval (CI) | 1-Alpha |
|----------------------------------|------------|-------------|--------------------------------|--------------------------------|---------|
| <i>Like a great deal</i> | 436 | 0.53106 | 0.496859 | 0.564971 | 0.950 |
| <i>Like a moderate amount</i> | 213 | 0.25944 | 0.230626 | 0.290494 | 0.950 |
| <i>Like a little</i> | 63 | 0.07674 | 0.060436 | 0.096978 | 0.950 |
| <i>Neither like nor dislike</i> | 53 | 0.06456 | 0.049691 | 0.083476 | 0.950 |
| <i>Dislike a little</i> | 12 | 0.01462 | 0.008381 | 0.025373 | 0.950 |
| <i>Dislike a moderate amount</i> | 15 | 0.01827 | 0.011103 | 0.029925 | 0.950 |
| <i>Dislike a great deal</i> | 29 | 0.03532 | 0.024705 | 0.050269 | 0.950 |
| Total | 821 | | | | |

Table II. Likelihood of using the service

Question: If it was available to you, how likely are you to use a drone delivery service?

| Response | Count | Probability | Lower CI | Upper CI | 1-Alpha |
|--------------------------------|------------|-------------|----------|----------|---------|
| <i>I have already used it.</i> | 119 | 0.14495 | 0.122517 | 0.17068 | 0.950 |
| <i>Highly likely</i> | 405 | 0.49330 | 0.459213 | 0.527451 | 0.950 |
| <i>Somewhat likely</i> | 209 | 0.25457 | 0.22596 | 0.285461 | 0.950 |
| <i>Somewhat unlikely</i> | 43 | 0.05238 | 0.039114 | 0.069806 | 0.950 |
| <i>Not at all likely</i> | 45 | 0.05481 | 0.041214 | 0.072555 | 0.950 |
| Total | 821 | | | | |

Table III. Effect of the pandemic on sentiment

Question: How has the COVID-19 pandemic changed your perception of delivery drones?

| Response | Count | Probability | Lower CI | Upper CI | 1-Alpha |
|---|------------|-------------|----------|----------|---------|
| <i>It hasn't changed my perception at all.</i> | 283 | 0.34470 | 0.312983 | 0.377867 | 0.950 |
| <i>It has given me much more positive opinions about drone delivery.</i> | 194 | 0.23630 | 0.208509 | 0.266542 | 0.950 |
| <i>It has given me somewhat more positive opinions on drone delivery.</i> | 336 | 0.40926 | 0.376122 | 0.443238 | 0.950 |
| <i>It has given me somewhat more negative opinions on drone delivery.</i> | 2 | 0.00244 | 0.000668 | 0.008838 | 0.950 |
| <i>It has given me much more negative opinions on drone delivery.</i> | 6 | 0.00731 | 0.003354 | 0.01582 | 0.950 |
| Total | 821 | | | | |

Table IV. Delivery versus other applications

Question: Do you perceive delivery drones more positively or more negatively than drones used for other purposes?

| Response | Count | Probability | Lower CI | Upper CI | 1-Alpha |
|--|------------|-------------|----------|----------|---------|
| <i>I view delivery drones much more positively than drones for other purposes.</i> | 219 | 0.26675 | 0.237633 | 0.298035 | 0.950 |
| <i>I view delivery drones somewhat more positively than drones for other purposes.</i> | 186 | 0.22655 | 0.199231 | 0.256422 | 0.950 |
| <i>I view delivery drones neither more positively or more negatively than drones for other purposes.</i> | 311 | 0.37881 | 0.346462 | 0.41248 | 0.950 |
| <i>I view delivery drones somewhat more negatively than drones for other purposes.</i> | 20 | 0.02436 | 0.015824 | 0.037327 | 0.950 |
| <i>I view delivery drones much more negatively than drones for other purposes.</i> | 23 | 0.02801 | 0.018739 | 0.041686 | 0.950 |
| <i>I have no opinion about this distinction.</i> | 62 | 0.07552 | 0.59355 | 0.095634 | 0.950 |
| Total | 821 | | | | |