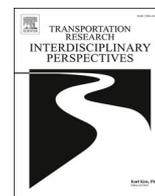


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Surveying aircraft operators about aviation safety in Alaska: Survey Development, Design, Methodology, and Administration

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ABSTRACT

The state of Alaska has a high rate of aircraft-related fatalities, injuries, and illnesses; to better understand this phenomenon, the Alaska Aviation Operators Survey was developed and administered. The goal of this research was to update the results of a previous study with the safety attitudes and opinions of aviation industry workers. Overall, research findings were limited by a low response rate (14.3% overall, 17.1% adjusted), reducing representativeness and generalizability. A thematic analysis of survey follow-up phone call conversations revealed that 89% of respondents' reactions to the survey were comprised of themes reflecting attitude, call issues, and logistics. This report focuses on detailing the development of the survey, including the design, methodology, and administration. Surveys are becoming an increasingly difficult way to gather data; understanding research methodologies that are declining in success in the aviation industry is essential to moving forward with new research techniques in the future.

Introduction and background

Flying in Alaska is as much a part of daily life as it is a part of tourism. With 82 % of Alaska communities not accessible by a road system, air transport is required for year-round travel between populated areas; medivacs; and mail, goods, and services delivery (Alaska Department of Transportation and Public Facilities [DOT], n.d.). Most of these communities are rural (in Alaska, this is referred to as "The Bush") and not serviced by sophisticated infrastructure (Federal Aviation Administration [FAA], 2021). This necessity for air transport, in addition to extreme weather, complicated terrain, and lack of infrastructure, makes flying in Alaska particularly hazardous (FAA, 2021).

"Bush pilot syndrome" – described as a pilot's willingness to fly into unfavorable conditions – is often ascribed to pilots who fly in Alaska, and is seemingly accepted as a standard part of the work. Thomas et al., found that Alaska crashes due to controlled flight into terrain were attributed to pilot error, including the decision to continue flights from conditions of good weather into poor weather (2000). Paired with outside and organizational pressures to fly, unsafe attitudes regarding flight risk arguably exist among Alaska bush pilots (National

Transportation Safety Board [NTSB], 1980; Bearman, Paletz, Orasanu, & Brooks, 2009). From 2008 to 2017, the total accident rate in Alaska was 2.4 times higher than for the rest of the United States; the fatal accident rate in the state was 1.3 times higher. (NTSB, 2020).

FAA interventions are continually being implemented to reduce the burden of aircraft-related fatalities in Alaska. Interventions include, for example, placement of weather cameras, implementation of automatic dependent surveillance – broadcast (ADS-B) technology, operation of flight information services-broadcast (FIS-B) products, changes in air traffic communication policies, infrastructure improvements, and workgroup facilitation to improve operations safety management. Although Alaska's per capita rate of fatal aircraft accidents remains high when compared to the United States as a whole, the rate has been gradually decreasing over time as additional safety interventions have been adopted (Mode, O'Connor, Conway, & Hill, 2012). This decrease has promoted complementary interest in Alaska's non-fatal aircraft-related occupational accident and injury rates (Case et al., 2018; Moller et al., 2020).

As of 2019, overall occupational injury incidence rates in Alaska were 44 percent higher than the United States as a whole (Department of

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Labor and Workforce Development [DOL, 2021]. The 2020 incidence rates of non-fatal occupational injuries and illnesses for Alaskans are higher than for all U.S. workers in 10 out of 13 reported industry sectors (DOL, 2021a), including the transportation and warehousing industry, which accounted for 4.2 occupational injuries and illnesses per 100 full-time workers (DOL, n.d.). When air transportation injuries and illnesses are extracted from the industry as a whole, this number jumps to 5.6 non-fatal injuries and illnesses per 100 full-time employees (DOL, n.d.a). The multifactorial risks associated with Alaska aviation must be addressed in overall safety culture and behavior among companies and pilots flying in Alaska in order to continue to reduce these high rates of accidents and injuries.

To better understand aviation worker attitudes and practices around these risks in Alaska, the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) contracted with the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage to design and administer five statewide aviation safety surveys in Alaska—one for operators and four for other aviation workers, namely: pilots, maintenance workers and mechanics, customer service representatives, and ramp, baggage, cargo, and dock (RBCD) agents. All surveys were designed to address Alaska aviation experiences, occupational injuries, and other safety-related topics.

The project was intended to update results from a previous study conducted by ISER in 2001–2002 (Conway et al., 2004) and allow comparison of results from the previous study. The operator surveys were designed to collect information about the company and solicit contact information for employees to survey these workers separately. A low response rate for the operator survey made the administration of the additional worker surveys impossible and precluded the researchers from direct comparisons with the previous survey.

The following is a procedural report that summarizes the operator survey design, development, administration, response collection process, and thematic analysis of the follow-up call log. The report outlines the challenges and barriers that likely contributed to the low response rate and provides recommendations for future research design in similar settings. This information is being presented to enhance understanding of the benefits and challenges in administration of a survey among aviation operators that serve rural areas, and to discuss possible alternatives amid broadly declining survey response rates (Sheehan, 2006).

Methods

Questionnaire development

The 2022 Alaska Aviation Operator questionnaire was based on the survey instrument administered between 2001 and 2002 as part of the Air Transportation Safety Among Air Carrier Operators and Pilots in Alaska study (Conway et al., 2004). When possible, questions from the 2001 and 2002 instrument were used verbatim. Operators were asked for information about company operations, workplace injuries and illnesses, and their ideas to improve aviation worker safety. Additionally, operators were asked to provide the names and contact information for their employees (pilots, mechanics and maintenance personnel, RBCD agents, and customer service agents) to survey these employees directly.

The questionnaire was designed to collect information from aviation company operators holding Part 135 certificates. These certificates are issued in accordance with regulations found in Title 14 of the Code of Federal Regulations Part 135 certification for commuter and on-demand operations (FAA, n.d.). These certificate holders are responsible for scheduled and non-scheduled (on-demand or air taxi) flights that make up the distribution system moving passengers, freight, and mail from transportation hubs to smaller communities, transporting tourists on flightseeing excursions, and evacuating patients due to medical emergencies in Alaska.

ISER and NIOSH researchers worked collaboratively to develop the questionnaires for operators and their employees. The draft versions of

the questionnaires were disseminated by NIOSH for peer review and pretesting by experts in the aviation field who were not part of the sample population. Research Triangle Institute International was contracted to conduct a thorough expert appraisal of the draft questionnaires and to identify issues that could potentially affect the comprehension and usability of the questions and the quality of resulting data. That review systematically evaluated the questionnaires' clarity, specificity, question ordering, potential sources of bias, response categories, and other possible complications. Pretesting feedback and Research Triangle Institute feedback were incorporated in the final versions of the questionnaires.

The 2022 Alaska Aviation Operator questionnaire was developed as an online survey using Qualtrics survey software, which screened and separated respondents based on whether operators held a specific Part 135 single pilot operator certificate. If operators indicated they did hold the Part 135 single pilot certificate, they were directed to the single pilot operator (SPO) portion of the questionnaire. If operators reported they currently employed more than one pilot or that they employed one pilot but did not hold a Part 135 single pilot operator certificate, they were directed to the portion of the questionnaire meant for Part 135 operators who did not hold a Part 135 single pilot operator certificate (NSPO).

The SPO portion of the questionnaire contained 66 numbered questions and the NSPO portion contained 45 numbered questions. The additional questions asked of SPOs collected information on their roles as pilots as well as operators. Several questions consisted of multiple parts. Skip and display logic were used throughout the questionnaire to direct respondents to the appropriate questions. Questions displayed depended upon answers to previous questions, so not all operators were asked every question. The surveys were estimated to take 25 min to complete.

Survey population and sample frame

In fall 2021, the NIOSH project officer obtained a dataset of operators holding Part 135 certificates from the Anchorage FAA office. The dataset included operator names, mailing addresses, email addresses, and the name of the Flight Standards District Offices (FSDOs) responsible for regulatory oversight of the operator. FSDOs are located in Anchorage, Juneau, and Fairbanks.

Some operators in the dataset no longer held certificates or the certificate holders were deceased. Clarification was provided through contact with the FAA, former certificate holder or business owner, and through media reports such as sales or closing of aviation businesses. When contact information was missing, researchers searched company websites, social media, and the Alaska Business License Database and made phone calls to operators with listed phone numbers. This process identified 314 operators holding Part 135 certificates with available contact information. 7 operators were excluded from the cleaned dataset: 5 operation owners were deceased, 1 business closed in 2019, and 1 certificate was surrendered. This produced the final sample frame of 307 operators (see Fig. 1).

Survey administration

Recruitment

The unit of analysis was an operator holding a Part 135 certificate. The recruitment materials were personalized by using the business name associated with the Part 135 certificate and an individual contact person representing the business (e.g., owner/operator, director of operations). When neither the name of the business nor the name listed under 'doing business as' (DBA) on the FAA's list or the business license was available, a recruitment letter was created with the contact individual's first and last name. A unique survey link was created in Qualtrics survey software for each operator.

Of the 307 operators included in the final survey sample, the primary means of survey distribution was via Qualtrics email distribution;



Fig. 1. Survey Population and Sample Frame. Flow chart describing the total possible survey population, exclusions, and final survey sample.

however, not all operators had email addresses available. Three recruitment panels were created to appropriately direct recruitment materials to the operators. The recruitment panels separated operators as follows (see Fig. 2):

- 1) Operators without an email address were sent via U.S. mail (n = 6).
- 2) Operators with an email address who did not have a DBA or business name listed. The first and last name of the contact was used in the recruitment materials. Recruitment materials were sent via email (n = 7).
- 3) Operators with an email address who held one or more DBA or business name. Recruitment materials were sent via the email address associated with each unique DBA or business name (n = 294).

Survey launch & reminders

Operators who had an email address (n = 301) were emailed the

recruitment materials on March 30, 2022. Operators who received recruitment materials via email and had not yet responded to the survey received a reminder email at the end of week two. A final reminder email was sent to non-respondents at the end of week five. Operators without an email address (n = 6) were mailed the recruitment materials on March 30, 2022, and those who had not yet responded to the survey received a reminder at the end of week one. A final reminder was sent to non-respondents at the end of week four.

Email bounce backs

Email bounce backs occurred when emailed survey invites failed to send due to the email address being incorrectly entered or invalid. These were corrected within the first three days of the survey launch. For email bounce backs (n = 23), ISER researchers first attempted to send the recruitment materials to a listed alternate email address if available (n = 10). If no alternate email address was available, ISER researchers called the operators at the phone number listed in the database to obtain a valid email from them, and recruitment materials were resent (n = 7). Operators were mailed the recruitment materials if they were unreachable through email or phone call follow-up (n = 6).

Telephone calls

Telephone follow-up with non-respondents was initiated on April 18, 2022, during the third week of survey administration. A telephone follow-up script and standardized procedure were used by ISER researchers during all calls. ISER researchers maintained a call log recording the date and time of the call, the call disposition or outcome, and descriptive notes to assist with future call backs.

Operators with a working phone number who had not completed the survey before the call period received at least one phone call. The first group called were operators who had not started the questionnaire. The next calls were made to operators who had clicked the survey link but not yet started the questionnaire, and then operators who had started but not yet completed the questionnaire.

If operators had not completed the survey after the first phone call, they received a second phone call. Operators with whom ISER researchers had not made direct contact (e.g., line busy, left messages, spoke with someone else), and had not completed the survey, were called a third time, and a fourth time if contact with the operator or a representative was not made during the third call. Each round of phone calls was spaced by one week. When warranted during data cleaning, ISER researchers made additional calls to ask operators clarifying questions about ownership and use of their Part 135 certificate (e.g., if

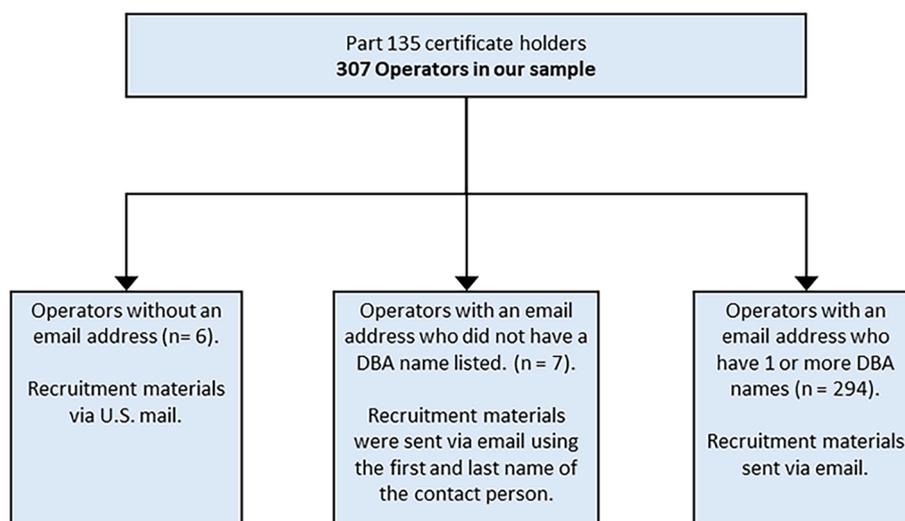


Fig. 2. Recruitment Process. Flow chart describing the three different methods used to send out initial recruitment materials. These methods were additionally used to send participation reminders.

still active, if used across multiple DBAs). Operators who had completed or opted out of the survey, or were found to be out of business for any reason before the call date, were not called. If operators hung up on the researcher, it was considered a hard refusal.

After all operators had been called once, ISER researchers identified operators with non-working numbers or numbers with a constant busy signal. ISER researchers searched for alternate phone numbers associated with the business or identified an individual contact person using internet searches (via Google, Facebook business pages, etc.). Using the newly identified contact information, these operators were called, and contact information was updated based on the success of these calls.

For operators ISER researchers were unable to reach (line constantly busy, wrong number, etc.), the State of Alaska Department of Commerce, Community, and Economic Development (DCCED), Division of Corporations, Business and Professional Licensing database was used to determine if operators had an active business license. The DCCED maintains an online searchable database of licenses on their website. The database was searched to determine the status of business licenses for operators who ISER researchers were unable to reach. ISER researchers identified the following business license statuses for operators: Involuntarily Dissolved, License/Name Expired, and License Revoked. If a business was determined to be inactive for any reason, they were removed from the sample population and no longer called (n = 24).

Messages were not left during this first round of phone calls. If the operator did not answer when called a second time, ISER researchers used a voicemail script and left voicemails or messages with operator representatives during the second call. During the second or subsequent calls, if an operator’s representative volunteered information about a person that may be more appropriate or more available to speak (safety manager, co-owner, operations manager, chief pilot, etc.), ISER researchers would attempt to contact the suggested respondent. Contact information was updated in the call log.

Results

Out of the 307 operators contacted, 44 responded to the survey (36 completed surveys, eight partially completed [i.e., <100 % but > 50 %]). Response rates (RRs) were calculated using an adjusted survey population based on business status changes discovered after implementation of the survey and outcomes from phone calls. In accordance with information found in the DCCED business license database searches and other information, the following dispositions were removed from the RR calculation: involuntarily dissolved, license revoked, license/name expired, non-working/wrong number, operation inactive, and out of business. This resulted in an adjusted survey population of 258 operators. The total RR using the adjusted survey population was 17.1 % ([44 completed surveys/258 operators] × 100). See Table 1 for a complete itemization of dispositions.

When analyzed by FSDO area, the RRs for Anchorage and Fairbanks operators were similar with 15.98 % and 14.29 %, respectively; Juneau operators had a higher RR with 21.31 %.

Call log thematic analysis

To better understand potential contributing factors to the low survey RRs, researchers analyzed information recorded from the follow-up telephone calls. A thematic analysis was performed using the call log notes. Five substantive thematic categories were derived from this analysis: attitude about our survey, attitude in general, call issues, logistics, and structure of business.

Call log

ISER researchers maintained a call log and recorded information from each operator phone call. The call log was populated with each operator’s contact information, base of operations and associated FSDO, survey status, and call information. Call information included the call

Table 1
Operator Survey Dispositions.

Alaska Aviation Operator Survey Status	Count	Percentage
Total Operators	307	100 %
Complete	36	
Complete < 100 % but > 50 %	8	
TOTAL Surveys Completed	44	14.3 %
<i>Dispositions That Count Against the RR</i>		
Declined	20	
Refusal	192	
Respondent Away During the Survey	2	
TOTAL Surveys Not Completed	214	69.7 %
<i>Dispositions That Do Not Count Against the RR</i>		
Involuntarily Dissolved*	9	
License Revoked*	2	
License/Name Expired*	5	
Non-working Number/Wrong Number	19	
Business Inactive*	4	
Out of Business	10	
TOTAL Operators Not Included	49	16.0 %
TOTAL Adjusted Operator Survey Population	258	84.0 %

*DCCED Database Definitions.

date and time, disposition, and notes.

Call log dispositions were used as an organizational tool to prioritize and schedule follow-up calls, to aid researchers in determining what further action was needed, and to determine the final RR. Call notes were used to record the overall tone of the call, any pertinent information about business status, new link requests, new contact information, applicable respondent quotes regarding the survey, and ISER researcher actions during the phone call.

Thematic analysis

After the conclusion of the operator survey, Atlas.ti was used to code call log notes for analysis. Each note contained in the log was coded to group the qualitative data into quantifiable themes based on content from conversations with (or attempts to contact) respondents. Notes were detailed and often required more than one unique code per respondent. Every unique code used was co-coded with the respondent’s associated FSDO area to allow for stratification by FSDO. Overall, 48 different codes were established.

Each of the 48 codes were grouped and classified based on the overall theme of the call. To ensure reliability of these themes, the data were grouped and coded by three researchers, independently. When coding was completed, researchers compared classifications of the data and discussed until a coding consensus was reached. Six main themes resulted from the coding consensus. For clarity in analysis, sub-themes were agreed upon as appropriate. The agreed upon themes and sub-themes used to analyze the data include:

1. Attitude about our survey
2. Attitude in general
3. Call issues
 - a. Calls
 - b. Mail
4. Logistics
 - a. Clarify business structure
 - b. Contact information – new link
 - c. Contact information issues
5. Structure of business
6. Region

Thematic analysis results

The organizational code categories for the region theme are excluded. By broad theme, call codes were roughly distributed as follows: 18 % under “attitude about our survey,” 12 % under “attitude in general,” 30 % under “call issues,” 29 % under “logistics,” and 11 % under “structure of business.” A comprehensive breakdown of the

distribution of codes by theme is provided in Table 2.

Within each theme, several code categories stand out as widely shared call experiences. The top code categories in the “attitude about our survey” theme include “respondent willing to look at survey,” “respondent saw 1st invite email but has not started survey,” and “thinks

Table 2
Code Categories, Code Counts, and Code Percentages by Theme.

Theme Group	Code Categories	Code Count	% by Theme	
Attitude about Our Survey	Willing to look at survey	127	58.0 %	
	Saw 1st invite email but has not started survey	33	15.1 %	
	Thinks SPO info not important	15	6.8 %	
	Owner/Operator/Life Partner/Office Manager will ask employee to fill out survey	12	5.5 %	
	Didn't like the survey questions	6	2.7 %	
	Safety is a personal responsibility	5	2.3 %	
	Too many/too difficult questions	4	1.8 %	
	Concerned results will cause increased regulations	4	1.8 %	
	Interested in results of study	4	1.8 %	
	Started survey, but haven't finished	3	1.4 %	
	Wanted a link to send to employees	3	1.4 %	
	Thanked us for creating the survey	1	0.5 %	
	Saw mailed survey, but did not want to take it	1	0.5 %	
	Team is persistent	1	0.5 %	
	<i>Category Total</i>	219	100 %	
Attitude in General	Too busy	70	46.4 %	
	Not interested	32	21.2 %	
	Hung up after researcher introduction	19	12.6 %	
	Deleted email invite	10	6.6 %	
	Too much federal oversight/involvement	9	6.0 %	
	Asked to fill out too many surveys	8	5.3 %	
	FAA needs more training	3	2.0 %	
	<i>Category Total</i>	151	100 %	
	Call Issues	No answer	139	38.0 %
		Left message	114	31.1 %
Line busy		53	14.5 %	
Non-working Number		37	10.1 %	
Wrong number		15	4.1 %	
Bad connection		6	1.6 %	
Mail survey		2	0.5 %	
<i>Category Total</i>		366	100 %	
Logistics				
Logistics-Contact Information – New Link		Asked for 2nd link	143	40.3 %
		Didn't see 1st email invite	82	23.1 %
Logistics-Contact Information Issues	Asked for link to be sent to email not on file	66	18.6 %	
	Asked for a 3rd link	8	2.3 %	
Logistics-Clarify Business Structure	Used listed alternate phone number to reach respondent	23	6.5 %	
	Used a 2nd alternate phone number to reach respondent	18	5.1 %	
	Used a 3rd alternate phone number to reach respondent	9	2.5 %	
	Used a 4th alternate phone number to reach respondent	3	0.8 %	
	Called to clarify business status/DBAs/Part 135 certs	3	0.8 %	
<i>Logistics Category Total</i>	355	100 %		
Structure of Business	Respondent not available to talk	72	51.4 %	
	Under new ownership	33	23.6 %	
	Not operational	9	6.4 %	
	Multiple DBAs	8	5.7 %	
	Office not yet open for season	8	5.7 %	
	Retired	5	3.6 %	
	Multiple Part 135 Certs	3	2.1 %	
	Company not in AK	2	1.4 %	
	<i>Category Total</i>	140	100 %	

SPO info not important.” These code categories suggest some interest among operators called to consider participation in the survey but relay some hesitancy as well. The top code categories within the “attitude in general” theme include “respondent too busy,” “not interested,” and “hung up after researcher introduction.” The code categories within this theme broadly suggest that prior to moving into a discussion of the survey, operators were reluctant to engage with the research.

Within the “call issues” theme, the most common code categories include “no answer” followed by “left message” and “line busy.” Within the logistics theme, the top code categories include “respondent asked for 2nd link,” “didn't see 1st email invite,” and “send link to email not on file.” The most common “structure of business” code categories include “respondent not available to talk” and “under new ownership.” Throughout each of these themes, common code categories indicate that there were logistical barriers to reaching prospective survey participants.

The thematic analysis of the call log provides additional insight about possible challenges to robust survey participation. One common respondent sentiment noted that the respondents were too busy or simply hung up on the researcher. Several respondents stated that they were busy getting ready for the upcoming season or were already busy in the current season. Some examples of these types of responses related to being too busy for the survey include:

- Respondent says he doesn't have time for all these surveys and hung up.
- Respondent stated he deleted the email and doesn't have time, he then hung up on me.
- Respondent states that they do not have time and the time they spent on the phone with me stopped them from doing other work.
- Respondent apologized for not finishing the survey yet, and stated that it is a very busy time to be starting additional paperwork. Respondent stated they would try and get into it and finish it.

Additionally, while many respondents noted being willing to look at the survey, a prominent subset of respondents cited reservations, remarking that they believe safety is a personal responsibility, they worry that the survey will lead to additional regulations, or they have issues with the survey questions. Examples of such responses include:

- Respondent doesn't care for how the results of surveys are often skewed/biased and don't actually measure what respondent intended when filling out the survey.
- Surveys like this usually lead to more regs and red-tape, people making these regs think they know more about business than operators do.
- Respondent said having experienced workers is the best way to reduce injuries and improve safety. Respondent said that fathers and mothers need to teach their kids about safety and let them get hurt so they can learn what not to do young instead of learning on the job the hard way.

The call logs indicate the possibility of logistical barriers to survey participation. The high number of respondents who had not seen the first email, requested follow-up links be sent, or asked for the link to be sent to a different email, suggests that the original survey email was not getting through to the potential survey participants. The high number of wrong numbers, non-working numbers, and number of businesses who were under new ownership further suggest a logistical challenge to reaching potential survey participants. Together, these responses indicate the immense challenge posed by the lack of up-to-date contact information.

Discussion

The aim of this study was to enhance understanding of aviation

safety attitudes and practices among aviation company operators in Alaska. Gaining insight into the attitudes and practices of workers in the industry is vital for adopting effective policies and practices to curb the high rates of aviation accidents and injuries in the state. Developing this body of knowledge, however, is becoming increasingly challenging. This research establishes an increasingly documented trend in low RRs and highlights that, even within a limited survey population, challenges such as unreliable and incomplete contact information, can make traditional survey practices inadequate.

Declining response rates

This study suffered from low RRs (Table 1). Notably, the RR is only about a quarter that of a similar study conducted about 20 years ago with the same target population (Conway et al., 2004). However, this low RR is not dissimilar to more current RRs among similar groups of target survey participants. Survey RRs have declined in the United States, and around the world. Regarding survey research in general, Sheehan (2006) reviewed literature published between 1986 and 2001 on studies using email surveys to collect data ($n = 31$) and found RRs have steadily declined, averaging 62 % in 1986, 52 % in 1996, and 24 % in 2000. Shih & Fan (2009) conducted a meta-analysis of 35 studies conducted between 1996 and 2006, and compared RRs in email and paper surveys. They found email surveys have lower RRs than mail surveys (33 % vs. 53 %, respectively). The Pew Research Center (Keeter et al., 2017) examined RRs to telephone surveys conducted between 1997 and 2016, and also found a substantial decline from an average of 36 % in 1996, to 21 % in 2006, before stabilizing at 9 % in 2012 through 2016.

While much of the literature seeks to understand ways to increase RRs using various techniques in survey design (e.g., number of questions, mobile-friendly electronic surveys) and distribution (e.g., incentives, pre-contacts, reminders), there is no definitive gold standard for an acceptable RR. RRs vary across fields and sectors of research, as well as methods of survey distribution and populations surveyed (Melahi & Harris, 2016).

The low RR created an additional challenge in this setting as a second phase of the survey relied on participation in the first phase of the survey. Specifically, researchers originally intended to conduct a second round of surveys with employees working in aviation (pilots, mechanics and maintenance personnel, RBCD agents, and customer service agents). It was not possible to conduct the secondary surveys. The initial operator survey included requests for the contact information of aviation employees in the company; however, operators failed to provide these details.

Out-of-Date administrative data

While several factors are believed to have contributed to the sub-optimal RR from Part 135 certificate holders, one hurdle that is well-documented in the call log is the inaccurate or out-of-date contact information for the survey sample population. In addition to the seven operators initially excluded (Fig. 1), 33 of the businesses were under new ownership, nine were no longer operational, and five were retired. Further, even for those who were operational, phone numbers and emails provided by the FAA were often obsolete. In the follow up calls to encourage survey participation, 37 phone numbers in the contact list were no longer working, and 15 were wrong numbers. Researchers devoted significant time to finding good phone numbers for operators and ultimately found 53 alternative phone numbers. Roughly a quarter of operators contacted by phone told the researchers that they had not seen the first email invite, and more than 20% of operators asked the researchers to send the survey link to a different email that was not on file. As the low RRs reflect, the lack of reliable contact information was a major hurdle for the research project. Ensuring up-to-date contact information will be invaluable for future research.

Operational pressures

An additional factor that likely contributed to the low RR was the operational pressure aviation operators were facing during that time. Many operators in Alaska experience seasonal peaks, or only operate seasonally, thus the number of people employed increases in summer months (DOL, 2012). Hiring and training of seasonal staff must take place prior to commencing summer operations.

Many operators were preparing for the first full season of business following disruption due to the Covid-19 pandemic and were engrossed in reviving their businesses and preparing for a release of pent-up demand. During the pandemic, most rural Alaskan communities had imposed a ban on non-essential travel (DOT, n.d.a) and the state experienced a near cessation of travel (DOL, 2022). The travel restrictions negatively affected the aviation industry and in April 2020, Alaska's largest Part 135 operator declared bankruptcy (Reorg Research, 2020), resulting in a 90% reduction in air service in the state (DOT, 2020). Existing operators were able to meet the air transportation needs of communities during the pandemic, but experienced higher demand for services after travel restrictions were eased.

Most major cruise ship operators canceled voyages from the northwest United States to Alaska during the Covid-19 pandemic due to a maritime law requirement to stop in Canada, which had banned cruise ships (Yeginsu, 2021). Public Law 117-14, passed on May 24, 2021 (Alaska Tourism Restoration Act, 2021), permitted cruise ships to transport passengers directly between ports in Washington and Alaska without stopping in Canada; this allowed an influx of passengers to southeast Alaska, many of whom booked flightseeing excursions.

While demand rose for air travel in Alaska, a diminished number of pilots, maintenance technicians, RBCD agents, and customer service agents put additional strain on the industry. By the end of 2021, the aviation worker count in non-scheduled operations remained at 9 % below the pre-pandemic level, except in Anchorage and southwest Alaska, where worker counts increased by over 25 % (DOL, 2022). Operators' priority on hiring and training workers plausibly took precedence over other tasks.

Conflicting survey requests

A survey overlap occurred during the rollout of the Alaska Aviation Operators Survey. The FAA uses an annual General Aviation and Air Taxi Activity (GAATA) survey to anticipate and meet demand for national airspace system facilities and services, assess the impact of regulatory changes on the fleet, and implement measures to assure the safe operation of all aircraft in the national airspace system (FAA, 2023). The surveys query general aviation and non-scheduled Part 135 aircraft owners, and are conducted annually by a contractor to the FAA. The GAATA data collection effort was initiated with emails sent February 8, 2022, and postcards mailed on February 11, 2022, inviting aircraft owners to complete the survey on the internet. Mailed questionnaires were sent on March 11, 2022 (FAA, 2023). The timing of the GAATA survey coincided with the researchers' survey, and though different objectives, originators, and formats were defined, respondents expressed confusion, redundancy, and duplication of efforts.

Strengths and recommendations for future research

The main strengths of this cross-sectional study were the protocol and survey questionnaire development. The survey was adapted to update previous survey questions for current practices and policies, to include injury and illness questions, and to gather opinions on safety, risk, and crash prevention. The thorough design can lead to a better understanding of SPO and NSPO groups and lead to targeted safety interventions.

This study was limited by a low RR, which prevented researchers from contacting aviation workers for further surveys. It is recommended

that future research considers data collection methods alternative to targeted online or written surveys when there is a potential for low RRs (such as with SPO and NSPO groups that serve rural areas with low infrastructure).

Focus groups are a qualitative data collection method, that involve group interviews with a small number of demographically similar people, used to gather information about their experiences and opinions. Focus group discussions allow for follow-up questions to responses, extraction of additional details, probing of specific experiences among occupational groups, and have the potential to yield a wealth of qualitative data. A smaller number of participants and collection of qualitative rather than quantitative data, should be considered in future studies where survey data collection methods may be constrained.

Crowdsourcing, or using a large, decentralized community of people to participate in online surveys with restrictions on industry, geographic location, or job titles, can be conducted using various platforms, such as Amazon's Mechanical Turk (MTurk), Clickworker, or Prolific. Allowing participation by social media users and advertising among targeted groups on social media platforms such as Facebook can also increase RRs. Crowdsourcing data is an option with the advantage of holding survey times open until the goal number of responses is reached, however, data quality errors and bias must be carefully controlled using these alternate populations for survey data collection.

Conclusion

With the projected increase in aviation operations (FAA, 2023a; International Civil Aviation Organization, n.d.) and cruise ship passengers in Alaska (DOL, 2023), and high demand for pilots and maintenance technicians (Boeing, 2022; Pilot Institute, 2022; Leval, 2022; Costanza et al., 2022; Lampert & Ganapavaram, 2022; Murray et al., 2023), prioritizing aviation safety will remain critical. Understanding operator and worker attitudes, experiences, perceived risks, and needs are key to developing interventions, trainings, and other tools to protect workers and passengers. The survey development, design, and methodology of this study are presented to augment awareness of the benefits and challenges in administration of a survey questionnaire among SPO and NSPO aviation operators that serve rural areas. Future studies are needed to assess aviation worker attitudes regarding injury and crash prevention, risk exposure, and safety culture; however, careful consideration to the data collection method is warranted.

CRedit authorship contribution statement

Ashley Kathryn Schroeder: Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis. **Mary Kopriva:** Writing – review & editing, Writing – original draft, Supervision, Project administration. **Ashley Hannigan:** Writing – review & editing, Data curation. **Jessica Passini:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Mary O'Connor:** Writing – review & editing, Writing – original draft, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Disclaimer

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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Appendices A and B. Supplementary data

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