INTERVIEWS OF GENERAL AVIATION PILOTS: AN INSIGHT TO AIRSPACE INFRINGEMENTS

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This paper finds contributory factors to airspace infringements concerning the planning undertaken by general aviation pilots. Twenty seven recreational pilots who flew a light fixed-wing motor, glider and ultralight aircraft were interviewed using semi-structured interviews in Finland, Norway and United Kingdom. These countries experienced a major problem with the number of reported AIs. Interview transcripts were analysed using thematic analysis. The success of this study is attributed to the carefully design of both the questions of the interview and the sample that comprises the diverse general aviation sector. The newly found contributory factors are associated with a pilot's performance as well as airspace design features that can influence the pilot's flight route decision-making, e.g. wished flying altitude is higher than the lower boundary of controlled airspace in the capital of a country. The findings can aid the incident investigation and the development of mitigation actions of these incidents.

General aviation (GA) represents a unique group of airspace users that fly for a range of purposes using a diverse aircraft fleet that can sometimes be ill-equipped to fly in controlled airspace (Civil Aviation Authority United Kingdom, 2006; International Civil Aviation Organization, 2009). Typically, most GA pilots fly for recreation purposes at the weekends and when the weather conditions offer good visibility because most pilots fly under visual flight rules (VFR). GA pilots increasingly use digital devices to plan their flight pre- and in-flight. As with all such technologies, their use can improve as well as degrade a GA pilot's performance. Such influences can lead GA aircraft to fly into controlled and restricted airspace without receiving permission from the Air Traffic Controller (ATCO), who is responsible for managing the traffic in these areas. Such airspace infringement (AI) incidents can cause safety and other air traffic management problems, e.g. delays, with the worst case being a mid-air collision. On average, there are approximately 100 and 600 AIs every year involving GA in Norway and United Kingdom respectively (General Aviation Safety Committee, 2016).

This paper, therefore, aims to find contributory factors (CFs) of AIs involving GA flights and these CFs will relate to the flight planning undertaken by GA pilots. This paper is structured as follows. In the following section, the studies of AIs, conducted by European stakeholders, will be briefly disccused regarding the data, method and key findings, and the potential of findings pilot's related CFs in interviews will be discussed. Next, the participants, the interview design and the method to analyse transcripts used in this paper will be outlined. The CFs will be presented and discussed before concluding.

Literature review

During the past decade, two major studies of AIs in Europe were conducted in order to understand the underlying reasons behind the occurrence of AIs by two stakeholders (European Air Traffic Management, 2007a; European Air Traffic Management, 2007b; European Air Traffic Management, 2008; Safety Regulation Group, 2003). The CFs found in these studies are not exhaustive. There are generic factors, e.g. airspace design and flight planning, that indicate their importance with AIs; however, they are of limited use and further study is needed to distinguish these generic factors. There are also ill-defined factors and their poor definitions limits their use as well. Furthermore, the CFs do not comprise of factors related to the impact of technologies currently used by GA pilots on AIs as found in (O'Hare & Stenhouse, 2009; M. Wiggins, 2007). In general, factors related to a pilot's performance were also not found in the studies whilst such factors are found in the literature of aviation psychology, e.g. a pilot pursues the flight into adverse weather due to a past successful situation. (Molesworth, Wiggins, & O'Hare, 2006; M. W. Wiggins, Azar, Hawken, Loveday, & Newman, 2014).

Literature in decision-making used: questionnaires in which participants rated scenarios (Hunter, Martinussen, & Wiggins, 2003), simulated flights (Molesworth et al., 2006), scales (Hunter, 2005) and incident and accident data (M. W. Wiggins et al., 2014). It is evident that research questions that are broad or explorative, questionnaires are preferred over simulation studies. It is remarkable, though, that interviews were not commonly used in the literature given their evident success to address explorative research questions that knowledge in the field as in (Nascimento, 2014). Regarding the sample design used in the literature, the sample often consisted of GA pilots and commercial pilots whilst the results were presented for all the participants (Hunter et al., 2003; M. Wiggins, 2007). This aggregation might have prevented differences between these two types of pilots from becoming apparent. Hence, the design of the sample should account the diversity of GA sector. Last but not least, the validation method used in the literature was often not clearly stated whilst validation is essential. Validation can be conducted by a subject matter (Nascimento, 2014) and by a comparison with similar studies or data (Hunter et al., 2003; Hunter, 2005) .

In order to identify CFs of AIs related to the flight planning, interviews of GA pilots, who are the key contributors to AIs, will be conducted and the sample of the study will represent the diversity of GA sector. The sample, the interview design and the method of analysis of the interviews are presented in the following section.

Method

Interviews of recreational GA pilots were conducted in Finland, Norway and United Kingdom (UK) that possess a problem with AIs involving GA flights and their aviation stakeholders collect AI incident reports. Interviews were conducted between March and November in 2015 and their duration was between 45 and 70 minutes. A convenient time for the face-to-face interview was arranged at the participants' flying club or city of residence. Participants were found directly from flying clubs in the UK and through the airspace navigation service provider and national aviation authority in Finland and Norway.

Participants

Participants were selected based on four criteria as follows given analysis conducted of reported AIs in these countries. The geographical location of their flying base was a selection criterion in that approximately 80% of the participants used an aerodrome located in the region of the capital and subsequently 20% of the participants departed from other cities. The reason is that the safety analysis of reported AIs in these countries showed that most AIs located in the region of the capital of the countries whilst the airspace design might also relate to AIs. In order to ensure that the diversity of GA fleet is represented in the sample, even though most reported AIs occurred by fixed-wing motor aircraft, pilots of an ultralight and glider aircraft will also be interviews as follows: 80% of the participants flew a light fixed-wing motor aircraft, 10% flew an ultralight aircraft and 10% flew a glider aircraft.

In order to control the diverse activities, pilots must fly for recreational purposes and have a VFR-rating. Given that the flying hours of GA pilots can vary, the sample must consist of GA pilots who were recently issued their flying licence and have been flying for a long time. The flying activity in the last three months is also considered to account the inactive flying period in the winter. Pilots who fly cross-country flights will also be interviewed. Finally, participants must be fluent in English language as the interview will be conducted in this language. The involvement of the participants in an AI, their age, occupation and gender are not taken into account in the sample design.

The sample consisted of 27 GA recreational pilots as shown in Table 1. There were 20 pilots that flew a fixed-wing motor aircraft, three pilots that flew a glider and three pilots that flew an ultralight aircraft. Ultralight and glider pilots were difficult to find and thus, the minimum required number of these pilots was selected. In Norway, participants, who were based in the capital region were found only.

Table 1.
Design of the sample

Criterion	Fixed-wing motor aircraft	Glider aircraft	Ultralight aircraft	Total
Country				
Finland (Helsinki)	6	1	1	10
Finland (Southern Finland)	2			
Norway (Oslo)	5	1	1	7
United Kingdom (Greater London)	5	1	2	10
United Kingdom (South England)	2			
Total	20	3	4	27
Total flying hours*	505.5 (1310.7)	500 (822.7)	100 (35)	N/A
Flying hours in the last three months*	14.5 (24.3)	8 (24)	11 (1.5)	N/A
Number of pilots who also flew cross-country flights	17	1	0	N/A

Note. *median (standard deviation), N/A: not applicable

Interview design

A semi-structured interview was designed to address research questions beyond the research question of this paper. Participants were asked ten questions whose objectives were the description of the planning of a flight, the material and devices they use for planning and navigation and the pilots' involvement in AIs and other safety related incidents. For this paper, the responses concerning the description of the manner to which they decide the flight route for their desired destination including the difficulties they expect to experience will be used. The questions were open-ended and probe questions were asked, e.g. 'will the temperature affect your flight route decision?'

Analysis of Interview

The interview transcripts were analysed using the phenomenological method thematic analysis (Coyle & Lyons, 2007). The transcripts were coded and the codes were grouped to develop the themes and their sub-themes that will be the findings of the analysis. The analysis followed the guidelines for 'Publication of Qualitative Research Studies in Psychology and Related Fields' (Elliott, Fischer, & Rennie, 1999). For the analysis of the interviews, the qualitative data analysis and research software 'ATLAS.ti' was used. In particular, the analysis was conducted as follows.

Two randomly selected interview transcripts from each country were read so that the author became familiar with the content. For these transcripts, codes were created for meaningful text chunks. Once the coding was completed, codes were revised to remove duplicated codes, combine similar codes and then group the codes into meaningful categories. The revised list of codes was used to code the remaining transcripts and it was again revised at the end of this step. If the codes changed, the transcripts were coded again and the above process was repeated three times. Finally, the codes were grouped into themes and their sub-themes. Again, the themes were revised to remove duplicated sub-themes and combine similar sub-themes and themes.Whilst the aim of this paper is to present key CFs, the themes regarding the manner in which pilots plan the flight route and the features pilots consider were transformed to CFs. The participants' recall of AI incidents was also used to identify CFs.

The results were validated by a SME, who had ten years of expertise in aviation safety and interview analysis. The SME was provided with the themes at level 1 and 2 and was requested to assign the theme for 100 quotes. In the first stage, the description of the themes was not provided and the agreement was at 68%, which was below the minimum expected rate of agreement, i.e. 85%. In the second stage, the SME re-assigned the themes for each quote whilst the SME was provided with the description of the themes. At this stage, the agreement was 90%, and thus, the themes were successfully validated. The suggestions for re-naming two sub-themes were incorporated.

Results

A key finding of the interviews was the decision that pilots make to fly in uncontrolled airspace and near the boundary of controlled and restricted airspace (FB decision). In such a flight, the pilot can unintentionally infringe for a range of reasons (i.e. contributory factors), e.g. the pilot does not notice the minor change of the wind direction that succeeded to change the heading of the aircraft towards controlled airspace. This FB decision is influenced by a range of factors and these factors are also CFs of AIs. Such CFs can relate to the aircraft design, airspace design, airspace procedures, flight-route decision, communication skills of pilots, the pilot's personal factors and their risk management. For example, a '*pilots' wishing flying altitude is higher than the altitude of the lower boundary of controlled airspace'* and thus, the pilot flies as close as possible to the desired altitude. In such a situation, pilots who believe that the gliding distance is inadequate may fly very close to the boundary, e.g. 10ft below.

Other factors that can influence the FB decision can be the following. In the situation that the '*flight route passes through many controlled airspace areas'*, e.g. cross-country flights, the flight route is modified to pass through a fewer number of controlled airspace areas and subsequently the pilot will contact a fewer number of ATCOs given that communications can increase a pilot's workload. The '*pilot wishes to fly only in controlled airspace'* and thus, in areas that an entry to controlled airspace is less likely to be permitted, the pilot will make the FB decision. Another factor can be the '*ill-fitted ultralight and glider aircraft that cannot fly in controlled airspace'* and thus, these aircraft divert the route around controlled airspace; however, the diverted route is almost similar to the initial planned route.

The manner in which pilots plan their flight route pre-flight can also contribute to AIs and was found to be influenced by the technologies used by GA pilots as follows. Animated planning apps suggest a straight, direct flight route that might not be optimal for the aircraft, the area and the weather conditions. Pilots that do not change this suggested route might infringe, especially if '*the flight route is near controlled airspace'*. This CF is the '*unchallenged flight route that is suggested by the planning* app'. Due to the use of such planning apps, the *'pilot plans the flight route quickly'* and '*starts the planning closer to the time of departure' even just prior to take-off*. Both CFs can result in the situation whereby the '*pilot uses less number of landmarks'* and '*the pilot is inadequately prepared for the flight'* in that the pilot do not visualise the shape of the airspace, the local weather, e.g. wind of varied direction over mountainous area, and the potential traffic density in certain segments of the flights.

It was evident in the interviews that the pilots were confident of the accuracy of both the planning and navigation devices, e.g. animated apps and Global Positioning System receivers. Whilst the benefits of using these emerging technologies were stated by almost all the participants, their limitations and their potential to contribute to AIs were not clearly shared by all the participants. Such devices can run out of battery, freeze at any time and the positioning, especially that of tablets, might not be as accurate as the pilots believe. In the situation that the navigation device fails, the pilots have to switch to traditional navigation by comparing landmarks on the ground and the map. If the pilot did not find the landmarks that he/she flies over, the pilot would probably prioritise the tasks to identify the position of the aircraft and thus, this might lead to a loss of situational awareness.

Discussion

This study found factors related to planning that can contribute to airspace infringements involving GA flights. The CFs are detailed and thus, they overcome the limitation of the past studies of AIs that found generic CFs. The findings were validated by a SME. The newly found CFs are associated with a GA pilot's performance as well as airspace design features and these CFs can influence the pilot's flight route decision. For example, a low altitude of the lower boundary of controlled airspace in the capital of a country influences pilots to fly in uncontrolled airspace and near the boundary in order to maximise their gliding distance in the event of an engine-failure. The study also identified the impact of the planning apps that are increasingly used by pilots. In particular, pilots that use such apps might start the planning just prior to take-off and make more flight-route decisions in-flight due to access to information when airborne.

The key to this achievement was both the carefully designed semi-structured interviews of recreational GA pilots and of the sample. The enriched results were derived from the participants' description of the manner in which they typically decide the flight route. CFs, such as *'unchallenged flight route that is suggested by the planning app'* was found for the first time and this can be an example of the potential degradation of a GA pilot's performance due to the use of emerging technologies. Of equal importance, consideration of the diversity of the aircraft type and the flying base of the pilots succeeded in identifying their differences. A distinctive finding was that ultralight and glider pilots decided to fly in uncontrolled airspace due to the fact that the aircraft were ill-equpped to fly in controlled airspace. Another key finding is the impact of the heavily controlled airspace in the capitals of the countries in that pilots, who were based in these areas, e.g. London, where the uncontrolled airspace was narrow, and consequently planned the flight near controlled airspace.

The findings of this study shed light on the AI domain and thus, the findings can be used to develop a bespoke taxonomy of CFs of AIs. This taxonomy can aid the AI incident investigation and analysis as well. Such detailed findings, e.g. airspace design features, use of apps by the pilots, could also be used to develop mitigations actions of AIs involving GA flights.

Conclusions

This study successfully found contributory factors of AIs involving GA flights. The findings presented in this paper focused on the planning of pilots that is essential for completing a safe flight. For the purpose of this study, semi-structured interviews were conducted in Finland, Norway and UK and a sample of recreational GA pilots was carefully designed based on four criteria concerning operations and personal factors, e.g. country, aircraft type, city and flying hours. The findings can be used to develop a bespoke taxonomy of contributory factors and this taxonomy will comprise the diversity of GA operations, the environment the GA pilots fly and a GA pilot's performance. The findings can aid the incident investigator and support aviation stakeholders to design mitigation actions of AIs.

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