Effects of verbal versus graphical weather information on a pilot's decision-making during preflight

Effects of Verbal Versus Graphical Weather Information on a Pilot's Decision-making during Preflight

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Abstract: This study focused on the older technology of a verbal preflight weather briefing compared with the newer and emerging technology of digital textual and graphical weather pertinent to the flight route the pilot has chosen. The target population for this study was aviation students and instructors at Part 61 and 141 flight schools across the country. The accessible population for this study was flight students at a Florida university that had at least a private pilot's license through being employed as flight instructors. The 36 participants were selected from the accessible population based upon their availability and willingness to participate in the study. Institutional Review Board (IRB) approval was obtained from the university before conducting trials with human subjects.
Two weather scenarios were selected for the trials. Participants were assigned to one of four groups based on the order of the two formats, verbal or visual (graphical/textual), for the two different scenarios. Four open-ended questions for the two weather scenarios were given to participants, which resulted in a total of eight open-ended questions per participant. The open-ended questions designed and included in the instrument captured the "why" behind pilots' decision to "go" or "no-go." The qualitative analysis software, Nvivo®, was used to analyze the four open-ended questions for each of the two weather scenarios. To visualize this data, a diagram was formed. The study results, discussion, and future research are presented in the paper.

1. INTRODUCTION

The purpose of this study was to determine if a pilot's likelihood to make a "go" or "no-go" decision during preflight is affected by the same weather information delivered in either a "verbal" or "visual (graphical/textual)" format. This study examined a pilot's confidence in his or her decision and risk perception based upon the weather that is presented in two different scenarios. The goal of this study was to make recommendations to Part 61, 91, and 141 pilots to determine which method for receiving preflight weather is more suitable for their learning style and ability to perceive risks.

Deteriorating weather conditions have been a threat to general aviation pilots for many years. Adverse metrological conditions have contributed to 35% of general aviation accidents, with 60% of these accidents occurring in instrument metrological conditions (Fultz & Ashley, 2016). Before conducting a flight, a pilot is legally responsible for being aware of weather conditions at his or her origin, destination, and flight route between both airports. All pilots have varying levels of risk perception and assessment, depending on their experience and level of aviation certification. Pilots also differ from one another with different learning styles that are best matched with presentations of the same weather information.

Traditionally, pilots have obtained a preflight weather briefing via a telephone call. This phone call allows pilots to receive all pertinent weather information verbally. The pilot is also able to receive a preflight advisory from the weather briefer, suggesting that the flight should be terminated based upon the outlook of adverse weather along the intended flight route. This advisory is included in your briefing by the briefer

stating, "visual flight rules (VFR) is not recommended," which is triggered by current or forecasted weather conditions falling outside of the set parameters for the duration of the flight.

With the advancement of technology, pilots are now able to obtain preflight weather information textually and graphically over a computer, tablet, or smartphone. This newer method over the option of a verbal format cuts out the addition of the flight service station (FSS) providing a recommendation to the pilot to terminate his or her flight if hazardous weather is detected. Based on the learning style and experience level of the pilot, the different delivery methods for a preflight weather briefing may influence the likelihood of a "go" or "no-go" decision being made.

2. BACKGROUND INFORMATION

2.1. Aviation Weather Briefings

General aviation pilots operate under Part 91 of the Federal Aviation Regulations under Title 14 of the Code of Federal Regulations. Part 91.103 titled *Preflight action*, and subsection (a) describes what a pilot must obtain before conducting a flight. "Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. For a flight under instrument flight rules (IFR) or a flight not in the vicinity of an airport, weather reports, and forecasts…" (FAA, 2017, 91.103a). These regulations do not define the sources of weather information that the pilot must use to obtain a preflight weather briefing; they only state that the pilot must be aware of all the weather concerning his or her flight.

The FAA only provides pilots with information related to weather products that are distributed by the National Weather Service and state that pilots need to exercise caution when using unfamiliar weather products and to consult an FSS (FAA, 2016). It further describes that as new weather products are developed, older textual and graphical products are phased out, leading to confusion between regulatory requirements and the new products. The FAA addresses this issue by stating all flight-related aviation weather decisions should be based on all available pertinent weather because every flight is unique, and multiple products may be necessary to meet weather regulatory requirements.

2.2. Theories Related To Analyzing Preflight Weather

The FAA (2009) devotes a lot of attention to educating pilots on the different forms of decision-making, also known as aeronautical decision making (ADM). ADM is defined as the ability to take a structured and systematic approach to analyze changes that occur during flight and how these changes could affect the safe outcome of the flight. Using ADM properly requires good judgment, something which the FAA states can be taught through instruction and is not always exclusively a byproduct of experience. To capture decision-making in this study, specific Likert-type scale and open-ended questions that focused on both a final decision reached by a pilot after analyzing a preflight weather briefing and how confident they were in their decision were included in the final instrument.

One form of ADM that most closely relates to the analysis of a preflight weather briefing is analytical ADM (FAA, 2009). This follows the DECIDE model, which has pilots detecting a change or hazard, estimating the need to counter this change, choose a desirable outcome, identify actions that can successfully control change, do the necessary action, and evaluate the effect of the action. Analyzing all parts of a preflight weather briefing encompasses the DECIDE model as pilots already have a desired outcome for their flight and must weigh the changes detected in the weather briefing against this safe outcome.

Risk management is a second theory that is relevant to pilots analyzing preflight weather briefings. The FAA (2009) developed a risk assessment matrix that breaks down risk management into two functional processes: the analysis of risk likelihood and risk severity. Risk likelihood was rated from improbable to remote, occasional, and probable. Risk severity was rated from negligible, marginal, critical, and catastrophic. Pilots must consider all risks and their respective likelihood and severity, especially if the risk falls into the "high likelihood" and "high severity" region of the assessment matrix. Assessing risks

associated with weather is unique in that pilots can be provided with approved analyses, observations, and forecasts that describe the severity of hazardous weather. Weather forecasts, in particular, also give the pilot the ability to analyze both risk severity and risk likelihood. Pilots utilizing a weather briefer can also receive a dynamic analysis of their preflight weather when working with another human being who is disseminating the weather information relevant to the particular flight. To capture the pilot's perception of risks during a preflight weather briefing, there was a Likert-type scale question for each scenario that asked participants to rank the severity of perceived risks. This was also captured via two open-ended questions after each scenario that asked participants to describe the perceived risks and how these impacted their decision to "go" or "no-go."

3. METHODS

3.1. Target Population And Sample

The target population for this study was aviation students and instructors at Part 61 and 141 flight schools across the country. The main reason students and instructors at flight schools were the target population are because this was the level of experience and certification directly related to this research. The accessible population for this study was flight students at one university. These students all held at least a private pilot's license up through certified flight instructors. These potential participants were located on or near the college campus that was easily accessible logistically to participants. Participants were required to have held at least a private pilot's license to establish that they had initial training on obtaining and analyzing a preflight weather briefing. The design of this study was chosen to compare varying weather conditions with the verbal and graphical/textual delivery of the preflight briefing. Each of the 36 participants was shown two weather briefings, one in a graphical format and one in a verbal format.

3.2. Qualitative Data Analysis

Each survey contained four open-ended questions for both of the two weather scenarios, which resulted in a total of eight open-ended questions per participant. The four questions captured how the pilots reached the decision to "go" or "no-go," perceived risks after reading the weather briefing, how these risks affected their decision, and the reasons for the levels of confidence listed for each scenario. A categorical analysis method was used to find commonalities or differences between the verbal and visual formats for the weather briefings and any answer to an open-ended question that stood out or directly tied into a hypothesis from this study.

The qualitative analysis software, Nvivo®, was used to analyze the four open-ended questions for each of the two weather scenarios. The open-ended responses from the 36 participants were compiled into two documents: verbal and visual formats. A categorical analysis process was then performed by identifying common answers or themes among the 36 participants. To visualize this data, a comparison diagram was formed. These diagrams show the same open-ended question asked in both scenarios. The bubbles at the center of the diagram represent the format of weather briefing presented: either verbal or visual. These bubbles are linked to the open-ended question that was asked (the same question repeated twice for the two weather scenarios). Each bubble that branches off the open-ended question bubbles are the categories of common answers found when analyzing the open-ended responses. The numbers at the center of the bubbles show the number of responses by participants per category for a particular question. The "child" label on each arrow linking the bubbles together represents the software identifying the flow from the weather briefing format, to the open-ended question, and then to the category as a parent-child relationship. The numbers reflected are more than 36 because participants could respond with as many applicable answers as desired. Figure 1 below provides an example of the matrix provided by Nvivo.

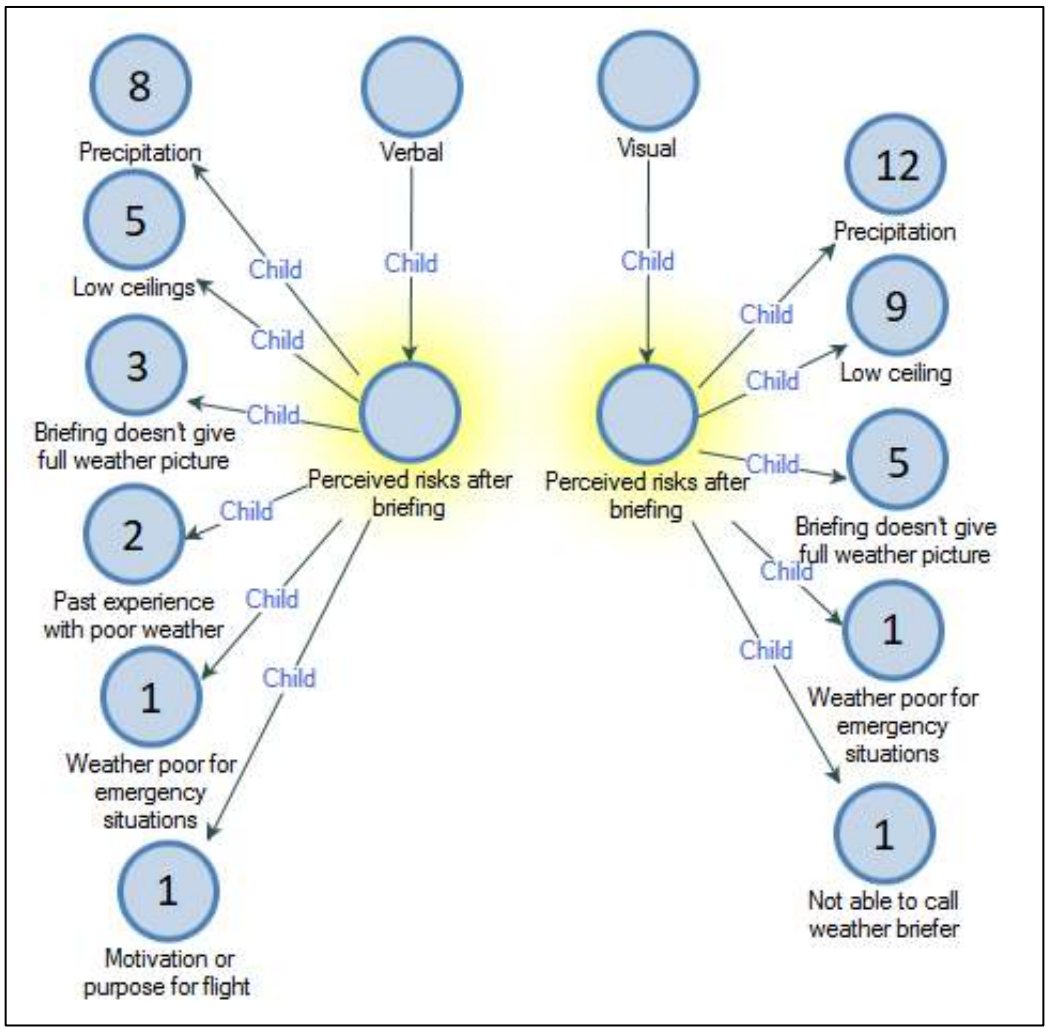

Figure 1 Perceived risks after receiving a weather briefing

4. RESULTS

4.1. Weather Briefing Format Comparison

The first open-ended question asked to each participant in both the verbal and visual formats for each weather briefing scenario was how the pilot rated the likelihood to either "go" or "no-go" on a VFR flight to the specified airport. This question generated many different types of answers and had the highest number of categories compared to the proceeding three questions. As seen in Figure 1, the most popular response for the verbal scenario was that 20 of the 36 pilots cited low cloud ceilings as the factor that contributed the most to their decision. This was followed by seven of the 36 pilots citing precipitation as the second highest factor when indicating how likely they were to proceed with their flight. These responses were also the highest reported factors for the visual scenario, with eleven of the 36 pilots indicating low ceilings and fourteen of the 36 pilots indicating that precipitation was a contributor to their likelihood to "go" or "no-go."

It is interesting to point out that 20 out of 36 pilots cited low ceilings as a contributor to their likelihood to decide to "go" or "no go" in the verbal scenario. In comparison, only 11 did the same in the visual scenario. Likewise, 14 out of 36 pilots cited precipitation as a contributor to their likelihood to make a decision in the visual scenario. In comparison, only seven of the 36 pilots did the same in the verbal

scenario. There were six of the 36 pilots in the visual scenario and two of the 36 pilots in the verbal scenario that identified a lack of weather information in their briefing, and this contributed to their decision to "go" or "no-go." Contributors to decision-making that were only mentioned for the verbal briefing included not being comfortable with a solo flight and that the weather conditions in the briefing were poor for a possible emergency situation. Each of these was reported by one out of 36 pilots. Likewise, asking for ATC assistance (reported by one out of 36 pilots), not being able to call a weather briefer (reported by one out of 36 pilots), and the usage of the visual radar (reported by 5 out of 36 pilots) were unique to the visual briefing format and were each listed by one out of 36 pilots.

For the verbal weather briefing, five of the 36 pilots said that the type of flight they were conducting played a role in proceeding with or canceling their flight. The type of flight depends on whether VFR or IFR is being followed or the fact that a training flight was being used in each scenario. In the visual briefing, five of the 36 pilots identified using the image of the radar, which shows the location and intensity of precipitation, as a contributor to their decision-making. The lack of aviation experience or a higher pilot certification was listed by four pilots for the verbal weather briefing and one pilot for the verbal briefing as a contributor to their final decision.

4.2. Perceived Risk

The second open-ended question asked to participants regarding the two scenarios was to identify risks that they perceived after analyzing each weather briefing. The risk reported the most was precipitation, with eight of the 36 pilots identifying this in the verbal scenario and twelve of the 36 pilots identifying this in the visual scenario. Low ceilings were the next-highest reported risk in each briefing, with five of the 36 pilots reporting it in the verbal briefing and nine of the 36 pilots reporting it in the visual briefing. A third common perceived risk between the two formats was that the briefing does not provide a full picture of the weather, with three of the 36 pilots and five of the 36 pilots reporting this in the verbal and visual briefing, respectively. The remaining risks perceived in each briefing had two or fewer pilots report them. For the verbal briefing, two of the 36 pilots identified past experience with poor weather as a risk, while the motivation or purpose for flying and the weather conditions being poor for emergency situations being reported each by one pilot. In the visual briefing, the same pilot, as in *Question 1,* listed the inability to call a weather briefer as a perceived risk. Just as in the verbal weather briefing, a pilot identified the reported weather in the visual scenario as being poor for a possible inflight emergency.

4.3. Perceived Risk On Decision Making

The third question pilots were asked regarding both weather scenarios were how the risks they perceived affected their decision to "go" or "no-go." For a third time, low ceilings and precipitation were reported in both formats. Seven of the 36 pilots reported low ceilings, and one pilot reported precipitation as risks that impacted their decision-making for the verbal weather briefing. In the visual briefing, five of the 36 pilots reported low ceilings, while three of the 36 pilots reported low ceilings as risks that affected their decision.

The motivation or purpose of the flight was the highest-reported risk that affected a pilot's final decision between both formats, with seven of the 36 pilots reporting this in the verbal briefing and six of the 36 pilots reporting it in the visual briefing. A few participants indicated that the weather scenarios did not provide a full picture of the weather for the route they were flying, with three of the 36 pilots indicating this in the verbal briefing and two of the 36 pilots indicating this in the visual briefing. When it came to a lack of aviation experience or holding a higher pilot certificate, four of the 36 pilots reported this as a risk that affected their decision to fly in the verbal briefing. In contrast, only one pilot reported this in the visual briefing.

Past experiences with poor weather were reported by four of the 36 pilots in the verbal briefing, with two of the 36 pilots reporting the same for the visual briefing. The last commonly reported risk that affected decision-making between both scenarios was the weather that was too poor for an inflight emergency, one pilot reported this in the verbal briefing, and two of the 36 pilots reported this for the visual briefing. There

were responses that were unique to the visual briefing that did not fit into any of the existing categories. The first was that one pilot reported a lack of equipment inside of the aircraft that could provide inflight weather information. The second unique response, also reported by only one pilot, was that the weather in the scenario was deemed specifically "not hazardous," and therefore, the entirety of the information in the briefing was not a risk that affected decision-making.

4.4. Confidence In Decision

The fourth and final open-ended question asked to all participants twice, once per scenario, was to provide an explanation for the level of confidence that they expressed through answering the Likert-type scale question. Past experiences with poor weather were the most common answer for the verbal scenario reported by eight of the 36 pilot responses. In contrast, six of the 36 pilots reported the same in the visual scenario. The next highest-reported reason for each participant's level of confidence was the motivation or purpose for their flight reported by six of the 36 participants in the verbal briefing and four of the 36 pilots in the visual briefing. Three of the 36 pilots in the verbal scenario answered that the briefing does not provide a full picture of the weather for the flight. In contrast, five of the 36 pilot participants answered the same for the visual scenario. The last common reason for the level of confidence between participants from both scenarios was the lack of aviation experience or pilot certification. This was reported by two of the 36 pilot participants in the verbal scenario and by four of the 36 pilot participants in the visual scenario.

Categories that were unique to the verbal scenario were low cloud ceilings (reported by five of the 36 pilot participants), and the weather is too poor to handle a possible inflight emergency (reported by one pilot participant). There were also two categories of answers in the visual briefing regarding the participants' level of confidence in their decision to "go" or "no-go." The first was that the combined data between the image of the radar and the graphical/textual weather data matched each other, which was reported by eight of the 36 pilot participants. The second category was only answered by one participant; this pilot felt uncomfortable calling and receiving weather information from a briefer that they did not personally know.

5. DISCUSSION

The data from the open-ended questions suggest that the order in which a pilot receives a verbal and visual (graphical/textual) weather briefing does have an influence on their decision-making and confidence. This study provided each participant with two flight scenarios in different order. Both destinations were VFR training flights to an airport in Central Florida with similar weather between both scenarios. This simulated a pilot flying multiple legs, beginning at the origin airport and flying to either Sebring or Okeechobee, and then proceeding to the final destination. Multi-leg flights within the same region of one state are very common to general aviation training flights, which is directly relatable to the accessible population used in this study. The data suggests that the order in which a pilot receives different formats of weather briefings, dependent upon the type of weather at their destination, affects the likelihood to make a decision as well as the confidence in this decision. If a pilot is receiving a weather briefing for the first leg, the type of weather should determine which format of briefing should be used. Upon reaching this destination, if the pilot decides to continue with the flight, the pilot will then receive another briefing for the second leg. If the weather conditions have changed since receiving the first briefing, the pilot should consider which format of briefing to use due to the prior exposure to the initial weather and briefing from the first leg.

Another important factor to consider is the availability of equipment at various airports from leg to leg. An airport that has technology such as computers or tablets available for use will allow pilots to obtain visual weather briefings. However, depending on the size, location, and type of clientele, a smaller airport may only have telephones available, making a verbal briefing the only format available to visiting pilots. In this case, this study suggests that pilots should be aware of the preflight briefing equipment available at the various airports along their intended route of flight. If changing weather is to be encountered during the

various legs, and pilots are forced into choosing one format over another due to equipment limitations, decision and confidence could be affected.

6. REFERENCES

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