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How Nationality, Weather, Wind, and Distance Affect Consumer Willingness to Fly in Autonomous Airplanes

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Abstract

Several studies have examined passengers' trust in human-operated systems versus autonomous systems. Prior studies have also reported cultural differences among individuals from India and the United States. The purpose of this study was to investigate how nationality, weather, wind, and distance affect passengers' willingness to fly in autonomous aircraft. Participants included 161 volunteers from the United States and 137 volunteers from India. In 12 different conditions, participants were asked to rate their willingness to fly in an autonomous aircraft, given information about the weather (sunny, raining, or snowing), the wind level (no wind versus strong wind), and the flight distance (short flight versus long flight). These conditions were presented randomly to each participant. Subsequently, participants were asked qualitative, open-ended questions. The results indicated that Indian participants were generally positive about autonomous commercial flights, except in the most extreme conditions. American participants were generally negative about autonomous commercial flights, except in perfect conditions. Participants were also asked their opinions on advantages of automation, disadvantages of automation, and specific weather concerns. Implications for the findings are discussed.

Keywords: culture, autopilot, aviation, weather, nationality, willingness to fly

Introduction

Many studies have examined passengers' trust in human-operated systems versus autonomous systems. Previous studies have also demonstrated that there are cultural differences between individuals from India and the United States. However, an examination of how nationality, weather, wind, and distance affect passengers' willingness to fly in autonomous airplanes has been relatively unexplored. Since the aviation industry is consumer-centric, it is imperative to understand and take into account passengers' opinions and their willingness to fly in these particular situations. Therefore, the purpose of this study is to investigate how nationality, weather, wind levels, and distance affect consumers' willingness to fly in autonomous airplanes.

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Nationality and Cultural Considerations: India and the United States

What humans do and why they do it has long been a subject of scientific inquiry. This study continues the quest to understand human attitudes and behavior by researching whether there are significant differences in willingness to fly based on the nationality of the participants and various flight conditions.

Nationality may be a factor in certain consumer attitudes and behaviors. Explaining how nationality plays a role often leads to discussions of culture. Hofstede (1984) stated, "different nations have different cultural heritages which are largely invisible" (p. 253). Those invisible parts are held collectively and passed generationally. Helmreich (2000) defines culture as "the shared norms, values, and practices associated with a nation, organization, or profession" (p. 134). Taking into account the cultural side of consumers' perceptions requires an understanding of the variety of ways people's mind can be programmed by their life experiences. Trust, for instance, is an area possibly influenced by cultural background (Hofstede, 1980).

National culture can be difficult to define because of the complex interplay of individuals and their environment. Schwartz (2009) explained "cultures are never fully integrated and coherent" (p. 147). Nevertheless, researchers continue in efforts to define and refine membership in different types of cultures. The current study uses the United States and India, nations of differing cultures, as targets for research.

There have been many studies that have investigated the differences between American and Indian nationality potentially explained by individualistic and collectivist cultural views (Mehta, Rice, Winter, & Eudy, 2017; Rice, Mehta, Winter, & Oyman, 2015; Winter et al., 2015). Markus and Kitayama (1991) found that collectivist cultures, such as that of India, have an interdependent view of the self. Additionally, collectivism includes a preference for a tightly knit social framework in which individuals can expect their relatives and in-group to look after them in exchange for unquestioning loyalty (Hofstede, 1980). Even from an early age, individuals are taught to trust without question and take others' interests into higher regard over their own (Rice et al., 2014). In contrast, those from individualistic cultures show a preference for a more relaxed social framework in society, where individuals take care of themselves and their immediate families only (Hofstede, 1980, 1984). Regarding individualistic versus collectivist dimensions, India scored 48 out of 100 on Hofstede's Cultural Values by Nation Index. This indicates that India has a mainly collectivist culture with some individualistic features (Hofstede, 1980, 1984). The United States, however, scored the highest value of 91, illustrating a strong individualistic culture. Schwartz (2009) suggested Hofstede's conclusions were too high a level to effectively explain the complexity of culture. He said, "inferences about national culture may depend on which subgroups are studied" (p. 134). While his groupings varied from those of Hofstede, he also found distinctions between the national cultures of the United States and India.

Expansion of Technology, Automation, and Trust

Technology continues to expand our capabilities. At the same time, the demand for air travel continues to increase. For example, according to the International Air Transport Association (2017), Indian carriers flew nearly 100 million passengers on domestic routes in 2016, exemplifying India's drastic growth in the aviation market. With this continued development, India has the potential to be a leader in this new era of automated flight technologies. Increases in the demand for air travel have also highlighted pilot shortages in different countries. The United States saw a 29% decrease in the number of commercial pilot certificates issued, indicating a pilot shortage (Aircraft Owners and Pilots Association, 2010). Furthermore, Boeing (2013) reported that there would be a demand for 498,000 commercial airline pilots within the next 20 years worldwide. Automated flight could help alleviate pilot shortages. Consumers' perception of automated flight capabilities, combined with cultural influences, can directly impact the design and expansion of such advanced automated technologies within an aircraft (Rice et al., 2014).

Automation has become increasingly prevalent in today's society and has allowed users to successfully perform complex repetitive tasks quickly (Hoff & Bashir, 2015). Most importantly, automation enables users to multi-task in dynamic environments. Parasuraman and Wickens (2008) described the four stages of automation as acquisition, analysis, decision, and action. These stages have a definite resemblance to the human information processing system and could potentially influence passengers' comfort, trust, and willingness to fly in autonomous aircraft. An individual's trust in an automated system can be dependent on a variety of factors, including culture, age, personality, and even genetics (Parasuraman & Wickens, 2008). In addition, Lee and See (2004) suggest that "trust may play a critical role in people's ability to accommodate the cognitive complexity and uncertainty that accompanies the move away from simple technologies" (p. 51). Previous studies examined passengers' trust in autonomous operating systems (Mehta, Rice, & Winter, 2014; Rice, Winter, Deaton, & Cremer, 2016) versus human-operated systems (Hughes, Rice, Trafimow, & Clayton, 2009; Mehta et al., 2017; Rice et al., 2014; Rice & Winter, 2015; Winter et al., 2015). Hughes et al. (2009) reported that passengers had a more negative attitude toward autonomous autopilot systems as opposed to having human pilots controlling the aircraft, even when discounts were offered to those flying with an autopilot system.

Two studies investigated cultural differences between American and Indian perceptions of automated and remote-controlled commercial flight operations (Rice et al., 2014; Winter et al., 2015). Members of both nations appeared to prefer human pilots over autonomous/remote-controlled aircraft. However, the results of both studies found differences between the views of Indians and Americans. Lastly, the results seemed to confirm the categorization of Indians as a collectivist culture since their attitudes towards autonomous and remote-controlled configurations were less negative compared to those of Americans.

While differences between American and Indian cultures have been investigated in previous studies, differences of how nationality, weather, wind, and distance interact to affect consumer willingness to fly in autonomous airplanes have not been examined.

Current Study

Prior research has shown that willingness to fly on autonomous commercial flights is dependent on a variety of factors, including gender, nationality, passenger type, and type of aircraft (Rice et al., 2014; Winter et al., 2015). This research has also shown emotional factors primarily mediate that willingness to fly. However, to date, none of these studies has examined how weather, wind levels, or distance of flight might interact with nationality to affect consumer willingness to fly in a fully autonomous aircraft. Furthermore, a qualitative approach has not been widely used in the field to examine these issues. The current study examines these issues using both quantitative and qualitative analyses. The following were our research question and hypotheses for the quantitative portion of the study:

Research Question: How do nationality, weather, wind levels, and distance affect consumer willingness to fly in autonomous commercial aircraft?
H_{a1}: In general, participants from the United States will be less willing to fly in an autonomous commercial airplane compared to Indian participants.
H_{a2}: In general, participants will be less willing to fly in an autonomous commercial airplane in inclement weather compared to ideal weather.
H_{a3}: In general, participants will be less willing to fly in an autonomous commercial airplane in strong winds compared to no winds.
H_{a4}: In general, participants will be less willing to fly in an autonomous commercial airplane for long distances compared to short flights.
H_{a5}: There will be interactions between the variables; however, this was a non-directional hypothesis.

The following research questions were derived for the qualitative portion of the study:

RQ1: Why are participants less willing to fly in autonomous commercial airplanes in inclement weather, wind, or for long distances?
RQ2: What are some perceived advantages of flying in autonomous commercial airplanes?
RQ3: What are some perceived disadvantages of flying in autonomous commercial airplanes?
RQ4: Which weather conditions concern potential passengers the most?

Methods

Participants

One hundred and sixty-one (72 females) participants from the United States and 137 (40 females) participants from India took part in the study. The mean age was 30.12 (SD = 7.58). All participants were recruited from Amazon's® Mechanical Turk® (MTurk) via a convenience sample. MTurk provides participants who are willing to complete human intelligence tasks in exchange for payment. MTurk data have been shown to be as reliable as standard laboratory data (Buhrmester, Kwang, & Gosling, 2011; Germine et al., 2012; Rice, Winter, Doherty, & Milner, 2017).

Materials and Procedure

Participants first signed a consent form and then read instructions for the study. Following this, they were presented with a scenario about flying in an autonomous commercial airplane. Explicitly, they were told: "*Imagine that you are on a commercial flight from one major city to another. The aircraft is flown using an auto-pilot in place of human pilots. This means that the airplane is fully autonomous and there are no human pilots in the cockpit. One human pilot is located at an undisclosed ground location and can remotely take over the airplane in an emergency*."

Next, participants were asked to rate how willing or unwilling they were to fly in the airplane on a 7-point scale from Extremely Unwilling (−3) to Extremely Willing (+3) with a zero-neutral option. In 12 different conditions, participants were given information about the weather (sunny, raining, or snowing), the wind level (no wind versus strong wind), and the flight distance (short flight versus long flight). These conditions were presented randomly to each participant.

Following this, participants were asked the following qualitative, open-ended questions: (1) What other situations would affect your willingness to fly? (2) In your opinion, what are some advantages of flying with the autopilot compared to a human pilot? (3) In your opinion, what are some disadvantages of flying with the autopilot compared to a human pilot? (4) Which weather condition is the most concerning for you, and why? (5) Do you have any other thoughts that you would like to share?

Lastly, participants provided demographic information, were debriefed, and dismissed.

Design

The study used an experimental, mixed factorial design with four factors. The between-participants factor was Nationality. The within-participants factors were Weather (sunny, raining, or snowing), Wind (no wind versus strong wind), and Distance (short flight versus long flight).

Results

Nationality Comparisons

Figures 1 and 2 indicate that Indian participants were more willing to fly on autonomous commercial flights, regardless of the conditions. A four-way analysis

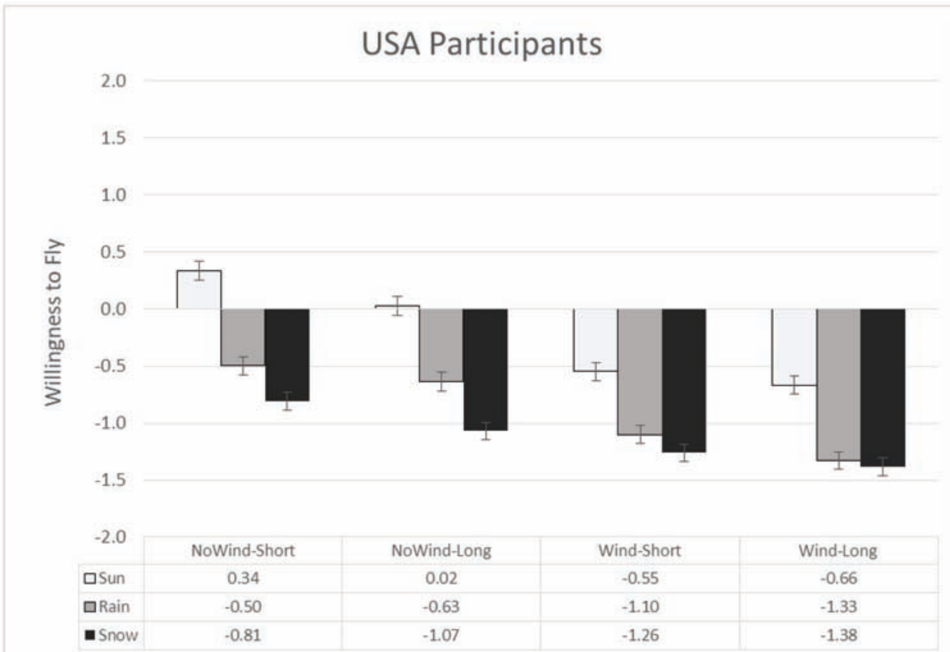

Figure 1. American participant ratings as a function of Weather (sun, rain, or snow), Wind (wind or no wind), and Distance (short flight or long flight) on a scale of −3 to 3. Standard error bars are included.

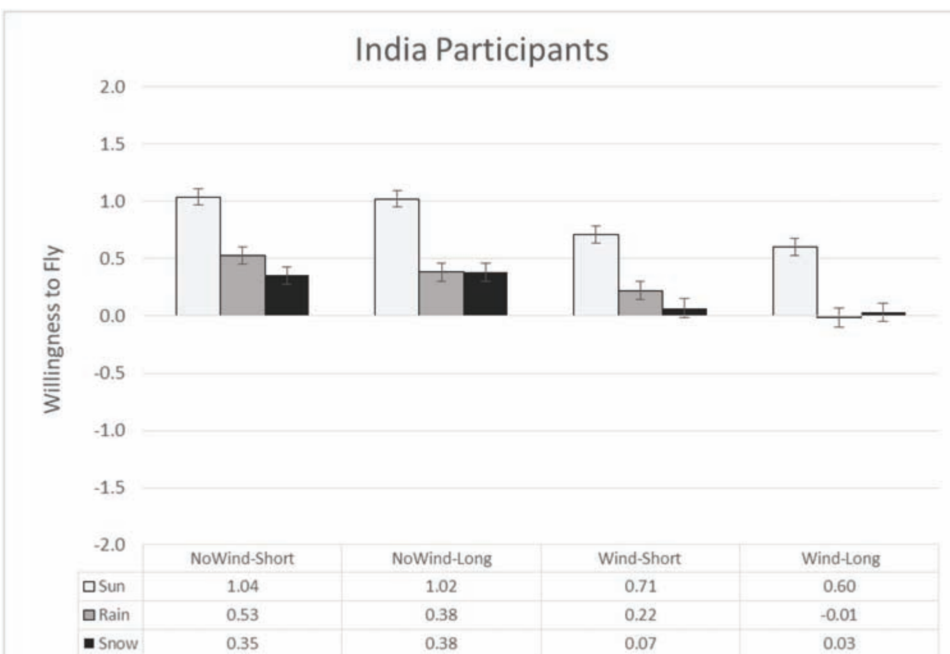

Figure 2. Indian participant ratings as a function of Weather (sun, rain, or snow), Wind (wind or no wind), and Distance (short flight or long flight) on a scale of −3 to 3. Standard error bars are included.

of variance confirmed this main effect of Nationality, $F(1, 296) = 38.72$, $p < 0.001$, *partial-eta squared* = 0.12. Using a Bonferroni correction ($p = 0.004$), we compared Indians to Americans in each of the 12 conditions and found significant differences for every condition (all p-values < 0.001). There were no significant interactions between Nationality and the other variables; therefore, we focus on each nationality separately in the analyses below.

American Participants

As shown in Figure 1, American participants were generally negative about autonomous commercial flight except in perfect conditions. A three-way analysis of variance using Weather, Wind, and Distance as the factors revealed main effects for Weather, $F(2, 320) = 77.43$, $p < 0.001$, *partial-eta squared* = 0.33, for Wind, $F(1, 160) = 72.40$, $p < 0.001$, *partial-eta squared* = 0.31, and for Distance, $F(1, 160) = 21.12$, $p < 0.001$, *partial-eta squared* = 0.12. There was a significant interaction between Weather and Wind, $F(2, 320) = 8.53$, $p < 0.001$, *partial-eta squared* = 0.05. None of the other interactions were significant.

Indian Participants

As seen in Figure 2, Indian participants were generally positive about autonomous commercial flights, except in the most extreme conditions (snow, strong wind, long distance). A three-way analysis of variance using Weather, Wind, and Distance as the factors revealed main effects for Weather, $F(2, 320) = 31.42$, $p < 0.001$, *partial-eta squared* = 0.19, and for Wind, $F(1, 160) = 19.64$, $p < 0.001$, *partial-eta squared* = 0.13. There were no significant interactions in the data.

Qualitative Analysis

Although the quantitative data in the prior analysis provided a detailed account of the data, another goal of the study was to more closely examine the qualitative responses from the participants and to gain feedback on why participants chose their responses. We used NVivo to analyze the data. NVivo is designed to aid the analysis and coding process of qualitative responses from participants. NVivo generates word clouds and frequency counts that illustrate common terms that each participant used in their responses. The software also helped identify participant attitudes and perceptions about flying in an autonomous aircraft.

Advantages of autopilot

Figure 3 presents an NVivo word cloud, which illustrates the most common word responses from participants. Word clouds are created by a word frequency query, where frequently occurring words or concepts in a qualitative data set are gathered. This query can be used to identify possible themes and analyze the most commonly used words for a particular question. The position and size of the words represent the significance and frequency in which the word was used. The most frequently occurring words appear in the center of the cloud and larger font. Less frequent words appear in a smaller font and are placed near the outer ends of the cloud. The data revealed that participants from both countries were mainly focused on reducing human error and fatigue as an advantage of flying with the autopilot as opposed to a human pilot. Numerically, this equated to 64% of the comments ($n = 150$) from American participants and 43% of the comments ($n = 120$) from Indian participants:

"There is less human error."
"No emotions involved, no human error."

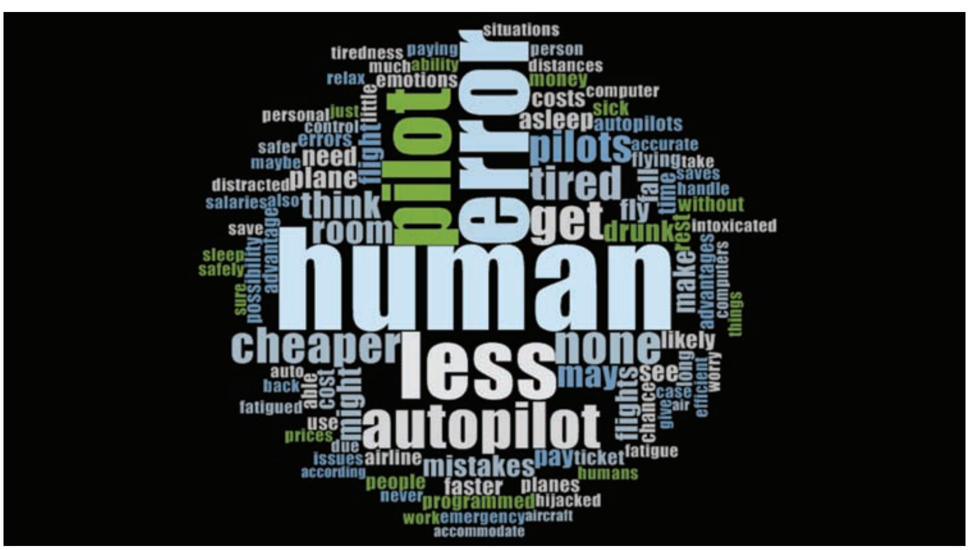

Figure 3. A word cloud showing commonly cited terms used by participants to describe the advantages of autopilot.

"The autopilot does not get tired, need to sleep, or eat."
"In my opinion, an advantage of flying with the autopilot compared to a human pilot is that the autopilot will never get tired or fall asleep."

In addition to a reduction in human error and fatigue, participants also commented on the potential lower cost associated with flying with an autopilot. These comments accounted for 19% of the comments from Americans and 7% of the comments from Indians:

"Cheaper flight costs."
"Some advantages may include a faster flight and cheaper ticket prices."
"Could make flying cheaper."

Disadvantages of autopilot

Again, NVivo was used to identify the most common themes that participants' focused on as potential disadvantages of autopilot. These included human, pilot, plane, autopilot, control, and emergency. The full responses indicated that the absence of a human pilot was a major drawback to their willingness to fly, especially as it relates to dealing with unforeseen conditions and potential emergencies. Numerically, this equated to 80% of the comments from Indians ($n = 106$) and 54% of the comments from Americans ($n = 156$):

"If something goes wrong, there is no human being able to take control."
"No control for unforeseeable circumstances."
"Not all autopilots will be capable of handling emergency situations."
"The pilot is not on board in case of an emergency."
"No human to communicate and talk to the passengers about what is going on."

Additional themes predominant in responses from American participants (30%) are system security, reliability, and trust:

"I don't trust computers to fly a plane. Computers are prone to malfunction."
"I don't trust a computer without human presence."
"It could get hacked or malfunction."
"No human touch."
"Autopilot is not a human and can malfunction."

Which weather condition is most concerning?

The data showed that participants were mostly concerned about weather conditions involving snow, ice, and rain. Comments regarding snow and ice were observed in 36% of the comments from Americans ($n = 158$) and 21% of the comments from Indians ($n = 126$):

"I think snow is the most concerning because I know it's dangerous to drive in snow and I feel like snow could negatively affect the aircraft in some way."
"Snow because it seems the most extreme."
"Snow, it's very slippery and can lead to dangerous icing of runway."

Participants also noted that rain, in terms of both visibility and effects on aircraft performance, was another weather concern that influences their willingness to fly and accounted for 21% of the comments from Americans and 26% of the comments from Indians:

"Rain because it would be harder to see."
"Rain, I'm afraid it could interfere with the autopilot."
"Rain because it is usually accompanied with thunder and lightning."

Wind was listed as a concern in 20% of the comments from Americans and 9% from Indians:

"Wind because it causes extreme turbulence."
"Wind. I do not like flying where there is wind and turbulence."
"Wind. Because the plane would be harder to control in my opinion."

The American respondents (16%) also specified thunderstorms as particularly concerning in their willingness to fly opinions:

"Thunderstorms, because the strong updraft and vertical wind shear are more disruptive to airplane flight than any other weather condition."
"Thunderstorms. Lightning and airplanes do not mix well."
"Thunderstorms would scare me for flying."
"…because it is unpredictable."

Discussion

The purpose of this mixed-methods study was to examine how nationality, weather, wind levels, and distance affect aviation consumers' willingness to fly in autonomous commercial aircraft. For the quantitative portion of the study, we examine five hypotheses, which we address in turn below. For the qualitative part of the study, we consider three research questions, which we also discuss in turn.

Quantitative Findings

The first hypothesis stated that participants from the United States would be less willing to fly compared to Indian participants. The data from the study supported this hypothesis, which suggests American participants were negative about autonomous commercial flight except in perfect conditions, while Indian participants were positive in most conditions. These findings are similar to those of other studies on autonomous aircraft and could potentially provide a stronger foundation to such a directional prediction (Rice et al., 2014). It is possible that Americans are less willing to fly than Indians as identified by Hofstede (1980, 1984), in that Indians and Americans generally come from different cultures which can influence perceptions of unfamiliar events. Indian culture, being generally collectivist, tends to be more willing and trustworthy of automation as opposed to the American culture, which is generally the most individualist in the world. This can be seen is a more recent study where passengers' attitudes towards autopilot and remote-controlled flights were evaluated (Rice et al., 2014). The study suggested that Indian participants were more forgiving in their attitudes toward autopilot and remote-controlled pilots compared to American participants. The collectivist nature of the Indian culture tends to be more trustworthy in something the government believes to be safe (Wu & Jang, 2008). Furthermore, collectivist cultures tend not to challenge the status quo, avoid extremist views, and do not petition or rebel against boundaries (Wu & Jang, 2008). Instead, they base their ideas on conformity and provide emphasis on traditions and religion (Rice et al., 2014).

The second hypothesis stated that participants would be less willing to fly in inclement weather compared to a sunny day. The results of the study supported this hypothesis that American participants were negative about autonomous commercial flight, except in perfect conditions. However, Indians were more willing to fly on autonomous commercial flights in every condition except in the most extreme ones. For Americans, there was a significant interaction between weather and wind suggesting that both factors influenced their willingness to fly and could result in a compounding effect. In contrast, there were no significant interactions between variables for participants from India, perhaps suggesting that Indians were processing the weather conditions independently of one another.

The third hypothesis stated that participants would be less willing to fly in strong winds compared to no winds. The results indicated that American participants showed negative attitudes toward wind conditions. Previous research suggests perceived risk associated with flying in an autonomous commercial aircraft may decrease willingness to fly (Rice et al., 2014). Americans, being of an individualistic culture, tend to be untrustworthy and display avoidance in ambiguous or uncertain events (Hofstede, 1980), which can lead to unwillingness to fly in any condition in an autonomous aircraft. The results also suggest that Indians were also less willing to fly in strong winds. However, when compared to Americans, they were more willing to fly during strong winds. Perhaps this can be attributed to cultural influence, in which Indians, being of a collectivist culture, hold more trust in leadership, thus having more trust in the autonomous operating system. Since this technology is new, individuals may want to fly in ideal conditions to test the system or create a sense of comfort.

The fourth hypothesis stated that participants would be less willing to fly for long distances compared to short flights. The results indicated that distance was not a factor in American or Indian participants' willingness to fly for a short distance compared to a long distance on an autonomous commercial flight. One possibility of this outcome could be given the introduction of new technologies such as automation; consumers may not be able to see a risk difference based on the duration of the flight. The most critical phases of flight are takeoff and landing, not cruise flight; perhaps the length of the flight may not be a significant concern to them (European Aviation Safety Agency, 2018).

The fifth hypothesis stated that there would be interactions between the other variables; however, this was a non-directional hypothesis. The results partially supported this hypothesis as an interaction effect was found between weather and wind conditions in Americans. That is, the effect of weather on willingness to fly depends on winds and vice versa. As stated above, Americans were less willing to fly in conditions of poor weather and strong winds. But, Americans were even less willing to fly in a combination of the two conditions. Although Indians were less willing to fly in poor weather conditions, as compared to Americans, they were more willing to fly in weather and wind conditions. There was no significant interaction effect in Indian participants between weather and wind.

Qualitative Findings

The first research question addressed was participants' opinions on the potential advantages of using the autopilot. The participants focused on the reduction of human error and fatigue. Wiegmann and Shappell (2001) explain that human error accounts for 70% to 80% of civil and military aviation incidents. Prior research supports this, stating "with the removal of the human in the system, no human error can occur" (Haight, 2007, p. 20). Also, automation can decrease pilot fatigue, which often occurs during cognitive tasks in flight (Galinsky, Rosa, Warm, & Dember, 1993; Harris, Hancock, Arthur, & Caird, 1995). However, while automation has been shown to offer improvements it is important to note that automation is not without failures as well. Studies suggest that performance impairments of fatigue are one of the foremost concerns of the National Transportation Safety Board (Hartzler, 2014), and fatigue remains one of the primary physiologic factors implicated in aviation mishaps and general mistakes made by aircrews (Drury, Ferguson, & Thomas, 2012). Another advantage participants discussed was the potential for cheaper airfare. This optimism aligns with previous studies suggesting the pursuit of public opinions on automation can aid in cost efficiency of airlines which could lead to potentially lower cost (Rice et al., 2014).

The second research question addressed participants' opinions on the disadvantages of using the autopilot. The results indicated that the majority of participants from both countries felt that the lack of human presence and lack of control during emergency situations were the primary disadvantages of the use of the autopilot. Flying is somewhat more dynamic and complex than traveling by other modes of transportation. While human error is possible, participants seemed reluctant to relinquish control to a machine preferring instead to have humans on board.

The third research question addressed participants' opinions on which weather condition was most concerning to them. The results suggested that a large portion of participants were concerned with conditions involving snowy and icy conditions. One explanation for this finding could relate to a consumer's personal experience with loss of control while driving automobiles in snowy conditions. A second explanation could relate to media reports of high-profile aviation accidents linked to snowy conditions. The December 8, 2005 Southwest Airlines accident in Chicago (National Transportation Safety Board [NTSB], 2007) and the March 5, 2015 Delta Air Lines accident in New York (NTSB, 2016) are examples of snow-related accidents of the type that may shape public perceptions. Rain was the other condition of large concern to participants of both countries. While it is challenging to know the reasoning behind this condition as compared to others (thunderstorms for instance), it could be due to concerns of reduced visibility and effects on aircraft performance, especially in the landing phase.

Practical Applications

Findings from this study can be used for future real-world applications to help guide aviation and airline industries with a direction for marketing strategies in different countries and provide information regarding public opinion. The knowledge that there are differences between culture and willingness to fly in an autonomous aircraft in certain weather conditions can potentially pave the way for testing grounds to educate the general population on trust in new automation. Correlations between aviation accident rates (or perceived aviation safety) and willingness to accept aviation automation could yield clues as to why certain perceptions prevail. Future research could be conducted to assess the level to which age and education regarding different factors may affect passenger perceptions. Since the aviation industry is consumer-centric, it is also imperative to focus on public perceptions. Data collected on understanding how consumers feel about automation can provide airlines with valuable information on potential exposure and educational techniques that may aid in increasing trust in new technologies as well as airline profitability.

Limitations

One limitation of this study was the use of a convenient sample population via MTurk. The use of this online survey tool limits researchers to identifying if the participants were the proper age to participate in the survey or if the informed consent was read thoroughly. Also, the results of this study can only be generalized to the population of online users of MTurk. Although prior research has suggested that data gathered using MTurk are equally reliable as data collected from a laboratory setting (Buhrmester et al., 2011; Germine et al., 2012; Rice et al., 2017). Another limitation of this study is the examination of perceptions of consumers from only two counties, and the recognition that consumers may have limited perceptions on weather conditions.

Conclusion

The purpose of this study was to examine how nationality, weather, wind, and distance affect passengers' willingness to fly in autonomous airplanes. The findings suggested that American participants were generally negative about autonomous commercial flights, except in perfect conditions. Indian participants were generally positive about autonomous commercial flights, except in the most extreme conditions. The data from this study support the initial hypothesis and therefore have demonstrated that different techniques need to be used when introducing automation to specific consumer populations. These findings are of significant practical use for the aviation industry to change marketing and education strategies to expose consumers to such modern technologies. It is essential to promote awareness of such technologies to alter perceptions and attitudes of automation, aiding in the growth and expansion of airline travel. Perhaps the development of research in this domain can positively encourage consumers to fly in autonomous aircraft in the future.

Funding and Conflict of Interest

This study was conducted without any external sponsorship, and the authors have no conflict of interest.

References

Aircraft Owners and Pilots Association. (2010). AOPA general aviation trends report fourth quarter 2010. Retrieved from http://www.aopa.org/about/general-aviation-statistics/general-aviation-trends

Boeing. (2013). Current market outlook. Retrieved from: http://www.boeing.com/boeing/commercial/cmo/pilot_technician_outlook.page

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality data? *Perspectives on Psychological Science*, *6*(3), 3–5.

Drury, D. A., Ferguson, S. A., & Thomas, M. J. W. (2012). Restricted sleep and negative affective states in commercial pilots during short haul operations. *Accident Analysis and Prevention*, *45* (Suppl.), 80–84. https://doi.org/10.1016/j.aap.2011.09.031

European Aviation Safety Agency (EASA). (2018). Annex I (Definitions) of the Regulation (EU) 965/2012 on Air Operations contains definitions for critical phases of flight for aeroplane and helicopters. Retrieved from https://www.easa.europa.eu/faq/19133

Galinsky, T. L., Rosa, R. R., Warm, J. S., & Dember, W. N. (1993). Psychophysical determinants of stress sustained attention. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *35*(4), 603–614. https://doi.org/10.1177/001872089303500402

Germine, L., Nakayama, K., Duchaine, B. C., Chabris, C. F., Chatterjee, G., & Wilmer, J. B. (2012) Is the web as good as the lab? Comparable performance from web and lab in cognitive/perceptual experiments. *Psychonomic Bulletin & Review*, *19*(5), 847–857.

Haight, J. M. (2007). Automated control systems: Do they reduce human error and incidents? *Professional Safety*, *52*(5), 20.

Harris, W. C., Hancock, P. A., Arthur, E. J., & Caird, J. K. (1995). Performance, workload, and fatigue changes associated with automation. *International Journal of Aviation Psychology*, *5*(2), 169–185. https://doi.org/10.1207/s15327108ijap0502_3

Hartzler, B. M. (2014). Fatigue on the flight deck: The consequences of sleep loss and the benefits of napping. *Accident Analysis and Prevention*, *62*, 309–318. https://doi.org/10.1016/j.aap.2013.10.010

Helmreich, R. L. (2000). Culture and error in space: Implications from analog environments. *Aviation, Space, and Environmental Medicine*, *71*(9–11), 133–139.

Hoff, K. A., & Bashir, M. (2015). Trust in automation: Integrating empirical evidence on factors that influence trust. *Human Factors: The Journal of Human Factors and Ergonomics Society*, *57*(3), 407–434. https://doi.org/10.1177/0018720814547570

Hofstede, G. (1980). Motivation, leadership, and organization: Do American theories apply abroad? *Organizational Dynamics*, *9*(1), 42–63. https://doi.org/10.1016/0090-2616(80)90013-3

Hofstede, G. (1984). *Culture's consequences*. Newbury Park, CA: SAGE.

Hughes, J. S., Rice, S., Trafimow, D., & Clayton, K. (2009). The automated cockpit: A comparison of attitudes towards human and automated pilots. *Transportation Research Part F: Psychology and Behaviour*, *12*(5), 428–439. https://doi.org/10.1016/j.trf.2009.08.004

International Air Transport Association. (2017). 2036 forecast reveals air passengers will nearly double to 7.8 billion. Retrieved from http://www.iata.org/pressroom/pr/Pages/2017-10-24-01.aspx

Lee, J. D., & See, K. A. (2004). Trust in automation: Designing for appropriate reliance. *Human Factors: The Journal of Human Factors and Ergonomics Society*, *46*(1), 50–80. https://doi.org/10.1518/hfes.46.1.50_30392

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, *98*, 224–253.

Mehta, R., Rice, S., & Winter, S. R. (2014). Examining the relationship between familiarity and reliability of automation in the cockpit. *Collegiate Aviation Review*, *32*(2), 1–13.

Mehta, R., Rice, S., Winter, S., & Eudy, M. (2017). Perceptions of cockpit configurations: A culture and gender analysis. *International Journal of Aerospace Psychology*, *27*(1–2), 57–63.

National Transportation Safety Board (NTSB). (2007). Aircraft accident report runway overrun and collision Southwest Airlines Flight 1248 (AAR-07/06). Retrieved from https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0706.pdf

National Transportation Safety Board (NTSB). (2016). Aircraft accident report runway excursion during landing Delta Air Lines Flight 1086 (AAR-16/02). Retrieved from https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1602.pdf

Parasuraman, R., & Wickens, C. D. (2008). Humans: Still vital after all these years of automation. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *50*(3), 511–520. https://doi.org/10.1518/001872008X312198

Rice, S., Kraemer, K., Winter, S. R., Mehta, R., Dunbar, V., Rosser, T. G., & Moore, J. C. (2014). Passengers from India and the United States have differential opinions about autonomous auto-pilots for commercial flights. *International Journal of Aviation, Aeronautics, and Aerospace*, 1(1). Retrieved from http://commons.erau.edu/ijaaa/vol1/iss1/3

Rice, S., Mehta, R., Winter, S. R., & Oyman, K. (2015). A Trustworthiness of Commercial Airline Pilots (T-CAP) scale for American consumers. *Journal of Aviation Technology and Engineering*, *4*(2), 55–63.

Rice, S., & Winter, S. R. (2015). Which passenger emotions mediate the relationship between type of pilot configuration and willingness to fly in commercial aviation? *Aviation Psychology and Applied Human Factors*, *5*(2), 83–92. https://doi.org/10.1027/2192-0923/a000081

Rice, S., Winter, S. R., Deaton, J. E., & Cremer, I. (2016). What are the predictors of system-wide trust loss in transportation automation? *Journal of Aviation Technology and Engineering* *6*(1), 1–8.

Rice, S., Winter, S. R., Doherty, S. & Milner, M. N. (2017). Advantages and disadvantages of using internet-based survey methods in aviation-related research. *Journal of Aviation Technology and Engineering*, *7*(1), 58–65.

Schwartz, S. H. (2009). Culture matters: National value cultures, sources and consequences. In R. S. Wyer, C. Y. Chiu, & Y.- Y. Hong (Eds.), *Understanding culture: Theory, research and application* (pp. 127–150). New York, NY: Psychology Press.

Wiegmann, D. A., & Shappell, S. A. (2001). Human error analysis of commercial aviation accidents: Application of the human factors analysis and classification system (HFACS). *Aviation, Space, and Environmental Medicine*, *72*(11), 1006–1016.

Winter, S. R., Rice, S., Mehta, R., Cremer, I., Reid, K. M., Rosser, T. G., & Moore, J. C. (2015). Indian and American consumer perceptions of cockpit configuration policy. *Journal of Air Transport Management*, *42*, 226–231. https://doi.org/10.1016/j.jairtraman.2014.11.003

Wu, C., & Jang, L. (2008). The moderating role of referent of focus on purchase intent for consumers with varying levels of allocentric tendency in a collectivist culture. *Journal of International Consumer Marketing*, *20*(3–4), 5–22. https://doi.org/10.1080/08961530802129128

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