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Indian and American consumer perceptions of cockpit configuration policy

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ABSTRACT

Prior studies have examined the passenger's trust in a human operated system versus an autonomous autopilot operated system. The results indicated that passengers had a more negative attitude toward the autopilot systems. The current study expands on this by examining perceptions of different cockpit configurations, and exploring cultural differences between Indian and American individuals. Participants from both India and the United States were asked to imagine a) that they were on a commercial flight, b) that they were sending a package on a cargo flight, or c) that they were on a corporate flight. In addition they were told that the aircraft was piloted by: a) two pilots in the cockpit, b) one pilot in the cockpit and one pilot located in a ground facility using remote controls, or c) two pilots in a ground facility using the remote controls. The results demonstrated that participants were strongly against having two pilots on the ground controlling the aircraft with remote controls, although most accepted this if the pilots were remote controlling cargo flights. In addition, American participants had more extreme views than the Indian participants, except with the cargo situation.

1. Introduction

Prior research clearly demonstrates that there are major cultural differences between individuals from India and the United States. In addition, studies have been completed that have examined the level of trust that a potential airline passenger would have in autonomous autopilot systems. However, there has been little research that examines the effect of culture on an individual's level of trust in these autonomous systems. Therefore, participants were polled from India and the United States. A brief background and theoretical foundation will be provided followed by the methodology, results and discussion, and then conclusions of the study.

2. Background and theoretical foundation

Passengers must place their trust in flight crews who operate the aircraft. As technology develops, it may become feasible to replace some or all of the cockpit flight crew with autonomous systems. Technology can allow this to happen, but it is important to capture the reactions of the passengers to the possibility that, instead of a pilot in the cockpit, the pilot or pilots are located in a room on the ground controlling and monitoring the flight. Additionally, it is useful to determine how an individual's cultural background affects their trust of these systems and therefore their willingness to travel as a passenger on such a flight.

While differences between Indian and American cultures have been found in many previous studies, differences in comfort, trust, and willingness to use automated technologies related to the flight of commercial aircraft have not been investigated in detail. Hence the purpose of this study is to: a) examine perceptions of different cockpit configurations, and b) explore cultural differences between Indian and American individuals with regard to these perceptions.

2.1. Comparisons of culture: India and the United States

Each year, there are approximately 50 million passengers that fly through India (Carrerio, n.d.). India is experiencing rapid growth in the aviation market and has the potential to be a leader in the transformation of the flight and automated industries (Couchen and Lieching, 2008). Meanwhile, the Aircraft Owners and Pilot's Association (2010) has estimated that the number of commercial pilot certificates being issued in the Unites States has decreased by

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29%, which indicates a potential pilot shortage in the near future. Furthermore, Boeing (2013) recently reported that within the next 20 years there would be a need for 489,000 new commercial pilots worldwide.

Increased advancements in automated and remote controlled flight technology may mitigate the pilot shortage problem. Public perceptions and culturally influenced attitudes toward such technologies should inform the regulation and marketing of such systems, as well as their design. Apple and Android applications have been increasingly utilized by airlines combined with the available Wi-Fi technologies in flight (Airlinetrends.com, 2013). The ability for passengers to communicate in real-time with the crew, and to access in-flight entertainment through their wireless devices, have allowed airlines to generate ancillary revenue through in-flight product purchases. The growing usage of these in-flight capabilities and applications is a useful indicator of the customer's potential feelings towards the technologies related to automated flight capabilities. It suggests that our society is becoming more open to using various types of technologies related in aviation. Culture, however, is another aspect that is an important factor in the acceptance of the use of these new technologies.

Helmreich (2000) defined culture as "the shared norms, values, and practices associated with a nation, organization, or profession" (p. 134). An individual's inclination to trust others may also be influenced by cultural background (Hofstede, 1980). Furthermore, it has been demonstrated that propensity to trust can be related to whether a person is considered an introvert or an extrovert, with the latter being more willing to trust other individuals (Gaines et al., 1997; Omodei and McLennan, 2000; Shikishima et al., 2006).

Individualism versus collectivism and uncertainty avoidance has been investigated to compare the national level of cultural difference between countries. Markus and Kitayama (1991) determined that collectivist cultures have an interdependent view of the self, and that they are taught to trust without question (Wu & Jang, 2008). Furthermore, people from a collectivist culture tend to regard the opinion of others more importantly with respect to their decision-making and would consider other people's interests over their own in order not to contradict or offend them.

India scored 48 out of 100 on Hofstede's Cultural Values by Nation Index regarding the individualistic versus collectivist dimension, indicating a mainly collectivist culture with some individualistic characteristics (Robbins and Judge, 2009). On the other hand, a country like Guatemala scored six, which is the lowest score possible, indicating a highly collectivist culture. A very individualistic culture such as the United States scored the highest value of 91.

Uncertainty avoidance (Robbins and Judge, 2009) is defined as the "extent to which a society feels threatened by uncertain and ambiguous situations and tries to avoid them" (p. 125). This can be used to determine a culture's feelings toward automated flight technologies because the use of automated or remote-controlled aircraft can be regarded as ambiguous or uncertain. In terms of uncertainty avoidance, India scored a 40 out of 100 and the US scored 46. This slight variance in score still indicates that there is a difference in uncertainty avoidance between India and the US, where Indian individuals would be less extreme in their responses toward new technologies than would US individuals.

2.2. Expansion of automated technologies and trust

The growth and reliability of automated technologies can improve task performance and allow users to successfully multitask (Wickens and Dixon, 2007). The four stages of automation are information synthesis, diagnosis, selection, and execution (Parasuraman et al., 2000). These four stages are similar to human information processing. Moreover, trust in the automation system by the user is dependent on a number of factors. Sorkin and Woods (1985) stated that an individual that can access raw data could make a choice to accept or reject the automation's recommendation; however, if it fails, both operator trust and dependence are affected.

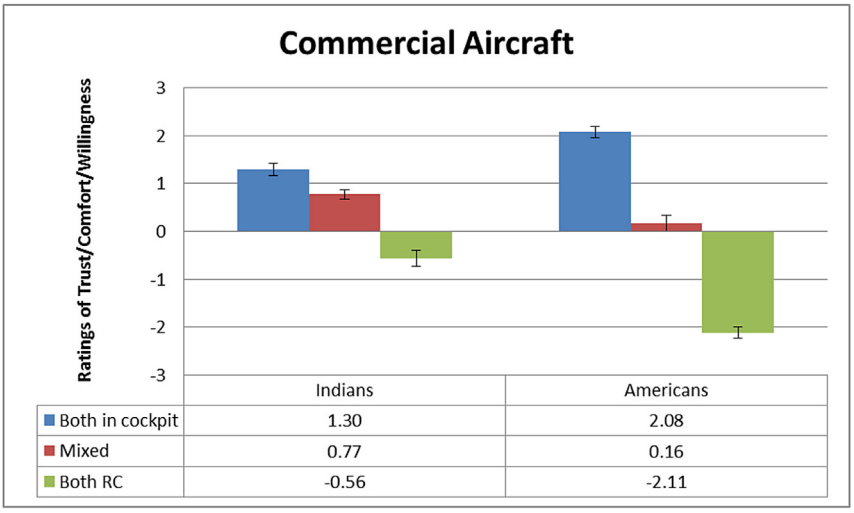
Comfort, trust, and willingness to use automated technologies are aspects that need to be considered due to the nature of potential negative consequences if used inappropriately (Merritt and Ilgen, 2008). Due to the exponential growth in automated technologies (Rice, 2009), individuals will interact with and use machines that they feel they can trust. Moreover, machine characteristics linked to perceptions of trust such as competence, predictability, and dependability can be related to these automated technologies, and can affect the level in which a user will place their trust in the system. Consumer willingness to use automated technologies will have a direct impact on the financial success of the air transport industry as these technologies are increasingly incorporated into daily operations.

A previous study investigated the passenger's trust in a human operated system versus an autonomous autopilot operated system (Hughes et al., 2009). The results indicated that passengers had a more negative attitude toward the autonomous autopilot system compared to having human pilots operating the aircraft, even when monetary discounts would be offered to fly with the auto-pilot system. A more recent study examined the cultural differences between Americans and Indians with respect to their perceptions of remote controlled and automated commercial flight operations (Rice et al., 2014). This had two layers. The first layer observed the passenger's comfort, trust, and willingness with respect to being in an aircraft piloted by either a human, a fully automated aircraft with no human involved, or with a human pilot located at a ground facility that had the capability to remotely control the aircraft. The second layer involved observing the cultural and sociological aspects by asking the same questions but comparing their responses on perceptions of the various flight configurations with who was on board the aircraft: themselves, their child, or their colleague.

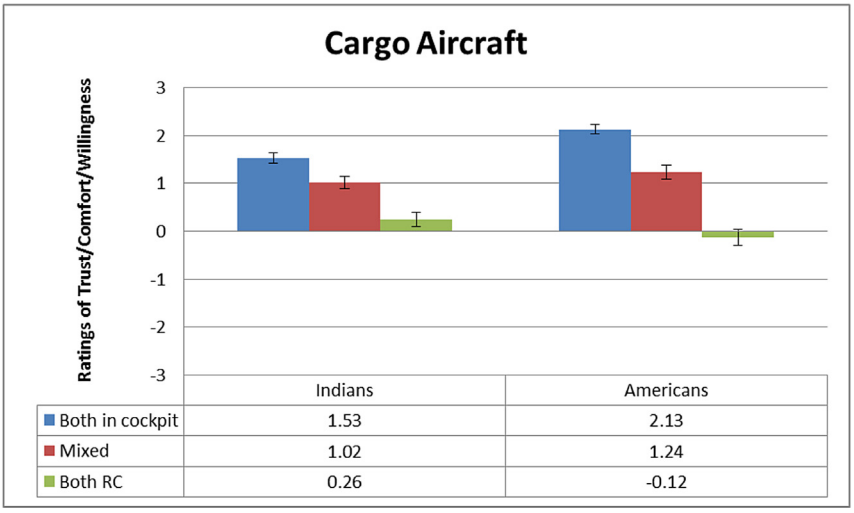
The results indicated that Indians and Americans both had a high positive view on having human pilots located in the cockpit, whereas completely automated or remote controlled configurations were negatively rated. Furthermore, the results confirmed that Indian culture is more collectivistic, because the attitudes towards automated and remote controlled aircraft were less negative compared to American participants. Lastly, the results demonstrated the concept of self-preservation and the desire to protect one's offspring. Both groups of participants across all three pilot scenarios had a lower rating in terms of trust, willingness, and comfort when these were to be on board as opposed to their colleagues. Furthermore, the participants had an even more negative rating when their child was on board compared to themselves or their colleagues.

2.3. Current study

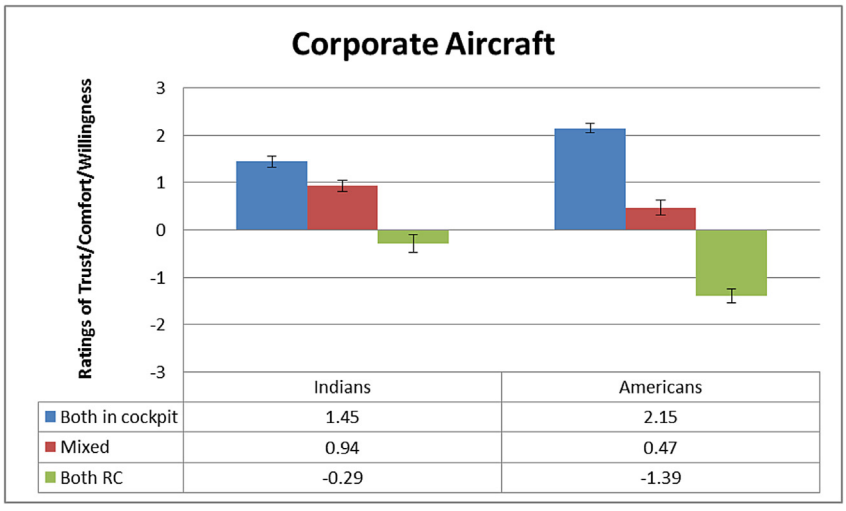
Previous research has shown the importance of consumer perceptions when proposing changes to the traditional cockpit. No research that we know of has looked at consumer perceptions of cockpit configurations where one pilot is located in the cockpit and the co-pilot is located at a ground facility, with the ability to fly the airplane via remote control. Participants from India and the United States were given scenarios about: a) two pilots located on the cockpit; b) one pilot located in the cockpit and one pilot located in a ground facility using remote controls; or c) two pilots located in a ground facility using remote controls. They were told that the airplane was a commercial, corporate or cargo flight. Participants



	Indians	Americans
Both in cockpit	1.30	2.08
Mixed	0.77	0.16
Both RC	-0.56	-2.11



	Indians	Americans
Both in cockpit	1.53	2.13
Mixed	1.02	1.24
Both RC	0.26	-0.12



	Indians	Americans
Both in cockpit	1.45	2.15
Mixed	0.94	0.47
Both RC	-0.29	-1.39

Fig. 1. Data from the study. Standard error bars are included.

were asked to rate their comfort, willingness to fly, and trust in the pilot configuration. We hypothesized the following:

H_1: That participants would feel more positively about having both pilots in the cockpit compared to the other two conditions, and that they would feel more positively about having a mixed configuration compared to having both pilots at the remote-control ground station.
H_2: That participants would feel more positively about the pilot configurations in the corporate aircraft compared to the commercial aircraft, and that they would feel more positively about the cargo aircraft compared to both others.
H_3: That American participants would have stronger opinions overall about the various scenarios compared to Indian participants.
H_4: That there would be possible interactions between the variables; however, this is a non-directional hypothesis.

3. Method

Six hundred and seven (with 206 females) participants from the United States and India took part in the study. The mean age was 31.53 (SD = 10.50). The survey was presented online using FluidSurveys®. Participants were recruited via Amazon's® Mechanical Turk® (MTurk). MTurk is a global online service that enables participants (Turkers) to participate in Human Intelligence Tasks (HITs) in exchange for monetary compensation. Participation in any HIT is voluntary and anonymous. MTurk has been shown to provide reliable data that is comparable to laboratory data (Buhrmester et al., 2011; Germine et al., 2012).

Participants first signed an electronic consent form. They were then asked to imagine themselves in one of the following scenarios: a) that they were on a commercial flight, b) that they were sending a package on a cargo flight, or c) that they were on a corporate flight. Following this, they were told that the aircraft was piloted by: a) two pilots located on the cockpit; b) one pilot located in the cockpit and one pilot located in a ground facility using remote controls; or c) two pilots located in a ground facility using remote controls. The scenarios were randomly presented.

After each scenario, participants were asked how comfortable they would feel in the scenario, how much they would trust the entity piloting the aircraft, and how willing they would be to participate in the scenario. These responses were given on a 7-point Likert scale from Extremely Uncomfortable/Distrust/Unwilling (−3) to Extremely Comfortable/Trust/Willing (+3). A neutral response of zero was permitted. Upon completion of the study, participants were debriefed and paid. There were two between-participant independent variables with 3 (type of aircraft) and 2 (country of participant) levels each, along with one within-participants variable (type of pilot configuration) with 3 levels. Thus, this was a 3 × 3 × 2 mixed factorial design.

4. Results and discussion

First, the three dependent variables (trust, comfort, and willingness) were subjected to a Cronbach's Alpha test to determine the level of internal consistency. The values ranged from .73 to .89. Due to the high internal consistency between the answers, the data were averaged into one score per participant. These data can be found in Fig. 1.

A 3 × 3 × 2 ANOVA was conducted on the data using Country and TypeOfAircraft as between-participant factors and TypeOfPilot as a within-participant factor. There were main effects of Country ($F(1, 601) = 7.27$, $p = .007$, $\eta p^2 = .01$), of TypeOfAircraft ($F(2, 601) = 32.77$, $p < .001$, $\eta p^2 = .10$), and TypeOfPilot ($F(2, 1202) = 595.98$, $p < .001$, $\eta p^2 = .50$). There was a 3-way interaction ($F(4, 1202) = 4.13$, $p = .003$, $\eta p^2 = .01$), along with 2-way interactions between Country and TypeOfAircraft ($F(2, 601) = 5.91$, $p = .003$, $\eta p^2 = .02$), Country and TypeOfPilot ($F(2, 1202) = 70.76$, $p < .001$, $\eta p^2 = .10$), and TypeOfPilot and TypeOfAircraft ($F(4, 1202) = 13.49$, $p < .001$, $\eta p^2 = .04$).

We first predicted that participants would prefer the traditional cockpit over the mixed configuration, which in turn would be rated more positively than both pilots located on the ground using remote control. The results from all three aircraft types clearly show this occurrence and support the predictions of the research. Participants felt more negatively about the completely remote controlled aircraft with two pilots on the ground as compared to the other two options, but the greatest differences in ratings were observed when dealing with the commercial aircraft.

Some of the possible influencers of these ratings are discussed in order to gain some plausible understanding. Airline consumers often make their judgments and develop beliefs based on emotions (Winter et al., 2014) rather than rational facts and scientific data. Technological advancements have shown that automation can be an extremely accurate and reliable tool, yet many consumers could be holding on to their beliefs of a traditional two pilot crew being the most comforting and reliable option for air travel. The traditional two pilot configuration may also be more favorable due to the perception that in case of a medical emergency affecting one pilot, there remains a person in the cockpit to rely upon.

The second hypothesis predicted that the participants would overall feel more positively about the corporate aircraft as compared to the commercial aircraft, while additionally feeling more positively about the cargo aircraft as compared to both the other options. This was supported in some part by the data. The participants felt less negatively about the configurations in the corporate aircraft as compared to the commercial aircraft, but the differences were not statistically significant. Their views on the issue did not substantially alter with the change of aircraft type in this case. The slight differences observed could be due to a number of factors, of which the most plausible or possible are the ones involving the participant's perceptions of corporate aviation. It could be perceived that corporate aviation is of a higher standard, with better, more professional pilots, more advanced and with safer aircraft. Additionally, a perception issue that may explain the findings is that people believe that with a smaller, sophisticated aircraft, there are fewer items that could fail, and therefore lead to one concluding that they are less likely to have failures.

The second hypothesis included the prediction that participants would feel more positively towards the various pilot configurations when dealing with the cargo aircraft as compared to the other two options. This was partially supported by the results, as the ratings of trust, comfort, and willingness with respect to the non-traditional configurations are less negative than those seen when rating the corporate and commercial aircraft. These findings are interesting and might be explained by a number of possible rationales. The most plausible explanation may lie in the concept that the lives of human passengers will not be at risk. Since cargo aircraft do not carry the burden of passengers' lives on board, consumers appear more willing to accept conditions that they would not accept if human lives were involved. Conversely, it is interesting to note that the participants may not have analyzed the scenarios from the perspective of aircraft as a hazard to human life on the ground. In that case, no matter the type of load on board the aircraft, it could still cause catastrophic damage and loss of life. We can only speculate whether or not participants took this into consideration.

The third hypothesis stated that the American participants would have more extreme responses than the Indian participants, and this was partly supported by the results of the study. Both sets of participants recorded results with the same trend of opinions, however American participants were more positive about having the traditional cockpit and generally more negative about having a non-traditional cockpit configuration. Base cultural differences of the individualistic American nature as opposed to the collectivistic Indian culture could largely be at play in this case (Markus and Kitayama, 1991; Robbins and Judge, 2009). The collectivistic culture has a tendency to trust and rely upon one's government and its authority (Robbins and Judge, 2009), and therefore appear less opposed to radical new technologies that have been deemed safe for public air travel. Previous research has proposed that the collectivistic nature teaches one not be a challenger, which could be influencing ratings of trust, comfort, and willingness (Gaines et al., 1997; Omodei and McLennan, 2000; Shikishima et al., 2006).

An interesting observation arising from the data lies in the ratings of the non-traditional cockpit configurations in the cargo aircraft option. In this case, the American and Indian participants show no significant differences in their opinions and attitudes towards the automation and the technological changes to the cockpit configurations. This could lead one to believe that the involvement of human life in the equation is causing the differences in ratings between the two different participant nations.

When comparing the different cockpit configurations and the aircraft types, certain interactions are witnessed, as was predicted in the fourth hypothesis. Fig. 1 reveals several interesting results. First, while participants across the board felt more negatively about having a non-traditional cockpit for all flights compared to the other types of aircraft, this was especially apparent in the condition where two pilots would be located in a ground facility using remote controls, with the largest differences appearing in the commercial flight condition. Second, the type of aircraft mattered when it came to views on the non-traditional cockpit; that is, in most cases, participants were more comfortable with the non-traditional cockpit in the cargo flight compared to the other two aircraft. Third, while Americans in general tended to be more extreme in their views about the type of cockpit configuration, this was most evident in the commercial and corporate flights.

5. Conclusions

The purpose of this study was to examine consumer perceptions of various cockpit configurations—two on-board pilots, a hybrid condition of one pilot in the aircraft and one remotely controlling from the ground, and two pilots on the ground using remote control. Additionally, two different cultures, Indian and American, were examined as well as various types of operations: commercial, cargo, and corporate aircraft. The findings suggest that participants felt most strongly against the configuration where two pilots were located on the ground and controlled the aircraft remotely, especially in the commercial aircraft example. The data shows that participants appear most accepting of the completely remote controlled configuration for cargo flights. In general, American participants had more extreme views than the Indian participants, except in the cargo condition. The results of this study, along with future research should inform the policies and regulations associated with increasing automation and remote control in aviation. Furthermore, marketing strategies must consider such consumer perceptions if automated air transport is to succeed.

Numerous real world implications can be derived from this study, and therefore this research is valuable to the aviation industry. Consumer perceptions are the backbone of a service-oriented industry such as aviation. Without the trust of the consumer, the economic viability of the industry would crumble, and therefore studies of this nature are needed to reveal consumer perceptions of both current and future scenarios. If the passengers are not comfortable with the technology being employed for air travel, they may not choose it as their first preference of transportation. This study allows aviation experts, airline operators, and the industry as a whole to gauge the readiness of the public to accept radical changes in terms of cockpit configurations. The data show that participants in general feel negatively towards completely remote controlled aircraft with no pilots in the cockpit, and thereby inform us that passengers are likely to be unwilling to fly on commercial or corporate aircraft employing the same.

Conversely, it shows that participants do not feel as negatively about having a hybrid cockpit with one pilot in the cockpit, while the co-pilot is located in a remote-control ground station. Furthermore, participants were not negative about new configurations being utilized in cargo aircraft operations. Future studies should delve further into this field to explore other possible economically efficient alternatives to the traditional two pilot cockpit, which continue to uphold the passenger's feelings of trust and safety. Along the lines of the hybrid cockpit configuration, future studies may see a need to decipher the optimal ratio of remote control pilots on the ground to the number of aircraft served airborne.

Though this research sheds some light on the opinions of passengers regarding the future of aviation, it does have some limitations. First, it only collects data from two different nationality bases. In order to obtain a more accurate and globalized generalization of consumers' perceptions, more data should be collected to include a more diverse group of nationalities. Second, the sampling of participants was limited to those who participate on Amazon's® Mechanical Turk®. While this population has been shown to provide reliable data, it is not representative of the entire population of either country. Third, the data was collected via hypothesized scenarios and not real-world situations, something that is currently impossible to do.

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