WHAT INFORMATION ABOUT CONSUMERS PREDICTS THEIR TRUST IN AUTOPILOTS?

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Introduction

In order for pilots to carry passengers from one destination to another they must rely on their indicators and controls to take them there safely. This also includes their ability to use autopilot technology to help facilitate ease of travel and safety for not only pilots but passengers, as well. Autopilot technology is always advancing and now we are seeing that technology being incorporated into commercial aviation and UAS's doing tasks such as transporting goods to people's homes to performing military operations Despite this advancement in technology, passengers may feel nervous about pilots relying on autopilot technology for flight instead of flying manually. What types of passengers trust autopilots and find that autopilots are reliable?

Autopilots have been around for many years and the technology keeps improving. However some may argue pilots rely too much on autopilots which can be looked at as a handicap instead of flying with manual controls. Autopilots are a valuable resource in not only helping to aid pilots with flying safely and accurately but also aid in long duration flights. In *Plane and Pilot* (2012) Bill Cox talks about the usefulness and importance of autopilots. Pilots traveling for long duration flights become fatigued and may have to navigate through turbulent weather thus relying on autopilots for aid and accuracy in flying. Without the aid of autopilot, flying could be more difficult with higher degrees of human error. To begin utilizing autopilot technology we must first have trust in automation.

With more processes and technology becoming automated consumers may have mixed feelings and perceptions which could lead to a lack of trust in automation. In order for automation to be successful there needs to be a certain level of trust from consumers. Three studies conducted by Dzindolet, Peterson, Pomranky, Pierce and Beck (2003) looked at the relationship among automation trust, reliability, and resilience. Participants were shown slides of Fort Sill terrain and were asked to specify whether or not there was a camouflaged soldier while being assisted by an automated decision aid. Initially they found participants were trusting of the automated aid until it started making errors. An explanation of errors was needed to regain trust in the automation so they would know why the error occurred. This study helps to show how trust of automated systems can be swayed depending on the reliability of the system. Our study was focused on discovering what factors determined a person's trust in autopilot. Our hypothesis is as follows:

Ho: There will be no significant predictors of trust in autopilots when controlling for all other variables
Ha: There will be at least one significant predictor of trust in autopilots when controlling for all other variables

Methods

Participants

Eighty-nine (48 females) participants from the United States participated in this study. The study utilizes participants that were recruited via Amazon's ® Mechanical Turk ®, and were compensated for their completion of the survey. The mean age was 37.12 (*SD* = 13.16).

Procedure, Materials and Stimuli

First, the participants were asked to fill out a consent form and given instructions. Participants were given a hypothetical scenario about flying on a commercial flight from one major city to another. The participants were told that an autopilot would control the entire flight from takeoff to landing. The study utilized a previously validated trust scale adapted to fit the context of this research (Rice, Mehta, Winter & Oyman, 2015). Participants responded to the trust statements along a 5-point Likert-type scale from Strongly Disagree (-2) to Strongly Agree (+2) with a zero neutral option. A second aspect to the study was that participants were presented with another hypothetical situation. Participants were told that they had ordered a package from an online retailer, and that the package would be delivered via a drone (Unmanned Aerial Systems – UAS) operated by an autopilot. The same scale was used to rate participants' level of trust in the autopilot. The participants were then asked for demographic information, as well as a series of questions about personality traits, after which they were debriefed and dismissed.

Design

The study employs a correlational design using two stepwise regressions in order to create two regression equations in order to find significant predictors to autopilot trust. The two prediction equations being created refer to trust in autopilots as it relates to commercial air travel, and the use of UAS for package delivery. The factors being tested in this study as potential predictors of autopilot trust are: gender, age, political affiliation, education level, income, Frequency of air travel per year, trust in technology, number of high-tech devices owned, ratings of aviation technology encountered, general attitudes towards technology, general attitudes towards machine, knowledge about autopilots. The dependent variable is the participants' trust scores.

Results

In this study, a regression analysis was conducted of the dataset with respect to participants' trust in autopilots as it related to a commercial airline flight. The predictors being tested were gender, age, political affiliation, education level, income, Frequency of air travel per year, trust in technology, number of high-tech devices owned, ratings of aviation technology

encountered, general attitudes towards technology, general attitudes towards machine, knowledge about autopilots. A backward stepwise regression was employed to eliminate statistically insignificant predictors. The resulting model included two significant predictors, general attitudes towards machines, and general attitudes towards technology out of the original twelve predictors. The regression equation created as a result of this analysis was:

$$Y = -0.09 + 0.29X_1 + 0.20\ X_2$$

where Y is predicted trust score trust in autopilots relating to commercial airline flights, and X_1 and X_2 are general attitudes towards machines, and general attitudes towards technology respectively. The model accounted for 29.40% (27.80% adjusted) of the variance in the criterion, $F(2,84) = 17.52$, $p < 0.05$.

Another similar regression analysis was conducted on participants' trust in autopilots as it relates to the use of UAS for package delivery. The predictors being tested were once again, gender, age, political affiliation, education level, income, Frequency of air travel per year, trust in technology, number of high-tech devices owned, ratings of aviation technology encountered, general attitudes towards technology, general attitudes towards machine, knowledge about autopilots. A backward stepwise regression was employed to eliminate statistically insignificant predictors. The resulting model included two significant predictors, trust in technology, and general attitudes towards machines out of the original twelve predictors. The regression equation created as a result of this analysis was:

$$Y = -0.60 + 0.01X_1 + 0.22\ X_2$$

where Y is predicted trust score trust in autopilots relating the use of UAS for package delivery., and X_1 and X_2 are trust in technology, and general attitudes towards machines respectively. The model accounted for 26.90% (25.10% adjusted) of the variance in the criterion, $F(2,84) = 15.43$, $p < 0.05$.

Discussion

As the field of aviation becomes increasingly automated, particularly around the topic of fully-automated commercial flights and UAS's, it is important to discuss the consumers' attitude toward the automation. The purpose of this study was to determine what factors were significant indicators of a person's trust in autopilots in the context of a commercial air travel and the use of UAS for package delivery. Twelve potential factors were considered; however, the stepwise regression model only identified two factors as being significant predictors: general attitudes toward technology and general attitudes towards machines. Presumably, participants who have had consistently reliable experiences with electronic devices, and who had a more positive attitude toward technology, were more trusting of autopilots. Majority of participants probably have a large amount of trust in their own electronic devices; therefore, they have more feelings of trust toward all electronic machines. Likewise, if they have a more positive attitude toward technology in general then they will be more likely to have a more positive attitude toward autopilots.

We hypothesized that at least one of the twelve factors would be a significant predictor of trust in autopilots. As predicted, general attitude toward technology and general attitude toward machines were significant predictors of trust in autopilot. During an interaction with automation, a person's trust is expected to be dynamic depending on their experience in the past and during the present. Social psychology literature has found that when lacking contradictory information, people tend to view each other, and unfamiliar or unknown things, as good (Cacioppo, Gardener, & Berntson, 1997; Dzindolet, Peterson, Pomranky, Pierce, & Beck, 2003). If people already have positive feelings toward machines and technology, then it may be possible that this positivity bias is extending to autopilots, as well.

Theoretical Contributions

Previous studies have shown that a person's willingness to use an automated device is moderated by the automation's reliability and the operator's trust in automation (Itoh, Abe, & Tanaka, 1999; Lee & Moray, 1992; Muir & Moray, 1996). In this context, "trust can be defined as the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability" (Lee & See, 2004). When people trust the automated devices they already own, because there is high reliability, this translates to trust in the autopilots within commercial aviation and UAS's.

In addition, the level of reliability of the automated device plays an important role in determining the consumers' level of trust in the device (Cohen, Parasuraman, Freeman, 1998; Dzindolet et al., 2003; Parasuraman & Riley, 1997). The more reliable an automated device is, the more trust a consumer will have in that device. Likewise, consumers tend to have less trust in automated devices that are less reliable. In everyday life, people's experiences with automated devices tend to be fairly reliable; our computers don't crash every single day, phones reliably send texts and receive calls, air conditioning turns on and off as scheduled, etc. Therefore, people who experience high reliability with the automation devices they already own might judge autopilots in airplanes and UAS's as highly reliable, as well.

Applications

As society becomes increasingly automated, it is important to consider how consumers feel about fully automated technology, such as self-driving cars and fully autonomous airplanes. Companies will need to consider the best methods of encouraging trust between the user and the automation. Our study provides evidence of two factors that are significant predictors of trust: general attitudes toward machines and general attitudes toward technology. Companies should consider that automation that is highly reliable encourages consumers to have higher trust in the automation, and therefore use it more frequently. Future research should consider how to strengthen a person's attitude toward machines and technology. If this relationship can be strengthened, then it may be possible to influence the amount of trust a person has in automation and their willingness to use automated devices.

Limitations

One limitation of our study may be the use of convenience sampling via MTurk. MTurk has been shown to have similar reliability, gender, and ethnicity data composition as data that is collected in the lab (Johnson & Borden, 2012). However, since we are not in control of who participates, it is possible that our pool of participants did not contain a large amount of variability. Additionally, participants responded to the questionnaire using pre-determined answer choices. While this allows for everyone to have to same options, we may have missed information identifying potential predictors because participants were not allowed to write in their own answers.

Conclusions

Technology has allowed for several advances in automation and it is important to consider what factors predict consumers' trust, particularly in high-risk environments, such as autopilots for commercial aviation and UAS's. Previous research has shown that a person's willingness to use an automation device is moderated by the automation's reliability and the operator's trust in automation (Itoh, Abe, & Tanaka, 1999; Lee & Moray, 1992; Muir & Moray, 1996). Our study determined two factors that were significant predictors of consumers' trust in autopilots in commercial aviation and UAS's, general attitudes toward machines and general attitudes toward technology.

Participants were given a hypothetical scenario about flying on a commercial flight and responded to trust statements along a 5-point Likert-type scale from Strongly Disagree (-2) to Strongly Agree (+2) with a zero neutral option. In a second hypothetical situation, participants were told that they had ordered a package from an online retailer, and that the package would be delivered via a drone (UAS) operated by an autopilot. The same scale was used to rate participants' level of trust in the autopilot. A regression analysis was conducted of the dataset with respect to participants' trust in autopilots with twelve different factors being considered. The resulting model included two significant predictors, general attitudes towards machines, and general attitudes towards technology. Further research should be done to explore the relationship between general attitudes towards machines/ general attitudes towards technology and trust in autopilots.

References

Cacioppo, J., Gardener, W., Berntson, G. (1997). Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. Personality and Social Psychology Review, 1(1), 3-25. doi: 10.1207/s15327957pspr0101_2

Cohen, M.S., Parasuraman, R., Freeman, J.T., 1998. Trust in decision aids: A model and its training implications. Proceedings of the 1998 Command and Control Research and Technology Symposium. CCRP, Washington, DC.

Cox, B. (2012). *Autopilots equal safety*. Braintree: Madavor Media LLC.

Dzindolet, M., Peterson, S., Pomranky, R., Pierce, L., & Beck, H. (2003). The role of trust in automation reliance. International Journal of Human-Computer Studies, 58(6), 697-718. doi:10.1016/S1071-5819(03)00038-7

Itoh, M., Abe, G., & Tanaka, K. (1999). Trust in and use of automation: Their dependence on occurence patterns of malfunctions. IEEE International Conference Proceedings. doi: 10.1109/ICSMC.1999.823316

Johnson, D., & Borden, L. (2012). Participants at your fingertips: Using Amazon's Mechanical Turk to increase student-faculty collaborative research. Teaching of Psychology, 39(4), 245-251. doi: 10.1177/0098628312456615

Lee, J., N. Moray (1992). Trust, control strategies and allocation of function in human machine systems, ergonomics, 35(10), 1243- 1270.

Lee, J., & See, K. (2004). Trust in automation: Designing for appropriate reliance. The Journal of the Human Factors and Ergonomics Society, 46(1). doi:10.1518/hfes.46.1.50_30392

Muir, B., Moray, N. (1996). Trust in Automation. Part 11. Experimental Studies of Trust and Human Intervention in a Process Control Simulation, Ergonomics, 39(3), 429-460.

Parasuraman, R., & Riley, V. (1997). Humans and automation: use, misuse, disuse, and abuse. The Journal of the Human Factors and Ergonomics Society, 39(2), 230-253. doi: 10.1518/001872097778543886

Rice, S., Mehta, R., Winter, S., & Oyman, K. (2015). A trustworthiness of commercial airline pilots (T-CAP) scale for American consumers. Journal of Aviation Technology and Engineering, 4(2), 55.