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## Risk Perception Analysis of a Small Aircraft Transportation System

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### Abstract

This study examines the impact and relationship between demographic factors and risk perceptions toward Small Aircraft Transportation Systems (SATS). The study included 178 participants who responded to an electronic survey administered to Purdue University faculty members and to selected leaders within the Purdue Intercollegiate Athletics department. Participants were surveyed as to their demographic identities including gender, age, academic position, and aviation familiarity, as well as their perceptions of physical, financial, and status risk from a SATS program. Results of this study showed that certain demographic factors are significant predictors of certain SATS travel risk perceptions. Participants' intentions to travel via SATS also are identified to be a function of their demographic identity. Future research topics are discussed to further validate the results of this study.

*Keywords:* risk, risk perception, small aircraft transportation systems, general aviation, transportation

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### Introduction and Purpose of the Study

In late 2010, Purdue University acquired a fleet of Cirrus SR20 aircraft and an Embraer Phenom 100 aircraft. In addition to serving as training aircraft for the university's flight program, these aircraft were conceptualized to serve in a collegiate Small Aircraft Transportation System (SATS), providing efficient and economical transportation services to university personnel for official travel. However, it was recognized that before full implementation of a university-driven SATS program could be completed, further research would be needed on issues such as pilot training, economical benefit, efficiency, and risk analysis. This paper focuses on the risk analysis component.

The purpose of this study was to complete an impact analysis of risk perceptions of selected faculty and staff from Purdue University, relative to the SATS mode of transportation. Existing relationships among population demographic variables, risk perceptions, and intentions to travel via a collegiate SATS program were studied in order to understand the values of those who would possibly use such a system. A summary of SATS concepts is presented, and a review of the literature concerning risk, risk perception, demographic predictors, and the impact of each is discussed. The literature review is followed by the methodology, data analysis, and results and discussion of the study.

## Review of the Literature

### *Background on the Small Aircraft Transportation System*

The National Aeronautics and Space Administration (NASA) has conducted research programs attempting to determine the viability of a nationwide SATS program. These research programs were developed from the realization that the capacity of current transportation infrastructure, including the hub and spoke system of scheduled air carriers, struggles to meet the nation's rapidly-growing transportation demand, especially to smaller communities (Tarry & Bowen, 2001; Holmes, Durham, & Tarry, 2004).

To address these issues, NASA invested \$69 million toward a five-year research initiative that concluded in 2005 (NASA, 2008). The vision of the research was to develop a new mode of transportation that would allow people to avoid overly-congested interstate highways and inefficiently scheduled air carriers by creating an infrastructure of small aircraft that could provide access to more communities in less time. NASA proposed a Small Aircraft Transportation System that would utilize advanced, four- to ten-passenger aircraft, which would provide efficient, safe, and reliable access to the nation's 5,400 public-use airports, of which only 660 are served by scheduled carriers (NASA, 2008). NASA's vision was to significantly reduce travel time and relieve the currently congested transportation systems by making use of the nation's small airports, of which approximately 98 percent of the population lives within 20 miles (NASA, 2008).

A research committee appointed by the Transportation Research Board (TRB) and funded by NASA published its findings and suggestions concerning SATS in Special Report 263, *Future Flight: A Review of the Small Aircraft Transportation System Concept*. Results supporting the pursuit of SATS included the potential to shift highly-congested air traffic to more lightly used areas, as well as to extend air transportation services to small communities (Transportation Research Board, 2002). The research committee also identified potentially unfavorable outcomes of SATS. A highlighted concern about SATS was its affordability for the general public and individuals who are price sensitive when selecting a means of transportation. In addition, committee members felt that infrastructure limitations at small airports and a lack of significant demand outside of metropolitan areas would create large obstacles to the success of SATS (Transportation Research Board, 2002).

Motivated by NASA's research, a study was undertaken at Purdue University to determine the feasibility, impact, and advantages of an intra-collegiate SATS program. The Purdue SATS program will utilize Cirrus SR20 and Embraer Phenom aircraft, owned and operated by the university. These aircraft fit NASA's description of SATS aircraft, as they provide single-pilot utility, make transpor-

tation services available to small airports, and utilize advanced technology to allow operations through complex airspace.

### *Defining Risk*

To create a favorable market in which a SATS operation can prove successful, the origin and development of risk perception must be thoroughly understood (Reisigner & Mavondo, 2005). Webster's defines risk as a "possible hazard or danger" (2002, p. 375). Risk perception, the focus of the study, is defined by Pidgeon (1998) to "include people's beliefs, attitudes, judgments, and feelings" (p. 5) toward the purchase of a product or service, or participation in an activity. After considering alternatives, an individual will finally make a decision based on the association between the individual's perception of risk and his or her risk tolerance level (Reisigner & Mavondo, 2005).

Recently, economics, finance, science, and many other disciplines have all used theories of risk as decision-making tools (Dowling & Staelin, 1994). Schiffman and Kanuk (1991) identified seven types of risk in consumer behavior studies: financial (loss of monetary value if the service is worse than predicted), functional or performance (not meeting the customer's needs), physical (injury to oneself or losing respect), social (lowering perceived status with society or losing respect), psychological (effect on self-esteem), satisfaction (not personally satisfied), and time (lack of efficiency). Financial, physical, and social risks were included in this study, as they pertain most directly to SATS within a university environment. The term 'social risk' was replaced with 'status risk' to focus more directly on participants' perceptions on how SATS would affect their public image.

### *Identifying Perceptions Towards Risk*

Pidgeon (1998) theorized that the public's view of risk in one society is likely to be very different from that in another, due to the development of distinct personal values within each culture, as well as within separate social demographics. To better define these differences, relationships must be found between risk perceptions and demographic predictors (Pidgeon, 1998). This methodology is commonly referred to as the cultural theory of risk perception (Rippl, 2002). Popularized by Karl Dake in the early 1980s, cultural theory measures the impact of values and cultural influence on an individual's perception of risk. Wildavsky and Dake (1990) explained that cultural biases determine how individuals perceive risk. Individuals are viewed as active organizers who choose what to fear in order to support their way of life. These concepts relate to the current study as the demographics of participants may play an important role in determining the type and level of perceived risk (Flynn, Slovic, & Mertz, 2006).

According to a study by Barke, Jenkins-Smith, and Slovic (1997), gender differences are accepted as a reliable predictor of risk perception; they found that women perceived greater environmental risk hazards than men. In a study of the Canadian public, it was found that women perceived risk higher than men in 37 out of 38 hazard studies (Slovic, Flynn, Mertz, & Mullican, 1993). In many cultures, women are raised as caregivers and nurturers, which may increase their perception of hazards as risks. Men also tend to exploit resources to a greater extent and be less sensitive to hazards or threats (Slovic et al., 1993). This suggests that gender may play a role in comfort level and likelihood of using a SATS program.

Perceptions of safety and perceived risk may greatly influence an individual's acceptance of a SATS program. If perceived risk is too high or above risk tolerance levels, individuals will likely choose an alternate form of transportation perceived to be less risky (Stewart, 2004). The influence of one's personal judgments and feelings has a much greater effect on decision-making than objective facts (Stewart, 2004). This study is necessary to develop a better understanding of an individual's risk perceptions of SATS.

**Methodology**

*Instrumentation*

A structured questionnaire was administered to Purdue University professors and administrative staff identified as potential users of a SATS program. An introductory e-mail was sent to the participants inviting them to complete the anonymous, electronically-distributed, voluntary, and self-administered survey. No information regarding SATS was provided to participants prior to completion of the survey. Participants' demographic characteristics were recorded, including age, gender, academic position, and aviation knowledge, as was the participants' perception of physical risk, financial risk, status risk, and potential intentions to travel via the SATS model. Response data were analyzed using Qualtrics, a statistical analysis software package.

*Data Analysis*

An analysis of the data was completed to identify possible demographic predictors of participants' perceived risk of SATS. The results consisted of categorical data, and a Chi Squared test was used to compare means and identify significant differences at a  $p = .05$  level (Boslaugh & Watters, 2008).

**Results and Discussion**

*Participant Demographics*

The SATS Risk Perception Survey was administered to faculty members from the College of Technology, the

College of Agriculture, and selected senior staff from Purdue Intercollegiate Athletics, for a total of 531 targeted subjects. A response rate of 34% was achieved with 178 participants completing the survey. A limited number of participants chose to skip some questions such as age and gender, due to the sensitive nature of these questions. Therefore, an n value will be supplied for all analyzed questions. The demographics of the responses are shown in Table 1.

*Physical Risk*

Participants were asked five questions addressing their perceptions of physical risk when traveling via various forms of air transportation. When asked if they would feel comfortable flying in a university-owned single-engine airplane, more males than females agreed that they would be comfortable. Of the male participants, 78% agreed that they would feel comfortable flying in a university-owned single-engine airplane, compared to only 61% of the female participants,  $\chi^2 (2) = 6.03, p = 0.05, n = 170$ . Additionally, 13% and 29% of the male and female respondents, respectively, reported that they were undecided concerning their comfort level. The disagreement rates for both genders, however, were similar, with 9% of the males and 8% of the females reporting that they would feel uncomfortable in a university-owned single-engine airplane. These findings are consistent with an earlier study completed by Barke et al. (1997), which concludes that

Table 1  
Demographics of Responses

Demographics	Survey Participants	
	n	Percentage
Gender (n=175)		
Male	133	76.0
Female	42	24.0
Age (n=159)		
18-29	1	0.6
30-39	26	16.4
40-49	40	25.2
50-59	56	35.2
60-69	32	20.1
70-79	4	2.5
Academic Position (n=178)		
Staff	6	3.2
Instructor	5	2.8
Assistant Professor	38	21.3
Associate Professor	54	30.3
Professor	57	32.0
Dept. Head or Chair	8	4.5
Dean	2	1.1
Senior	2	1.1
Administration		
Other	6	3.2
Pilot Certificate Holder (n=178)		
Yes	28	15.7
No	150	84.3

gender differences are a reliable predictor of risk perception, and women perceive greater environmental risk hazards than men in many different scenarios.

The participant’s familiarity with general aviation also showed statistically significant differences in his or her comfort level with SATS. A Likert scale with response options of 1 to 5 was used for participants to rank their familiarity with general aviation; 1 being not familiar with general aviation and 5 being very familiar with general aviation. A Chi Squared test, comparing participants’ familiarization with general aviation to their comfort in a university-owned general aviation airplane, showed that more familiar participants were also more comfortable. Of the participants who indicated no familiarity with general aviation, 43% agreed they would be comfortable in a single-engine airplane, compared to 89% of the participants who indicated a high familiarity with general aviation,  $\chi^2(8) = 23.19, p < 0.01, n = 173$ . A similar result was observed when comparing the answers from those participants having a pilot certificate to those without; those with a pilot’s certificate were much more comfortable flying on a single-engine airplane. For the participants holding a pilot certificate, 96% would be comfortable in a university-owned single engine airplane, in contrast to only 70% of those without a pilot certificate,  $\chi^2(2) = 7.46, p < 0.05, n = 173$ .

In the comment section, 29% mentioned the word ‘small’ (referring to aircraft size) when describing why they would not fly via a SATS program. Several expressed concerns about this issue, with comments such as “(I) don’t like small planes, feel the turbulence too much,” or “I don’t trust small planes, too noisy.” Those who are more familiar with general aviation and have greater knowledge about small aircraft seem less likely to possess such perceptions of physical risk associated with SATS-type aircraft.

*Financial Risk*

To identify financial risk, participants were given three scenarios, followed by a series of questions to determine their preferred means of transportation for a given business trip. Each scenario required participants to consider three hypothetical business trips departing from Lafayette, IN and traveling to Louisville, KY; Atlanta, GA; and Miami, FL. An example scenario read as follows, “You must travel from Purdue University to Atlanta, GA for a meeting that begins at 10am and ends at 3pm (Distance = 600 miles or 965 kilometers).” For each example, participants were asked to estimate the number of days away from the university that would be required if they were traveling via a car, Cirrus airplane, Phenom airplane, and airline. Next, participants were asked to rank the four means of transportation representing their preference in transportation for each given scenario. Participants were asked to make their rankings after considering the assumed operating cost of the vehicle and the value of their time.

After answering the three scenario-based questions, participants were asked to rank the importance of the cost of transportation, time spent in transit, schedule, and convenience when selecting a means of transportation to complete a business trip. The results are shown in Figures 1 and 2. Figure 1 includes responses solely from assistant professors and indicates that the cost of transportation was selected as the most important variable. In contrast, Figure 2 includes responses from only full professors where time spent in transit was selected as the most important variable. The differences between the assistant professor and professor groups may be explained by a dissimilar view of the value of time. Professors place the most value on time, while assistant professors place the most value on cost. The contrast in participant’s views was further emphasized in the

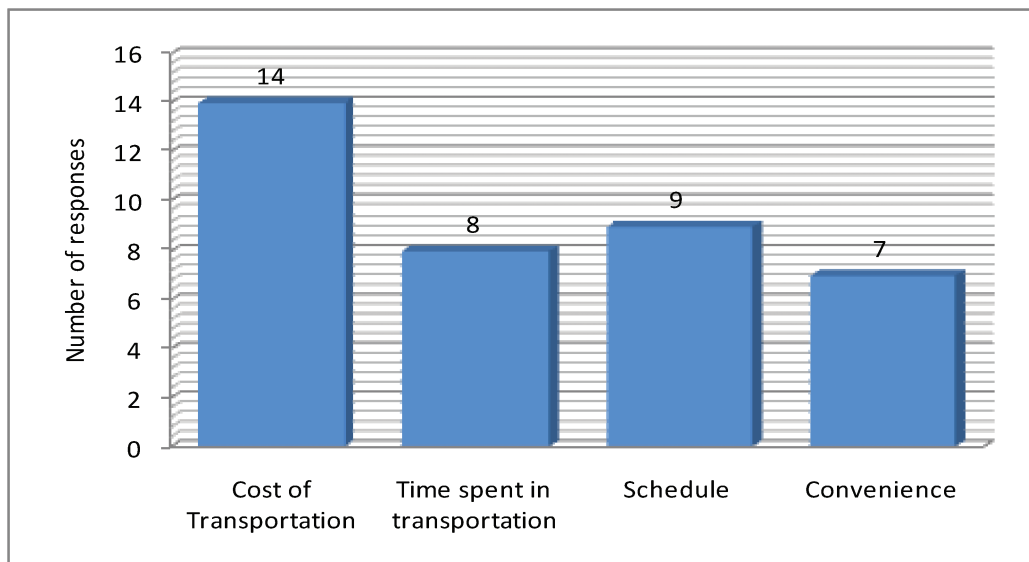


Figure 1. Highest ranked travel concerns for assistant professors.

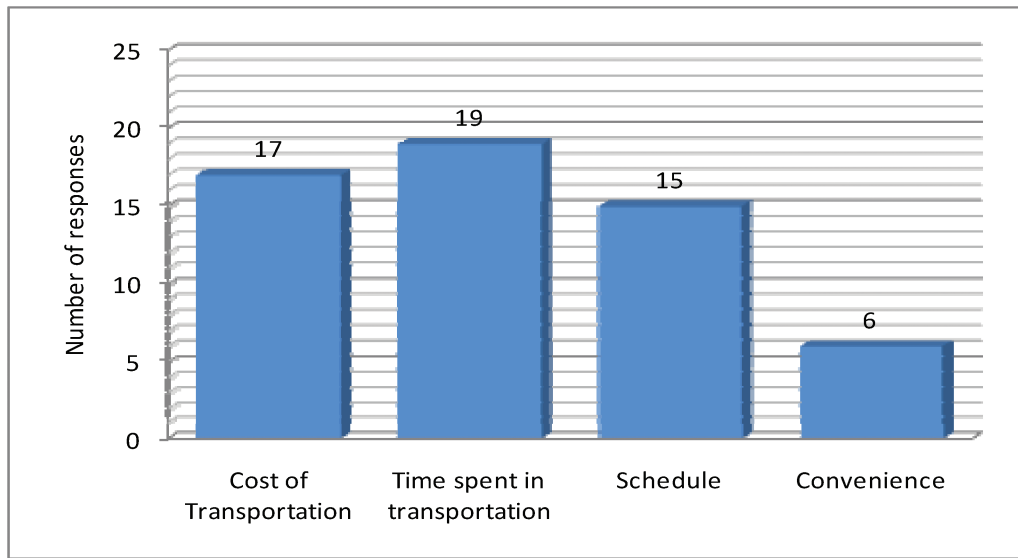


Figure 2. Highest ranked travel concerns for professors.

comments section. Time, convenience, and/or cost were identified in 44% of the comments. Comments such as, “time is my most valuable resource and reducing travel time is of great importance to me,” compared to, “too expensive for what I do,” clearly demonstrates disparity in the value of time / cost among participants.

*Status Risk*

Pictures of four airplanes were shown to participants: an Embraer Phenom, Beechcraft King Air, Cirrus SR20, and Piper Arrow. After observing the pictures, participants were asked if the airplanes would positively, negatively, or not at all, affect their public image.

Gender seemed to impact the perceived status risk associated with traveling in each type of airplane. A Chi Squared test showed that more men thought arriving in either a King Air or a Phenom would positively affect their public image than did women. In both cases, a substantially greater number of males indicated that their public image would be positively affected, while more females answered that their public image would not be affected,  $\chi^2(2) = 9.13, p = 0.01, n = 166$  and  $\chi^2(2) = 11.72, p < 0.01, n = 166$ , respectively. Results also indicated that a statistically-significant response difference exists between those with varying aviation familiarity levels when considering status risk perception with the King Air  $\chi^2(8) = 16.8, p < 0.05, n = 169$  and Cirrus  $\chi^2(8) = 18.11, p < 0.05, n = 168$ . Participants were considerably more likely to respond that the King Air and Cirrus would positively affect their public image if they were more familiar with general aviation.

Additionally, the survey data revealed how participants thought airplane type could affect their social status. The Phenom resulted in the highest positive effect on public image at 53%, followed by the King Air at 42%, the Cirrus at 27%, and the Arrow at 21%. The ‘negative effect’ responses

are similar across all four types with the Phenom at 4%, the King Air at 2%, the Cirrus at 9%, and the Arrow at 10%.

*Likelihood of Utilizing SATS for Transportation*

In a final focus of the study, participants were asked to indicate whether or not they would travel via a Cirrus and/or Phenom on their next university business trip. Response options were yes, no, and undecided. Participants more familiar with general aviation were more likely to agree to fly on a Cirrus,  $\chi^2(8) = 18.52, p < 0.05, n = 164$ . For the Cirrus, 86% of participants with familiarity of general aviation and 33% of participants with little familiarity of general aviation would use the Cirrus for their next business trip. However, general aviation familiarity did not seem to contribute as much in a participant’s decision to select the Phenom for his or her next business trip  $\chi^2(8) = 10.79, p = 0.21, n = 164$ . For those participants familiar with general aviation, 91% would choose to utilize the Phenom on their next business trip, along with 57% of the participants who said they were unfamiliar with general aviation. These findings seem to suggest that a greater number of participants feel more comfortable flying in the Phenom aircraft than the Cirrus. Further research could validate these findings and attempt to identify the perceived increase in comfort level with the Phenom aircraft.

*Summary and Conclusions*

Findings from the current study provide a view of the travel risk perceptions associated with SATS implementation within a university environment. Gender, academic position, and general aviation familiarity appear to be the greatest predictors of SATS risk perceptions for participants. Similar to research conducted by Barke et al. (1997), gender was shown to produce significantly different responses to questions about perceived physical risk. Academic position differences were the most reliable predictor of financial risk perception within

the sample group. Participants with a higher academic position placed more emphasis on the value of their time over the cost of transportation, and are more likely to utilize SATS for university travel. General aviation familiarity was a significant predictor of physical risk perception and status risk perception. These findings may be the result of greater knowledge, thus reducing any associated perceived risks. Further research could attempt to strengthen these results by measuring participants' level of risk perception before and after an educational seminar about general aviation.

Understanding the significance of relationships between demographic characteristics and risk perception may improve efforts to support SATS implementation within the university environment. With this knowledge and awareness, educational strategies can adapt to these issues and properly target demographic groups with appropriate messages. Effective awareness can also encourage the use of SATS for university travel by minimizing the associated perceptions of risk.

## Appendix A—Summary of Statistical Results

Section	Independent Variable	Dependent Variable	Statistical Test	Test Statistic	Statistical Significance	Conclusion
Physical Risk Perception	Gender	Comfortable flying in a university owned single-engine aircraft	Chi-Square	$\chi^2 (2) = 6.03$ $p = 0.05$ $n = 170$	YES	Findings suggest gender is a reliable predictor of comfort level flying in a small aircraft
	Familiarity with general aviation	Comfortable flying in a university owner single engine aircraft	Chi-Square	$\chi^2 (8) = 23.19$ $p < 0.01$ $n = 173$	YES	Familiarity with general aviation appears to be a reliable predictor of comfort level flying in a small aircraft
	Pilot Certification	Comfortable flying in a university owned single engine aircraft	Chi-Square	$\chi^2 (2) = 7.46$ $p < 0.05$ $n = 173$	YES	Participants certified as pilots are more comfortable flying in a single engine aircraft than participants who were not.
Status Risk Perception	Gender	King Air's positive affect on public image	Chi-Square	$\chi^2 (2) = 9.13$ $p = 0.01$ $n = 166$	YES	Gender appeared to be a predictor of participant's view towards how the King Air would affect public image
	Gender	Phenom's positive affect on public image	Chi-Square	$\chi^2 (2) = 11.72$ $p < 0.01$ $n = 166$	YES	Gender appeared to be a predictor of participant's view towards how the Phenom would affect public image
Status Risk Perception	Gender	Cirrus' positive affect on public image	Chi-Square	$\chi^2 (2) = 1.87$ $p > 0.05$ $n = 165$	NO	Gender appeared to not be a predictor of participant's view towards how the Cirrus would affect public image
	Gender	Arrow's positive affect on public image	Chi-Square	$\chi^2 (2) = 2.22$ $p > 0.05$ $n = 167$	NO	Gender appeared to not be a predictor of participant's view towards how the Arrow would affect public image
	Familiarity with general aviation	King Air's positive affect on public image	Chi-Square	$\chi^2 (8) = 16.8$ $p < 0.05$ $n = 169$	YES	Familiarity appeared to be a predictor of positive public image for the King Air
	Familiarity with general aviation	Phenom's positive affect on public image	Chi-Square	$\chi^2 (8) = 8.45$ $p > 0.05$ $n = 169$	NO	Familiarity appeared to not be a predictor of positive public image for the Phenom
	Familiarity with general aviation	Cirrus' positive affect on public image	Chi-Square	$\chi^2 (8) = 18.11$ $p < 0.05$ $n = 168$	YES	Familiarity appeared to be a predictor of positive public image for the Cirrus
	Familiarity with general aviation	Arrow's positive affect on public image	Chi-Square	$\chi^2 (8) = 8.53$ $p > 0.05$ $n = 170$	NO	Familiarity appeared to not be a predictor of positive public image for the Arrow
	Likelihood of SATS Use	Familiarity with general aviation	Selection of Cirrus (Yes, No, Undecided)	Chi-Square	$\chi^2 (8) = 18.52$ $p < 0.05$ $n = 164$	YES
Familiarity with general aviation		Selection of Phenom (Yes, No, Undecided)	Chi-Square	$\chi^2 (8) = 10.79$ $p = 0.21$ $n = 164$	NO	Familiarity appeared to have no effect on selection of the Phenom

\*NOTE: Descriptive statistical analysis was used to determine Financial Risk Perceptions. Therefore, these results are not summarized in the Appendix.

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