System Wide Trust Contagion Effect

By

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Abstract

TITLE: System Wide Trust Contagion Effect

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Trust is integral in any service industry, especially in the consumer-oriented field of aviation. The first step of this research is the reorganization of the importance of trust. To understand its importance on the industry, it is necessary to study trust and its effects in depth. The purpose of this study is to further explore the relationship between the passengers’ trust in automation, and trust in humans. Oftentimes, when automation fails, some human is responsible for harboring the blame. The theory of System Wide Trust (SWT) has only been recently developed, but its effect on the field of aviation is proving to be noteworthy. SWT theory predicts that an item will experience a decrease in trust due to a decrease in reliability of an unrelated item within the system. SWT theory therefore predicts merging of trust levels of independent components. SWT has the potential to be explored in several areas of aviation, and the full reach of the effect is still unknown. An area that has yet to be focused on is whether the effect is strong enough to have a contagion effect from the automation platform to the human entities in the system. This study seeks to determine if a contagion effect
from automation to human entity of a commercial flight system exists. The study will present the participants with either a scenario in which an automated aid fails during a commercial flight or one where there is no failure of automation. The participants will then rate their levels of trust in different human entities of a commercial flight system. This will be conducted through two different surveys and two different groups of participants for each survey. This study will expand the understanding of SWT effect as well as human’s trust in the context of aviation.
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Chapter 1

Introduction

Problem Statement

Trust and faith in automation play significant roles in commercial aviation. However, the relationship is believed to be more complex than merely the trust in automation. The aim of this study is to further research the effects and presence of system wide trust (SWT) in aviation consumers. SWT theory has been observed in different settings with operators using automated aids and is beginning to establish its presence in the scientific community. The predominant research within the realm of SWT has involved studies testing the effect of humans’ trust in automated devices. This has been done using both operators and consumers. This study will attempt to determine the presence, if any, of the contagion effect of SWT. The contagion effect under review involves the transference of lost trust on human entities when presented with a scenario involving an automation failure. The human entities involved are the flight crew, flight attendants, mechanics, and airline CEO. There could be a possible SWT effect on automation as well as human entities that are involved in the situation.
Purpose Statement

Being a new area of research, SWT theory has many potential avenues of exploration. Studies have dealt with the theory in different ways, using varying parameters such as analyzing operators and their trust in automated aids. Even though prior SWT research has been conducted in the field of aviation automation, previous studies have not covered the areas of any possible transference of feelings towards human entities during automation failures. This study will attempt to determine one possible contagion effect that may exist within the application the SWT theory. Due to previous issues with SWT effect on unrelated automated devices, the experiment will utilize 600 participants from India and the US. These participants will provide ratings of affect and trust in both automated and human entities based on hypothetical situations. The purpose of this study is to see if failures in automation have a negative effect on the trust in the human entities. For the purpose of this study, the hypothetical commercial airline flight will be referred to as the system. This system includes all the automated aids, including the one that may fail, and the human entities.
Operational Definitions

In order to enhance understanding and create an atmosphere of uniform understanding amongst all readers the following terms and phrases will be operationally defined.

Trust
A version of the definition of trust is the firm belief in the reliability, truth, ability, or strength of someone or something. For the analysis of this study, trust will refer to the participants’ scores on the Likert-type scale of the survey (see Appendix A).

Affect
Affect refers primarily to feeling or emotion (Hogg, Abrams, & Martin, 2010). In the context of this study, affect refers to the participants’ scores on the Likert-type scale of the survey (see Appendix B).

Research Questions and Hypotheses

Research Questions (RQ)

RQ1: Is there a contagion effect of System-Wide Trust from the failed automated aid to the human entity?

RQ2: Does the country of origin for participants influence this relationship?
RQ3: Does Affect mediate the relationship between the condition and trust?

Hypotheses

Null Hypothesis 1

H₀₁: In the failure condition, there will be no drop in trust in the unrelated automated aids or human entities.

Alternative Hypothesis 1

Hₐ₁: In the failure condition, there will be a drop in trust in the unrelated automated aids or human entities.

Null Hypothesis 2

H₀₂: There will be no difference in trust and affect ratings for the unrelated automated aids or human entities as a function of country of origin.

Alternative Hypothesis 2

Hₐ₂: There will be a difference in trust and affect ratings for the unrelated automated aids or human entities as a function of country of origin.
Null Hypothesis 3

$H_{04}$: The relationship between the condition and trust is not mediated by affect.

Alternative Hypothesis 3

$H_{A4}$: The relationship between the condition and trust is mediated by affect.

Null Hypothesis 4

$H_{05}$: There will be no interaction between the variables.

Alternative Hypothesis 4

$H_{A5}$: There will be an interaction between the variables. However, this is a non-directional prediction, as we have no a priori basis for a directional prediction.

Significance of the Study

The areas of trust and trust in automation have been significantly researched in the past. These studies have therefore lead to the exploration and development of the SWT theory. SWT research has predominantly focused on analyzing the effect on an operator’s trust in automated aids within the system when one device fails. As mentioned earlier, SWT theory has yet to reach its full potential and reach in the scientific community. The initial research studies dealing with the theory have yielded some
interesting results. These studies have solidified the basis of this theory within the academic community. This study aims at further exploring the capabilities of SWT while increasing its exposure in the aviation branch of the scientific community.

The next phase of this line of research involves a deeper exploration of the intricacies of SWT theory. With a deeper understanding of the SWT theory, will also come the knowledge of possible impacts of this phenomenon on different industries, aviation and otherwise (eg. Energy harnessing, nuclear power, etc.). This study’s significance lies in the attempt to determine one possible contagion effect with the transference of SWT effect from automation onto a human entity. The previous studies have all dealt with the SWT effect from one automated aid to other aids. This study seeks to expand the theory by adding the element of SWT transference. The transference of the SWT effect from automation onto human beings could reveal potential future areas of study for the scientific community in general. Based on this study, other lines of research may seek to explore their transference or contagion effect. This study will allow future research to expand the SWT theory and apply it to other realms and industries that were otherwise thought these connections to be irrelevant.

Some studies have also examined the cultural differences in the way a person trusts based on their nationality. The cultural analysis aspect of this study will be able to expand on that area of research. It will attempt to
gauge the influence of cultural upbringing on trust in automation. The cultural analysis attempts to identify differences in ratings of trust. This is a significant aspect as culture could influence the behavior of an individual when dealing with automation. The research into cultural differences provides a major significance to the study by being able to understand the effects of the theory on a global scale. This increases the study’s relevance as aviation is a global industry. The impacts of the findings will aid in its appropriate application in different manners in unique cultures.

Finally the mediation analysis attempts to provide statistical probability related to understanding the causal influences involved. The study will try to determine if affect mediates the relationship. Understanding the manner in which human beings tend to behave in this fashion when dealing with automation and other humans adds significance to the research. Understanding whether the effect is primarily based off of an emotional feeling or reaction will give great insight into the phenomenon. It will ultimately guide the manner in which the industry seeks to practically tackle the contagion effects in the future.
Assumptions and Limitations

Assumptions

To conduct any valid scientific research, some assumptions have to be made in to generate relevant findings. This study makes certain assumptions that are outlined in this section.

The first and major assumption involves the truthfulness and concentration of the participant while answering the online survey. The researchers assume that the answers provided are the participants’ genuine feelings. It is assumed that they are putting effort into their thought process rather than simply completing the task to receive compensation. Without this assumption, all the data collected would be inadmissible. The researchers would not be able to make scientific generalizations of the sample to the population. When dealing with a sample to make generalizations for a population, it is to be noted that a sampling error is present.

The study will employ an analysis of variance model as the primary methodology of data analysis. The researcher will make every effort to ensure that the variables are measured and analyzed precisely. Using a properly designed instrument of data collection, the assumption is made that the measurement is reliable. This will avoid any confounding errors of
estimation in the data analysis phase. Standard assumptions have to be made to ensure the results are in line with Type I or Type II errors. Osborne & Elaine (2002) showed that if the assumptions are not met, the results of the study could contain errors. Errors in assumption can lead to a Type I error (over-estimation) or Type II error (under-estimation). All statistical data analyses, assumptions, and estimations will be conducted using the IBM SPSS Statistics Software.

**Limitations**

Research in the field of SWT has not been extensive. It is still very much in its infancy. Dealing with a new area of research always poses certain limitations and issues to circumnavigate. This study has certain limitations that must be considered. The researchers must therefore account for these limitations in the analysis of the obtained results.

One of the main limitations of the study deals with the research instrument itself. The study utilizes an online survey tool called FluidSurveys ® and participants will be recruited via Amazon’s ® Mechanical Turk ®. This takes the control of the environment away from the researchers. As these platforms do not allow for any supervision, it opens the data up to certain risk exposures. This convenient sampling does allow for a random representative sample of the travelling consumer public. It does however also come at the cost associated with using an online
surveying tool. MTurk, an online source of participants who are compensated for their services, has increasing become a popular surveying tool in the research community. Prior studies have iterated that MTurk data is as reliable as laboratory data (Buhrmester, Kwang, & Gosling, 2011; Germine, et al., 2012). Additionally, it must be noted that participants were compensated for the participation in the study. This does add another layer of subtext to understanding the mindset of the consumer participating in the study.

When dealing with a new line of research as this study does, the financial support and funding are limited. For this reason, the bare minimum number of participants required was utilized. With additional funding and resources, the study could be more extensive with larger sample sizes. This would be able to more accurately determine the strength and extent of the effect.
Chapter 2

Literature Review

Introduction

Understanding the cognitive and emotional relationship between technology and humans, and between humans themselves, is a difficult task. The primary focus of the literature analysis tends to be centered on the analysis of trust. Arriving at a definition of trust that best suites the context of the study is key. Within the field of aviation, trust is a factor at play in several aspects, namely, the trust of the passengers in the aircraft, the pilot, the other airline employees; the trust between the pilots; and the trust of the pilot in his aircraft. The foundation of all this trust is the trust in the automation technology.
Section One

Trust

In large part, trust is considered to be a psychological construct and a product of human emotion. Trust can be defined in several different ways depending on the context and the relative field of study. Numerous studies have supplied varying definitions of trust that are accepted by the scientific community. For the context of this setting, some studies (Deutsch, 1958; Eckel & Wilson, 2004; Ergeneli, Saglam, & Metin, 2007) that define trust as the predictability in another person are applicable. Other research projects (Reeves & Nass, 1996; Rice, 2009; Parasuraman & Riley, 1997) have attempted to apply this understanding to the realm of automation and technology. By using the term predictability, the definition of trust merges with that of familiarity. If the predictability of an outcome is high and the result is as expected, it alleviates the fears and dangers associated with the unknown. This allows for the item or situation to be deemed more trustworthy. With the countless number of encounters humans face with each other, trust can play a major role in their outcomes. A high level of trust allows for one to predict and have faith that a person will do what is expected, leading to a positive interaction (Lee & See, 2004). It is important to note that trust is a construct of the trustor.
Other studies define trust in the terms of vulnerability and the relinquishment of control to another person or object to perform what is expected in the best interest of the trustor (Meyer, et.al., 1995). The common theme amongst all lies in the faith of a positive outcome. Trust is built with repeated positive outcomes of a specific task. Rotter (1967) discusses trust in a different form stating that the expectation of someone’s word or an agreement with an individual could be relied up was the basis of the idea of trust. Several works (Barber, 1983; Rampel et al., 1985; Rotter, 1967) explain trust as being dependent on the performance of the other individual, the chances of certain events occurring, and lastly, responsibility, monetary or otherwise. Theses studies classify the psychological relationship as a perception of expectancy. Trust affects dependence, which is considered to be a behavior.

Cultural and sociological characteristics affect the function of trust in a number of ways (Mechanic, 1996). Trustworthiness and trust are volatile functions. This is primarily due to the fact that they are subjective to a person’s feelings. Trustworthiness, unlike trust, is a psychological construct of the trustee. While trust is a trait bestowed upon someone, trustworthiness is a perception held by a person of someone else. Research has shown that trust can be easily affected, even though it is an extremely powerful psychological occurrence. Once trust in someone or something is influenced or lost, it can be almost impossible to recover. Trust is
sometimes impossible to be completely rebuilt to its previous level. This
could be the case even over extended periods of time. Some research even
stipulate that in certain situations, once trust is lost, it might never be
recovered or regained (Slovic, 1993). An important aspect of trust that
should be noted is that it varies significantly from one person to another. It
is relative to the people and the situation. Hassan and Semerciöz (2010)
stated that a person’s ability to trust, and to what level, is based on a variety
of different factors. These include individual personality traits, cultural
characteristics, and most of all past personal experiences.

People from varying walks of life are going to have differing points
of view towards trust. A person who has had negative interactions in a
specific scenario is less likely to be trusting in the future when placed in a
similar situation. A person is more likely to be considered trustworthy in the
future if the other parties involved have considered him/her to be
trustworthy in the past. In the same manner, people may have varying views
on what traits they believe are required to be considered trustworthy. The
development of an individual’s model of trust can be influenced by factors
such as cultural upbringing and societal characteristics. In the context of
this study, the predominant differences are seen when comparing citizens of
collectivistic societies, like those of India, to individualistic societies as
seen primarily in the United States. These aspects will be discussed in depth
in later sections.
As mentioned earlier, trust is a psychological construct that varies from individual to individual. A study conducted in the Cuddalore district of Tamil Nadu, India, focused on the perceptions of trustworthiness. The study stated that perception are based not just on the facts and analyses that are said to constitute information, but on the context within which information is accessed (Srinivasan, 2007). A study of consumer perceptions of trustworthiness from India identified certain characteristics as significant predictors of overall trustworthiness. These were integrity/honesty, communication/similarity, shared values, expertise, and ability/consistency (Roy, Eshghi, & Shekhar, 2011). The aviation industry is a consumer based market, and the traits of trustworthiness are relatively important in any consumer relation field. Sethi, and Allen (1984) stated that the traits of ability, interpersonal warmth, trustworthiness, interpersonal strength, motivation, and family orientation are highly desirable in Indian society. It can be inferred that these are highly desirable traits in the aviation market place, when considering the traits desirable in a pilot, or any other human being in the system.

Within aviation trust is an ever-present aspect of most of the connections and relationships. First, the research into the existing research will consider the human-to-human trust levels. The passengers trust several people when boarding a commercial flight. Some of these people include the pilots, the flight attendants, the maintenance crew, and other people
either directly or indirectly responsible for their flight. Secondly, the pilots must be trusting of each other to do what is expected of them, and of the maintenance crew to deliver an aircraft fit to fly. In the context of man and machine, there are a host of relationships that heavily depend on trust. The passenger’s trust in the automation and technology running the aircraft are central to this line of research.

**Automation**

Technology is a constantly evolving phenomenon to be contended with in the current day and age. Automation advancements have resulted in several innovations that have become engrained in the fabric of our everyday lives. The use of automation has become so common that we do not give it much thought. For example, the ability to have cruise control in our vehicles is now a routine commodity, but only a relatively short time in the past, it would have been an unfathomable technological ability. Automation can be equally problematic to define as trust. Similar to trust, each individual’s personal concept of automation is subjective. However, it is imperative to have a perspective based on the field or industry being analyzed. It can be fairly difficult task to encompass all aspects and pin down the definition of automation in one succinct statement. Several
researchers have attempted to do so, and the most apt definitions are discussed here.

Wickens and Hollands (2000) defined automation as accomplishment of work or a mechanical or electrical task that otherwise would need to be accomplished by a human operator. Some could extend the concept to say that a hammer being used to drive in a nail is a form of automation, as it enables an operator to perform a task that he otherwise would not be able to perform without considerably more amounts of effort. These are extremes, and they do not necessarily directly apply, but they aid in painting the picture of a range of concepts associated with this one term. While focusing on the aviation industry, the most commonly recognizable forms of automation are the technological abilities of new age aircrafts that run on several different computer systems. Due to the assistance provided by automation to the operator, resources are freed up. The operator is more available to dedicate attention to varying tasks. If automation is taking care of certain rudimentary functions, the operator is free to focus on other tasks. It enhances the ability of the operator to multi-task, and subsequently increases efficiency. Bainbridge (1983) showed one of the benefits of automation whereby it could perform tasks that were not suitable for a human operator to effectively perform, specifically, monitoring a series of gauges for an extended period of time.
The field of automation has created some useful technological products that have allowed mankind to extend its reach of possible tasks. The list of the benefits of automation and the aid that it can provide is endless. It does not however come without its skeptics and flaws. It is therefore necessary for the operator to be able to trust the automation and the automated systems that he/she is dealing with. Trust in automation is a fairly extensive research field. Several aspects of previous studies provide valuable insights into this line of research based on the human perception towards automation. One of the industries that has seen the biggest advancements in the use and impacts of automation is aviation.

Studies have shown that the operator’s trust and, in turn their dependence on the automation is significantly influenced by his/her perception of its reliability (Geels-Blair, Rice, & Schwark, 2013; Parasuraman & Riley, 1997; Rice, 2009; Rice & Geels, 2010). An issue arises as operators are aware of the downfalls of automation, but due to complacency or laziness, they often ignore the failure possibilities and put complete trust into the automation. We are quite aware of the different forms of automation failures, namely false alarms and misses. False Alarms (FA) are the instances where the automation believes a threat occurs in the environment when this is not actually the case. Misses are the cases where a threat truly does exist, and the automation fails to detect it. The more instances where the automation operates appropriately increases the pilot’s
trust in the system. On the other hand, malfunctions or errors caused by the technology could potentially cause the trust to be irreparably broken. The prior is more cause for concern, as it tends to build an attitude of complacency in the pilot. If he/she has an unrealistic perception of the automation’s reliability, it could harbor a situation where the pilot is unprepared for an automation failure. This could have devastating and even fatal outcomes.

Several research studies (Reeves & Nass, 1996; Rice, 2009; Parasuraman & Riley, 1997) have shown that the social psychology definition of trust can be translated to aid in understanding trust in automation. In these studies, trust is the predictability of another person (Deutsch, 1958; Eckel & Wilson, 2004; Ergeneli, Saglam, & Metin, 2007). The interactions between humans can be applied to how humans interact with machines; therefore, trust can be related to human-machine interactions (Geels-Blair, Rice, & Schwark, 2013). Parasuraman, Sheridan, and Wickens (2000) identify four stages of automation: synthesis, diagnosis, response selection, and response execution. This is where the operators’ trust and reliance in automation can be understood. If operators believe they are able to predict the outcome of the automation, then they will be more trusting of the system. Prior research has shown positive relationships between trust and reliance (Rice, 2009).
System-Wide Trust

This study offers a new research avenue in the field of automation based on the SWT theory. SWT theory introduces a concept where the operator tends to treat a group of automated aids as one system and assigns a single level of trust or reliance in the system as a whole rather than in the independent aids (Geels-Blair, Rice, & Schwark, 2013; Keller & Rice, 2010; Rice & Geels, 2010). To get a well-rounded understanding of the importance of the current study, the research must first identify the various other research that has been conducted in this field.

Research studies (Maltz & Shinar, 2003; Meyer, 2001, 2004; Rice, 2009) began with single-aid paradigms looking at trust towards automation. These studies aided the further understanding of the operator’s trust in automation and were useful to the industry. This translated to research that only introduced an operator to a single automated aid. However, in the aviation setting, it is unrealistic to consider trust in a single automated aid when the actual scenario that the operator is exposed to involves an entire system and network of different aids either working together or independently in harmony. In 2010, the research by Keller and Rice began to study this theory. The aim was to discover whether participants had component-specific trust or considered the aids as a system. Component specific trust refers to trust placed in independently on an aid regardless of
the trust in other aids in the system. For instance, in a cockpit, if the pilot is focusing on two different automated aids, and one was known to be reliable and the other not reliable, the pilot would make this differentiation and adjust his trust in each accordingly and independently of the other. The second form of trust is the one of concern to this line of research, namely SWT. SWT is the term for the occurrence when an operator has a combined perceived level of reliability of the system. Decreases in trust influence the trust of all the aids involved regardless of their independence of each other. In this construct or mental model, if one aid was found to be unreliable, the level of trust exhibited by the operator would diminish in all the other independent and reliable aids as well. This is the issue and the adverse effect of SWT.

Keller and Rice’s (2010) initial study aimed at simulating flight tasks that would aid in testing the two theories. The participants were placed in control of an unmanned aerial system (UAS) to be flown while monitoring two gauges for system errors. There were varying set-ups based on percentage reliability of the aids. One gauge was always at a percent reliability of 100%. The second gauge was varied to reflect three conditions with percentage reliability at 100%, 85%, or 75% respectively. The participants were informed of the reliability percentages of each of their gauges. They were then given the option to ignore the gauge or trust in it regardless of its reliability. The choice to do so was left entirely up to the
operator. The results of the study showed a distinct presence of SWT when dealing with automated aids/devices. When paired with a less than 100% reliable aid, the trust in the 100% reliable aid was negatively affected, demonstrating a perceived nature of treating the aids collectively as a system. The drawbacks of basing the theory on these conclusions were based on the fact only two gauges were used, which meant that the less than perfectly reliable aid comprised of half of the system.

This limitation was addressed in later studies in this same line of research conducted by Rice and Geels (2010). They furthered solidified the presence of this occurrence by increasing the number of perfectly reliable aids from one to three. This entailed that when the participants were being tested, they were exposed to three aids with 100% reliability and one of decreased reliability (either 100%, 85%, or 75%). This study made two important configurations in order to be able to accurately observe the presence of SWT effect. First it only employed a single-task paradigm in order to avoid the confounding issues created by dual task variables, and, secondly, the scenario used misses instead of false alarms to ensure to accurate presence of the effect. The results of the study strongly supported the theory and were a more concrete basis for the presence of SWT effect. Once the participants were informed of the unreliable nature of one of the four aids, their trust in the other three aids diminished, exhibiting the
presence of a perception of the aids as one system rather than individually unrelated automation aids.

The last installment in this line of research came from Geels, Rice, and Schwark (2013) who attempted to observe the presence of SWT when eight gauges were employed. This study also went further than previous studies to test the presence of the effect by comparing the results of using false alarms and misses in the failure/unreliable conditions. In this study, one of the eight gauges was either 100% or 70% reliable and failed in one of two ways, false alarm or miss. This study further corroborated the SWT theory and showed that even with an increased number of aids in the system, the operators’ trust in the seven reliable aids were negatively affected by the one unreliable aid. The last caveat of this study involved the analysis of the two types of failures. Interestingly, the study showed that the correlation between the failure and the SWT was greater with false alarms as compared to misses.

**Cultural Considerations**

As aviation is a global industry, any advancement within the field must be universally applicable. There is some benefit in understanding how a particular country feels towards a situation, but the value of understanding the entire global consumer base is more valuable. The current study will assess the theory in relation to two countries, the United States and India.
These two countries were strategically chosen to represent two different cultures and areas of the globe, one Western and one Eastern. Any observed differences between cultures could add significant depth to the understanding of the travelling public. It will also aid in choosing the correct direction to move forward as a global industry. Conversely, commonality in opinions between two widely varying cultures can be equally valuable in understanding the global culture of aviation.

Helmreich (2000) defined culture as norms, values and practices, on a national, organizational, and/or professional level that are shared within a society. This definition, though broad, well suits the purpose of this study, as the results will indicate if differences exist amongst the two countries in terms of norms, values, and practices as related to their opinions towards aviation and aviation related automation. A key area of interest in this research is the individualistic and collectivistic nature of the United States and India. India is generally considered to be a collectivistic society, which suggests that citizens are interdependent on one another (Markus & Kitayama, 1991). Conversely, the United States is commonly considered to be a nation that is individualistic in nature, which means that the people are more independent, in terms of being less influenced by others, and more autonomous of their fellow citizens. The independency factor could be inferred as a function of trust. Trust being a significant factor of this study, makes this cultural difference of greater importance. The trusting nature of
a collectivistic society would be interesting to note the differences in trust towards technology, automation, as well as other humans involved during a specified scenario of automation failure.

Other research studies have also observed that extroverts are more willing to trust other individuals than are introverts (Gaines et al., 1997; Omodei & McLenna, 2000; Shikishima, Hiraishi, & Ando, 2006). Wu and Jang (2008) stated that citizens of collectivistic societies are taught to totally trust without question. This is oftentimes ingrained in them from a very early age. It is said that individuals that belong to collectivistic societies exhibit allocentric tendencies, which is defined as having one's interest and attention centered on other persons. These individuals show a higher interest and concern for the opinions of others in during their decision-making process. For fear of offending a colleague, an individual raised in a collectivistic society may show a greater concern for the colleague’s well being over his/her own, and thereby avoid a contradictory decision. Similarly, most allocentric individuals look out for the best interest of the society, and have a very community-based mindset. Their collectivistic values and upbringing influence their decision-making processes and teach them to put the interest of others ahead of their own. This would have a dramatic bearing on the interpretation of data from the current study. Additionally, it is a characteristic to be mindful of when making comparisons between the two cultures. With regards to the avoidance of
contradictory decision-making, Indians, like most collectivists, are taught not to disrupt the harmony of a society by going against the grain or disturbing the status quo. They are taught to never question an authority figure, and always show utmost respect for others. This leads to an engrained nature in an individual to never contradict another person for fear of offending them and disrupting the harmony of the community. An example of this cultural trait, comes from the Japanese proverb that states, “The nail that sticks up will be hammered down,” suggesting that contradicting or standing out is not desirable; the individual will eventually be forced back into place to reinstate harmony in the society.

On the opposite end of the spectrum lies the individualistic society, as represented by the United States. In such a society, zeal and aggression are encouraged. People are taught to stand up for their beliefs, and speak out against opposition. The individualist is taught to stand on his own feet, without relying on anyone else. He/she is encouraged to stand his ground, never back down, and challenge the status quo. The United States embodies this persona and character traits, with its citizens being ever ready to confront another that opposes their point of view. Oftentimes, citizens put their own personal interests at the top of their priority list. This is not to say that either form or lifestyle is better than the other, but rather to illustrate the differences observed between the two cultures. All these perspectives give added depth to the understanding of the mindset behind the two groups of
people, and could well have influencing traits on their responses in this study.

Hofstede (1980) conducted research that suggested that the people that belonged to collectivistic cultures were more likely to trust other people. He also stated that those cultures that were more individualistic in nature manifested citizens that were less likely to trust new people. These views directly affect the nature and motives behind the actions of the citizens. In a collectivistic society like India, there is a higher propensity for bettering the community versus the striving for the individuals best interest in a culture such as seen in the United States. This is not to say that citizens from each country will always behave in these manners, but on average the tendencies appear to lie in these regards. Hofstede’s cultural value by nation index scores countries on a scale from 0 to 100 in an attempt to quantify these values and characteristics. The United States scored the highest with a 98 out of 100, while India scored a 48. This showed that as compared to the United States, India was predominantly collectivistic, but still has the potential for individualistic characteristics (Robbins and Judge, 2009).

People that are raised in collectivistic cultures are brought up from their infancy to be more interdependent on one another; are taught to always keep the communities best interest above all else; discouraged from questioning authority; and are taught to totally trust without question (Wu & Jang, 2008). The difference in the manifestations of trust between
collectivistic and individualistic societies is only one possible influencer. Several other factors related to these two diverse nationalities could be at play and influence the relationship of trust. Additionally, the difference in the age and history of the aviation industry between these two countries is a facet that could be an influencer.

A study (Carrerio, n.d.) has shown that on an average, the Indian aviation market sees approximately 50 million passengers annually. Being a rapidly developing country, and therefore a rapidly developing aviation market, India is well poised to be frontrunner for trials of future technological and automated industries (Couchen, & Lieching, 2008). A fairly young market, may be more open to experimentation with future advancements, and can prove to be a valuable asset for the global aviation industry.

Another avenue of interest in the cultural considerations is one observed by some previous research studies (Rice and Kraemer, in press). The study corroborated the idea that the views of American participants tended to be more extreme than those of their Indian counterparts. The study found that the American participants were trusting of a human pilot but distrusting of a remote controlled flight with an autopilot. Indian participants exhibited similar points of view but were much less dramatic in their opinions as compared to their American counterparts. It bears upn this study to note their differences in the current study and see whether the same
form of dramatic disparity is observed between the points of view of the two cultures. The attitudinal differences between the two cultures have been observed by previous studies. This study seeks to draw on these studies but extend on them to consider the added layers that have been implanted, namely addressing the issues of transference of SWT effect from automation failure to human entities. This will give added depth to the expansion and understanding of SWT theory, thereby increasing its ability to be applied to other areas of aviation as well as industries outside of aviation.

A large part of this research deals with examining why human beings react certain ways in specific scenarios and what affects their trust in automation/technology and humans. Analyzing the factors motivating a culture’s feelings toward automation, researchers have identified the concept of uncertainty avoidance. Uncertainty avoidance has been defined as the “extent to which a society feels threatened by uncertain and ambiguous situations and tries to avoid them” (Robbins & Judge, 2009, p.125). Ambiguous situations oftentimes arise in any industry, especially when relating to technology and automation. Some cultures may react to automation failures, a form of uncertain or ambiguous situation, differently from others. Referring back to Hofstede’s Cultural Values by Nation Index, the United States scored a 46 out of 100, while India scored a 40 on this category. This is a dimension to be considered, as it could be a factor
influencing the final feelings of trust in the automation as well as the human entities. Keeping in mind the lack of any extreme difference between the scores, it must be acknowledged that there is a marked distinction between the two countries. This could possibly be an indication of cultural precedent. As mentioned earlier, citizens of eastern countries that have predominantly collectivistic societies are taught from an early age to trust completely without question. This could be translated into the concept of taking more risks. Therefore it could be inferred that Indians are more willing to take risk where the outcome is ambiguous or uncertain, as it is a cultural norm, as compared to their American counterparts.

**Affect**

Human beings are believed to allow feelings to play a role in decision-making. Humans have for the most part, not been able to eliminate emotions from decision-making. This is not to say that emotional decision-making is a negative aspect to this analysis, but emotions do bring in a large factor of variance and unpredictability. If decisions were to be taken with purely rational outlooks, the variability and risk involved may be minimized. Conversely, these decisions may not always be the most accurate or best yielding. Rational decision-making is based purely on facts, whereas most people make decision by taking into account their instincts and giving weight to their gut feelings.
Affect has been used as an in-depth area of focus in the field of research in recent years. Research of this field has put forth the possibility that in order to process several sources of information quickly and efficiently, emotions attempt to coordinate physiological, behavioral, and experiential responses. Decisions are a function of experience, memory, attention, and judgment all in one. It is important to understand the effect emotions have on decisions. These different perspectives show the wide range of influences it can have on the final outcome. As mentioned earlier, rational decision-making is an attempt to rely on emotionless decision-making, and focus purely on facts in order to minimize risks. However, research has shown that emotions can interfere with the mental cognitive processing and can place heavy attention on the emotional content instead. This is interesting to note, because not only do emotions become a factor at play, but also by this standard, emotions can actually interrupt rationality and become an overbearing aspect of the process.

Previous sections have extensively discussed the psychological nature and construct of trust between people. The emotional connection playing a large role in the feelings of trust between persons is evident. The concept of affect is likely to show the underlying process involved in deciding to trust another human being. It is therefore perceivable to consider trust as an affect-based construct. McAllister (1995) stated that affect-based trust could be considered as a type of trust in which emotional
ties between individuals are created by sincere concern and support. The connection that is fostered by affect is the one that induces the psychological construct of trust. Once again, these understandings of the workings of affect are critical to the study as we seek to find out whether affect mediates the results of the SWT theory and its subsequent contagion effect. Other concepts in the field of affect study revolve around the phenomenon related to group based affect. When studying the relationships and feelings of trust, one research study found that if a subject had diminished trust in one individual, it resulted in a further diminished trust in the entire group that the individual was a member of. This shows the presence of a contagion effect that is not necessarily rational or based on any concrete evidence but a merely affectual, emotional decision. Essentially, experiencing negative feelings or distrust at an individual level spurred distrust on a larger scale. This is of course pertaining to human-human interaction. However, as shown earlier there is much to be said for the similarities found in the psychological characteristics of human-to-human interactions and human-machine interactions. Therefore, it is plausible to venture that an affectual decision of distrust in a system or automated aid made at an individual level could have much larger system wide effects across other aids and potentially have contagion influences feelings of trust on the humans involved in the situation.
Chapter 3

Methodology

Introduction

The purpose of this chapter is to discuss the process and organization of the study. This section will also include all the steps and measures taken by the researchers to construct the study. A description of the study’s framework will be given in chapter 3. An explanation of all the considerations taken when formulating the research design will be included as well. This chapter will deal with addressing specific aspects of the design and methods of the study. Description of the population and the sample of interest—sample size, sampling technique, and the participants’ eligibility requirements, the instrument used to collect the data, as well as the data analysis techniques, are examples of the methodologies. This entire study is put together with the aim of furthering the realm of research in SWT theory. Specifically this research is designed to test the transference and contagion effect of diminished trust from automated aids to the human components of the system.
Research Design and Approach

This research is a consumer perceptions study to gauge ratings of trust within the passengers of the aviation industry. The design will be centered on an experimental study with one additional quasi-experimental variable. The study can be considered an experiment due to the satisfaction of three criteria. These are manipulation of the independent variable, random selection, and random assignment. Random selection is satisfied through the use of Mturk and its system allowing participants to perform tasks for compensation. Random assignment to the failure and non-failure conditions is also achieved. This helps control for potential confounds. The country of origin is a quasi-experimental variable. This is due to the fact that random assignment is not possible when comparing participants from two different cultures/nations. With this loss of control over potential confounds, some internal validity is lost. Although being a limitation, this loss is acceptable. The benefits of the cultural comparison outweigh the limitations. The primary design of the research study is a 3-way ANOVA. The purpose is to analyze the variations and interactions between the variables. The design will be centered on an experimental study with one additional quasi-experimental variable (country of origin). Two sets of participants will be utilized to establish the study, using two separate questionnaires. Participants in both surveys will be asked to complete an
electronic consent form. Following this, they will be presented with presented with one of two scenarios and asked to answer certain questions about the same. The participants in one survey are presented with a failure of an automated system. The other group is presented with a scenario experiencing no failure. Each group of participants will be asked to rate their feelings in the scenario, and their trust in the automation and the human entities involved. The ratings will be measured on a Likert-type scale from -3 (extremely distrust) to +3 (extremely trust) with a neutral option of zero (neither trust nor distrust). Following this, participants will be asked to provide demographic information. This format will be followed for participants from both the United States and India. For the study, the independent variables are: Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin. The dependent variables are Trust and Affect. Additionally, a mediation analysis will be conducted to provide a layer of depth to the further understanding of the SWT theory.

Research Setting and Sample

Population

The target of this study is to be able to generalize the findings from the sample of consumer participants to the views and perceptions of the population. For the purpose of this setting, the population refers to aviation
consumers with access to the Internet, who are participants on Amazon’s Mturk service. It must be noted that participants were recruited from the two respective countries, U.S. and India. The issues being researched are universal to every nation’s aviation industry, and therefore this study has the aim to better understand commercial aviation passengers’ perceptions across the globe. Aviation is a global industry, and any further understanding of the relationship between the consumers and the automation will be universally beneficial.

Sample

The sample used in this research study comprises of randomly selected consumers of the commercial aviation industry. The study utilizes participants that will be recruited via Amazon’s ® Mechanical Turk ®, and will be compensated for their completion of the survey. To gain an accurate representation of the travelling public, the study will require approximately 158 participants. The pool will comprise of participants from both of the surveys from the United States and India. The sampling method is a limiting factor in the terms of being convenient sampling. The participants are asked demographic questions with the aim of understanding the variations in travelling experience. However, the research does not prohibit people that have never travelled from participating in the study. The reason this sampling technique was employed was for the primary reason of the vast
number of responses required to provide an accurate representation. Without this compromise, data would not have been feasible to obtain by any other sampling techniques.

**Power Analysis**

To ensure the validity and strength of the study, an a priori power analysis was conducted to determine the appropriate sample size. The analysis was conducted using the statistical calculating tool G*Power 3.0.10. The results from the calculations showed a requirement of 158 participants from both of the two national/cultural surveys. To arrive at this value, the following parameters were deemed appropriate for the input: effect size of .25, power (beta) of .80, and alpha level of significance .05. The type of power analysis conducted was a priori—computation of sample size given $\alpha$, power, and effect size as mentioned previously.

**Research Instrumentation and Materials**

**The Study Instrument**

The study will use a survey questionnaire as the primary instrument of data collection. The survey will be created using FluidSurveys ®. As mentioned earlier, participants will be recruited via Amazon’s ® Mechanical Turk ®. The study will employ a semantic type survey.
Participants from both the countries will be asked to rate their trust in the automation, as well as the humans involved in the system. This study will be conducted completely online. All 150+ participants will be subject to the same scenario, through the same medium. The purpose is to gauge the perceptions and feelings of trust of the average travellers. This will aid in obtaining a true representation of the flying public.

There will be two versions of the questionnaire. The participants will be randomly assigned to either of the groups, the failure situation, or the non-failure (control) situation. The first scenario is the non-failure condition, where the participants were presented with the following information:

“Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, the pilot comes on the intercom and tells you the altitude of flight and how long it will be before you land.”

Following this, the participants will be asked three questions to rate their feelings towards the situation based the scenario. The questions will be on a seven-point Likert type scale stating extremely negative (-3) to extremely positive (+3); extremely unfavorable (-3) to extremely favorable (+3); and extremely uncomfortable (-3) to extremely comfortable (+3). Each scale will have a neutral position scored by zero (0). Using a seven point Likert-type scale within the survey tool, the study will be able to measure the
variables. By doing so, the study allows for more precise data analysis. Based on the study by Murray (2013) the Likert scale is deemed most appropriate by researcher of several fields when attempting to measure characteristics of either individuals or groups. A traditional Likert scale is a five-point scale that ranges from strongly agree to strongly disagree using corresponding numerical values that usually range from -2 to 2 (Royeen, 1985). This study utilizes a modified Likert type scale based on the study developed by Rempel, Holmes, and Zanna, (1985). The study will make use of Cronbach’s alpha test as a measure of internal consistency. Cronbach’s alpha is defined as coefficient of internal consistency (Schweizer, 2011). The three questions of ratings of trust will be put through a Cronbach’s alpha test. This is done to be able to generate a single value attributing to the person’s overall feelings towards the situation. Once the participant has answered these questions, the survey will ask them to rate their feelings of trust in various different automated aids and human components. The survey will once again employ a seven-point Likert type scale that will ask the participant to rate their feelings of trust from extremely distrust (-3) to extremely trust (+3) with a neutral position of zero. They will be asked to answer the above question for the following items: automation that operates the oxygen masks, automation that operates the airplane's auto-pilot system, automation that operates the airplane's flaps, automation that operates the airplane's landing gear, automation that
operates the airplane's video screens on the backs of the seats, the pilot that operates the airplane, the co-pilot that operates the airplane, the maintenance manager for the airline, the CEO of the airline manufacturer, and the flight attendant on the airplane. Once this is completed, the participants will be asked to provide demographic information. All of the collected information will remain private. Once all items are complete, the participants will be dismissed to retrieve their compensation.

In the failure survey situation, much of the same procedure was applied as the previously stated non-failure scenario. In this condition, the participants will be presented with the following situation:

“Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, an alarm goes off throughout the cabin and oxygen masks fall from the compartments above passenger seats. Following this, the pilot comes on the intercom and says that there was a mistake and the automation that operated the oxygen masks failed. He says that there is no actual emergency and not to worry. The pilot then tells you the altitude of flight and how long it will be before you land.”

The participants will be asked the same questions as the non-failure condition to gauge their overall feelings of towards the situation. In the same manner participants will be asked to provide their ratings of trust in the various automated aids and human components of the system in
question. The participants will be asked for demographic information as well, and be dismissed with their appropriate instructions for compensation.

By conducting this research in the stated manner, it allows the research to employ a between participants analysis. Additionally this setup allows the researchers to appropriately gauge the differences in average commercial travellers. The non-failure condition acts as a baseline control, and is a benchmark to analyze the differences observed when passengers are presented with an automation failure.

**Variables**

**Independent Variable**

The three independent variables being measured in this study are type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin. The first independent variable is the Type of automated device or category of human entity, and there are ten levels of this variable. The ten levels include the five different human entities and the five different automated aids that the participant will rate. The human entities are the pilot, the co-pilot, the flight attendants, mechanics, and airline CEO. The automated aids are the oxygen masks, the auto-pilot system, the airplane’s flaps, the landing gear, and the video screens on the backs of the seats. The second independent variable is
condition of the automation. There are two levels to this variable, namely the failure and non-failure condition. The final independent variable is the country of origin of the participants. The study utilizes participants from the United States and India, which are the two levels. The scale of measurement for each of the independent variables is nominal.

**Dependent Variable**

The dependent variables for this research study are Trust and Affect. Trust is measured as the participants’ scores on the Likert-type scale of the survey (see Appendix A). The trust questions are measured for internal consistency. This is measured from the average of the scores from the trust questions. Internal consistency is said to exist if the Cronbach Alpha’s test is greater than 0.7. Affect is measured as the participants’ scores on the Likert-type scale of the survey (see Appendix B). The affect questions are measured for internal consistency. This is measured from the average of the scores from the affect questions. Internal consistency is said to exist if the Cronbach Alpha’s test is greater than 0.7. The scale of measurement for both DVs is ordinal, but the data will be treated as an interval scale of measurement. This assumption can be made as values of equal magnitude difference are assigned to each response of the Likert type scale (Göb, McCollin, and Ramalhoto, 2007).
Data Analysis

This research seeks to perform a three way ANOVA and a mediation analysis as the statistical tools of analysis. As outlined by the power analysis, the alpha-level of significance is set to ($\alpha .05$). All the results will be displayed and based on the findings of the previously stated statistical analyses. Once these results have been obtained interpretations and inferences can be made on the findings, so as to determine their relevance to the research question. Additionally, the results of the statistical analyses will allow the researchers to test the hypotheses and determine whether the predictions were found to be present or not. The purpose of the data analysis is to determine whether the independent variables of Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin can be shown to have an effect on a person’s ratings of trust. The mediation analysis will be conducted to show the probability of whether or not affect mediates the relationship between condition and outcome in this experiment. The data collected for the research will be analyzed using IBM SPSS Statistics Software.

Participants’ Eligibility Requirement

This research study provides no physical mental or psychological harm to the participants. In spite of this, it requires all taking the survey to
be at least 18 years of age. Participants being recruited via Amazon’s ® Mechanical Turk ® through the use of convenient sampling does not allow for much control over the participants’ frequent flying prowess. Analysis will be conducted based on the responses from the two different nationalities, but also though the demographics provided by the participants.

Participants’ Protection

The study will utilize an online tool for surveying, FluidSurveys ®, which does not require any confidential information from the participant. It therefore keeps the participant completely anonymous. Participant responses are completely anonymous and confidential, thereby ensuring the protection of the participant. Participant protection is extremely important to the researchers. Every effort and measure will be taken to ensure this is performed to this highest degree possible.

Legal and Ethical Consideration

There are no known or expected risks to the human subjects participating in this study. Participants will be vetted through the surveying tool administered using FluidSurveys ®, while participants will be recruited via Amazon’s ® Mechanical Turk ®. Participants’ responses will not expose them to any legal, physical, psychological, or social risks. The study
does not include any minors, as the participants are required to be 18 years or older.

**Conclusion**

The overall purpose of chapter three is to give insight into the methodology of the research. It attempts to discuss all other considerations taken into this study. This chapter is tasked with giving a broad understanding of the research design and approach, the defining population and samples, as well as the study instrument utilized in the study. Chapter three is to set up the research study with the data analysis tools. Its additional purpose is to prepare for chapter four. Chapter four will deal predominantly with the results obtained from the statistical analyses performed on the collected data.
Chapter 4

Overview

In the previous sections, the need for the study has been stated, and the research has been outlined. In chapter three, the design ideologies have been explained including all the necessary legal and ethical considerations. In chapter four, the researcher will analyze the data that has compiled. This section displays the results of the data analysis in both textual and graphical form. Both descriptive and inferential statistics will be displayed from the statistical analysis tool IBM SPSS Statistics Software.

General Design

The study utilizes an experimental factorial design with one additional quasi-experimental variable in addition to a correlational design to study possible mediation. The independent variables were Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin, and the dependent variable is Trust, with Affect being the mediating variable. As mentioned in previous sections, a three way ANOVA, and a mediation analysis were performed in order to study the area of SWT contagion effect.
Research Tool

The primary research tool is a survey questionnaire. As mentioned in previous sections, the survey was created using FluidSurveys®, while the participants were recruited via Amazon’s® Mechanical Turk®. Additionally, there are two versions of the questionnaire. One outlines the failure condition, while the other is the control condition experiencing no failure. The questions asked will be on a seven point Likert-type scale, ranging from -3 to +3. The surveys ask them to rate their feelings of trust in various different automated aids, and human components.

Data Analysis

Descriptive Statistics

This research required the sampling of the population in four different groups. These four different samples included American participants in the failure condition, Indian participants in the failure condition, American participants in the non-failure condition, and Indian participants in the non-failure condition. Each variant had a sample size (N=98). The total sample size of the study was (N=392), of which (N=131) were female participants.

There were 98 (28 females) Indian participants in the failure condition. The mean age was 31.439 (SD = 8.726). The second group was
the American participants in the failure condition. There were 98 (44 females) American participants in the failure condition. The mean age was 33.367 ($SD = 11.716$). There were 98 (24 females) Indian participants in the non-failure condition. The mean age was 32.480 ($SD = 9.247$). There were 98 (35 females) American participants in the non-failure condition. The mean age was 31.918 ($SD = 9.578$).

Even though the participants are only from two specific countries, there are some different ethnicities of participants involved. The ethnicities are broken down by percentage in Table 1 below. Each group had 98 participants. The first group was the Indian participants in the failure condition with 94% of Indian decent, and 6% were Asian. The second group was the American participants in the failure condition with 77% Caucasian, 6% African Descent, 8% Asian, 8% Hispanic, and 1% Native American. The third group was the Indian participants in the non-failure condition with 98% of Indian decent, and 2% were Asian. The fourth group was the American participants in the non-failure condition with 79% Caucasian, 7% African Descent, 9% Asian, and 5% of Hispanic descent.

**Affect Data**

In the Failure condition for Indian participants, the affect questions had a mean score of -0.510 ($SD= 1.605$). In the Failure condition for American participants, the affect questions had a mean score of -1.303 ($SD$)
In the Control condition for Indian participants, the affect questions had a mean score of 1.031 ($SD = 1.492$). In the Control condition for American participants, the affect questions had a mean score of 1.160 ($SD = 0.965$). These figures are tabulated below in Figure 1.

![Affect Data for Indian and U.S. participants for Failure and Non-Failure.](image)

**Figure 1.** Affect Data for Indian and U.S. participants for Failure and Non-Failure.

**Trust Data**

Each of the four groups was asked questions to gauge their ratings of trust in the five different automated aids, and the five human entities. These questions were scored on a 7-point Likert type scale ranging from extreme distrust (-3) to extreme trust (+3).

In the Failure condition for Indian participants, the average score of the trust questions for all the automated aids was 0.088 ($SD = 1.453$). The
The average score for the human entities was 0.398 (SD = 1.478). In the Failure condition for American participants, the average score of the trust questions for all the automated aids was -0.400 (SD = 1.329). The average score for the human entities was 0.322 (SD = 1.241). In the Control condition for Indian participants, the average score of the trust questions for all the automated aids was 1.271 (SD = 1.348). The average score for the human entities was 1.339 (SD = 1.335). In the Control condition for American participants, the average score of the trust questions for all the automated aids was 1.435 (SD = 0.966). The average score for the human entities was 1.369 (SD = 0.866). Figures 2, and 3 show the graphical representations of the trust ratings of both Indian and U.S. participants respectively.

**Analysis of Variance (ANOVA)**

The research uses a three way ANOVA in order to study the effect of the independent variables on the dependent variables. As explained in previous sections, the independent variables are Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin. The dependent variable is trust with affect being tested as a mediating variable. The three way ANOVA is conducted for the trust data to find statistical differences between the type of item, the country of origin, and the condition (failure or non-failure). A two way ANOVA is conducted on the mediating variable of affect purely on the country of
origin and the condition. The reason for this is to measure if any statistical differences arise in the feelings of the participants based on their country of origin and the condition of the group they were in, regardless of the items (human entities or automated aids).

Affect is being measured using three questions on the instrument to measure how the participants feel about the scenario. These three scores are averaged to produce one measurable value for the affect mediation analysis. A Cronbach’s Alpha test was conducted on the Affect data to measure for consistency between the responses to the questions. Due to high internal consistency scores ($r$ range from $= .896$ to $.930$), the Affect data was combined for further analyses. A two-way ANOVA was conducted on the affect data, with Failure/Non Failure of the automation, and Country of Origin of the participants as the factors. There was a main effect of Failure, $F(1, 388) = 225.610, p < .001, partial-eta squared = 0.371$. There was a main effect of Country, $F(1, 388) = 6.203, p = .001, partial-eta squared = 0.022$. These effects were qualified by a significant interaction between Failure and Country, $F(1, 388) = 11.960, p < .001, partial-eta squared = .003$, which indicates that the American participants were more extreme in their views towards failure condition as compared to their Indian counterparts.

A three-way ANOVA was conducted on the Trust data, with Type of automated device or category of human entity, Failure/Non Failure of the
automation, and Country of Origin of the participants as the factors. There was a main effect of Failure, $F(1, 388) = 104.878, p < .001$, partial-$\eta^2 = .021$. There were no other significant effects. There was a main effect of Type of automated device or category of human entity, $F(9, 388) = 48.459, p < .001$, partial-$\eta^2 = .111$; however, this effect was qualified by three significant interactions. The first was between items and country, $F(9, 388) = 12.621, p < .001$, partial-$\eta^2 = .032$. The second was between items and failure, $F(9, 388) = 28.571, p < .001$, partial-$\eta^2 = .069$. The final interaction was a three way interaction between items, country and failure, $F(9, 388) = 6.660, p < .001$, partial-$\eta^2 = .017$. These data indicate that there is a significant decline in trust in both human entities and automated aids, suggesting the presence of System Wide Trust effect and contagion effect. The data also suggests that American participants felt more positively about all items in the non-failure condition and more negatively in the failure condition, as compared to their Indian counterparts.
Figure 2. Trust Data for Indian participants for Failure and Non-Failure Conditions.

Figure 3. Trust Data for American participants for Failure and Non-Failure Conditions.

**Mediation Analysis**

The first mediation analysis was conducted using Indian participants to compare the failure condition to the non-failure condition with respect to their feelings towards the automated aids. The paths for this mediation analyses can be found in Figure 4A. In order to conduct the mediation
analysis, the correlation between Condition and Trust was first found to be significant, $r = -0.391, p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($Beta = -0.447, p < .001$); affect to trust ($Beta = 0.397, p < .001$); condition to trust controlling for affect ($Beta = -0.213; p = .002$). These data show that Affect had a partial mediating effect on the relationship between Condition and Trust.

The second mediation analysis was conducted using Indian participants to compare the failure condition to the non-failure condition with respect to their feelings towards the human entities. The paths for this mediation analyses can be found in Figure 4B. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -0.318, p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($Beta = -0.447, p < .001$); affect to trust ($Beta = 0.404, p < .001$); condition to trust controlling for affect ($Beta = -0.138; p = .052$). These data show that Affect completely mediated the relationship between Condition and Trust.

The third mediation analysis was conducted using American participants to compare the failure condition to the non-failure condition with respect to their feelings towards the automated aids. The paths for this mediation analyses can be found in Figure 4C. In order to conduct the
mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.622$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($Beta = -.766$, $p < .001$); affect to trust ($Beta = .513$, $p < .001$); condition to trust controlling for affect ($Beta = -.229$; $p = .004$). These data show that Affect had a partial mediating effect on the relationship between Condition and Trust.

The fourth mediation analysis was conducted using American participants to compare the failure condition to the non-failure condition with respect to their feelings towards the human entities. The paths for this mediation analyses can be found in Figure 4D. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.441$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($Beta = -.766$, $p < .001$); affect to trust ($Beta = .647$, $p < .001$); condition to trust controlling for affect ($Beta = .054$; $p = .544$). These data show that Affect completed mediated the relationship between Condition and Trust.
Figure 4. Paths for the mediation analyses.
Conclusion

Recall earlier, the aim of this study to further explore SWT theory and the contagion effect is achieved by means of a three-way ANOVA and a mediation analysis with affect as the mediating variable. The findings show the presence of both the SWT and contagion effects. The failure in the automated aid negatively affects the consumers’ level of trust in certain other automated aids and human entities within the system. The system being referred to is one of a commercial airline flight. The data also suggests that American participants felt more positively about all items in the non-failure condition and more negatively in the failure condition, as compared to their Indian counterparts. Finally, the results suggest that affect mediated the relationship between the condition and trust thereby suggesting that these perceptions were based on emotions.
Chapter 5

Overview

The purpose of this study was to expand the research in the field of system wide trust (SWT) theory. The study sought to understand if a contagion effect exists where consumers’ levels of trust in human entities are negatively affected by a failure in an automated aid. In this study, the system refers to a commercial airline flight, which includes the five automated aids and five human entities being tested. Although SWT theory has been researched a fair amount, this study is the first to research the presence of one possible contagion effect.

The study utilized 392 participants (131 females) from India and the United States. By doing so, the researchers were also able to analyze the effect for a cross-cultural perspective and identify differences in the effect based on country of origin. The participants were either presented with a failure condition where an automated aid failed or a control condition with no failure. These divisions were replicated for both the American and Indian participants. This created four groups each with 98 participants. Each group of participants was asked to rate their feelings based on the scenario, and their trust in the automation and the human entities involved.
The study utilizes an experimental factorial design with one additional quasi-experimental variable in addition to a correlational design to study possible mediation. A three way ANOVA, and a mediation analysis were performed in order to study the area of SWT contagion effect. For the study, the independent variables were: Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin. The five automated aids were the oxygen masks, the auto-pilot system, the airplane’s flaps, the landing gear, and the video screens on the backs of the seats. The five human entities were the pilot, the co-pilot, the flight attendants, mechanics, and the airline CEO. The dependent variables were Trust and Affect.

In summary, the researchers’ hypotheses were as follows:

Hₐ₁: In the failure condition, there will be a drop in trust in the unrelated automated aids or human entities.

Hₐ₂: There will be a difference in trust and affect ratings for the unrelated automated aids or human entities as a function of country of origin.

Hₐ₃: The relationship between the condition and trust is mediated by affect.

Hₐ₄: There will be an interaction between the variables. However, this is a non-directional prediction, as we have no a priori basis for a directional prediction.
Summary of Findings

The aim of the study was to replicate previous research in terms of identifying the presence of SWT effect when one independent automated aid within the system failed. In addition, the study collected trust data of the consumers on certain human entities involved in the system. This was done to identify the possibility of a contagion effect between automation failures and trust in human entities within the system. The results of the study have been detailed in chapter 4.

The results showed there was a main effect based on the condition, i.e. failure, or non-failure. Additionally the data analysis showed three significant interactions in the trust data. These were between items and country, items and failure, and a three-way interaction between items, country and failure. The significant decline in trust ratings support the presence of SWT effect and a possible contagion effect. Finally, a mediation analysis was conducted to determine whether affect was a possible mediator to these results. The findings suggest that affect had a partial mediating effect on the relationship between Condition and Trust for both Indians and American with respect to automated aids. Additionally, the results suggest that affect completely mediated the relationship between Condition and Trust for both countries with respect to human entities.
Discussion

While the results have been reported, it is important to analyze the interpretation of the findings. The study of a possible contagion effect within the SWT theory is a new subset within this line of research. Due to this, certain research predictions were made, which for the most part, were supported by the results of the data analysis.

The first hypothesis predicted there would be a drop in trust ratings in the unrelated automated aids or human entities. The drop in trust in unrelated aids was predicted based on previous studies that have researched similar scenarios. The prediction for the drop in trust in the human entities was the basis of establishing the contagion effect. The results of the data analysis supported the hypothesis. Trust ratings had a statistically significant decline when comparing the failure condition to the non-failure/control condition. The decline in trust ratings establishes the framework that the consumer is considering these unrelated automated aids and human entities as part of one system. Failure in one part of the system negatively affects trust levels in several other aspects of the system. While the contagion effect has not yet been studied using operators instead of consumers, the results show a similar pattern with relation to automated aids as that of prior studies (Geels, Blair, Rice, & Schwark, 2013; Keller & Rice, 2010; Rice & Geels, 2010). There may be several plausible
explanations for the decline in trust levels during the failure condition. While lack of aviation knowledge on automation may be a factor in the consumers’ feelings towards to the automated aids, it is interesting to note the marked decline in trust in the CEO as well. Studies suggest that there is a direct relationship between the leadership behavior and values of a CEO to the organizational culture (Tsui, Zhang, Wang, Xin, & Wu, 2006). A study by Berson, Oreg, and Dvir (2008) went further to state that the CEO’s values and dispositions not only affected organizational culture but also in turn affected firm performance. Based on these studies, a possible explanation could be that the consumers believe the CEO is responsible for the overall safety and safety culture, mindset and attitude of the employees, and is thereby indirectly responsible for potential hazardous situations. The mechanic could be penalized due to the direct involvement and responsibility in ensuring the components of the aircraft are in working condition. These are not necessarily directly relating human entities to the failure, yet it is relevant to note the strength of the contagion effect in order to be able to affect the consumers’ level of trust in the same based purely on the failure of an oxygen mask system.

The second hypothesis stated that there would be differences in ratings based on country of origin of the participant. The secondary aim of the study was conduct a cross-cultural analysis using participants from India and the United States. As stated earlier, these two countries were chosen to
determine if cultural upbringing in different societies would influence the consumer’s ratings. These countries represent two examples of different cultural societies, namely a more individualistic culture of the United States, and a more collectivistic culture of India. These classifications have been inferred based on the studies mentioned in previous sections (Hofstede, 1980). The differences in the two cultures have been enumerated in a previous chapter, and were the basis of this a priori prediction. Similarly, the prediction was based on similar findings of previous SWT studies. The findings of the study support the hypothesis, and statistically significant differences were found in the ratings based on country of origin. The results indicated that overall, American participants were more extreme as compared to their Indian counterparts in both conditions. The study showed that participants from the United States had lower ratings of trust in the failure condition, and higher ratings of trust in the control condition, as compared to the ratings of the Indian participants. It is important to note that while differences do arise in terms of magnitude, the direction of both groups run together. Both groups experienced declining levels of trust in the failure condition. As indicated by the review of previous literature, a possible explanation of this occurrence could be found in the differences in cultural norms of the societies. Citizens of collectivistic societies are taught to totally trust without question. Members of these cultures tend to exhibit allocentric tendencies. They are taught to never question an authority figure,
and always show utmost respect for others. On the other hand, the individualist is taught to stand on his own feet, without relying on anyone else. These members are encouraged to stand up for their beliefs. These cultural precedents may be influencing factors in the participants’ ratings of trust.

Lastly, the researchers hypothesized that affect would mediate the relationship between the condition and trust. Affect suggests the presence of an emotional reaction at play. The results support the research prediction and indicate that affect mediated the relationship, thereby suggesting that these perceptions were based on emotions. This was found to be the case within both groups of participants from India as well as the United States. The findings suggest that even though the analyses show statistically significant differences between the levels of trust between the two country groups, participants from both countries made these decisions based on emotions.

**Practical Implications**

Research studies not only enhance the scientific community but also impact the real world by contributing to a better understanding of an industry. The practical implications of the findings of a study are of equal significance. They could be the foundation that cause change within an industry. While SWT theory has been researched in the past, this study
explores a new area and seeks to find the presence of a possible contagion effect.

Being the first study in this new offshoot line of research, the implications are important. The results show that a contagion effect does exist. The findings suggest that a failure in an automated aid negatively affects the consumers’ level of trust in certain human entities within the system. These findings are of practical significance to any commercial flight operation. The understanding that passengers’ level of trust in the crew and other employees of the operation are negatively influenced by automation failures is useful information. Understanding the mind frame of a customer is of value in any business, including aviation. Additionally, the decline in trust in the human entities such as the CEO of the airline could reflect an overall decline in trust in the airline. This, in term, could result in a passenger choosing to fly with a competitor airline on their next journey. These implications are noteworthy, and the results of this study show that commercial operators need to be aware of the impacts of minor incidents on board.

If this contagion effect were found to be present within the commercial airline setting, it would suggest that other contagion effects could possibly exist between automation and consumer/operator trust. Based on the findings and methods of this study, future studies could
replicate the research in relation to other industries. This would expand the impact of this initial study on future scientific work, and the real world.

Another important aspect to the study is that it replicates the original research on SWT and thereby reinforces the findings of previous studies. This aids in validating the foundation of the theory and its overall importance and impact within various systems. Therefore this study in turn supports the practical implications of all previous SWT studies.

**Limitations**

Limitations exist in any form of research study and must be accounted for when analyzing results. Although aspects of SWT have been researched before, it is still a relatively new field of research. Therefore, extra attention must be paid to the limitations of such a study.

The primary limitation in this research is the sampling technique and method of data collection. Participants for the study were recruited via Amazon’s® Mechanical Turk®, which provides compensation in exchange for completion of online surveys. This poses two concerns, one of the reliability of the online data, and the second of participant compensation. Firstly, online surveying and data collection takes the control of the environment away from the researcher, and opens the study up to external vulnerabilities. The data is opened up to certain risk exposures due
to the lack of supervision. While online data collection is fast and easy, it does come at a cost. For the purpose of this study the negative drawbacks of online surveying were outweighed by the convenience and benefit of the same. These limitations are understood, noted and accounted for when interpreting the results of the data. Conversely, previous studies have stated that MTurk data is as reliable as laboratory data (Buhrmester, Kwang, & Gosling, 2011; Germine, et al., 2012).

In relation to the use of Mturk, a limitation arises where the effect found in the sample is only generalizable to the population that consists of purely online users of Mturk. While a large portion of the world does have an ability to gain Internet access, it is a limitation of the study. Additionally, the survey does not discriminate and exclude participants even if they have never been passengers on a commercial airline flight. Other similar factors include frequency of travel, knowledge of mechanics, and others. This is another limitation that must be kept in mind when interpreting the results. With the sampling technique, and the minimum number of participants required to conduct a robust study, certain compromises need to be made. The impact of this condition was considered to be an acceptable limiting factor of the study.

The study only polls participants from two countries, India and the United States. While this is beneficial to the cross-cultural analysis between Eastern and Western societies, it is a limiting factor when attempting to
generalize the findings to the entire aviation industry. Aviation is a global industry involving almost every country in the world, and so it must be noted that there is a limit to the applicability of these findings to the entire world.

Lastly, participants were compensated for their efforts, and this is important as it could impact the motivation and intent of the participant, thereby potentially impacting the results. The mindset of the consumer must be kept in mind as well when interpreting the results of the study.

**Recommendation for Future Research**

SWT theory is a field with the opportunity for several new research studies. The predominant focus of previous studies has been on automation and levels of trust in both consumers and operators. A large portion of the prior research has been in relation to the aviation industry.

The current research explores the possibility of one potential contagion effect from automation failure to human entity. While the study produces statistically significant results, the bare minimum number of participants required was utilized. With additional funding and resources, the study could be more extensive with larger sample sizes. Therefore, future studies could replicate the methodology with more participants. This would enable the researchers to more accurately determine the strength and extent of the effect. Secondly, the current study only utilizes participants
from two countries, India and the United States. Future research could replicate this study using participants from other countries and continents to get a more global perspective of the presence of this effect. Aviation being such a global industry, these future studies would allow researchers to make more accurate statements about the mindset of the global passenger.

In the same line of thought, future research should seek to understand what additionally factors that are unique to these two nationalities aside from cultural differences that are influencers in the relationship between trust and the conditions. While the cultural nature of these countries seems to be the leading contributors to the differences in trust, other factors could be at play. This research has focused in one of these facets, but future research could seek to expand and identify additional reasons to understanding these differences.

The applicability of SWT is widespread and could be used an analysis for several industries. The concept of SWT could be implemented in other consumer-oriented fields to better understand the mindset of the customer and how their levels of trust are affected. Additionally, the concept of the contagion effect, having never been researched before, allows for new avenues of research into SWT within aviation and outside. One such future area of research includes exploring the extent of the contagion effect. In other words, the purpose of a future study could seek to answer the question, “How far does SWT contagion go?”
Conclusion

The purpose of this research was to expand the understanding of SWT effect by adding a new dimension to the theory. With the use of 392 participants from India and the United States, this study was able to replicate the findings of the original study and successfully find the existence of one possible contagion effect between automation failures and human entities within the system. By expanding the theory, new avenues for future research have been created, both inside and outside the aviation industry. Moreover, the study has practical benefits to most commercial operations within aviation. The study helps in understanding the psychology of passengers and the impact of an automation failure on a person’s level of trust in the system. While this research does have its limitations, it offers a foundation that can be built upon in order to add knowledge to the scientific community.
References


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Appendix A

Questions measuring trust

Failure Condition

Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, an alarm goes off throughout the cabin and oxygen masks fall from the compartments above passenger seats. Following this, the pilot comes on the intercom and says that there was a mistake and the automation that operated the oxygen masks failed. He says that there is no actual emergency and not to worry. The pilot then tells you the altitude of flight and how long it will be before you land.

Please rate your trust in the automation that operates the oxygen masks.

- Extremely Trust
- Quite Trust
- Slighty Trust
- Neither Trust nor Distrust
- Slighty Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane's auto-pilot system.

- Extremely Trust
- Quite Trust
- Slighty Trust
- Neither Trust nor Distrust
- Slighty Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane's flaps.

- Extremely Trust
- Quite Trust
- Slighty Trust
- Neither Trust nor Distrust
- Slighty Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane's landing gear.

- Extremely Trust
- Quite Trust
- Slighty Trust
- Neither Trust nor Distrust
- Slighty Distrust
- Quite Distrust
- Extremely Distrust
Please rate your trust in the automation that operates the airplane’s video screens on the backs of the seats.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the pilot that operates the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the co-pilot that operates the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the maintenance manager for the airline.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the CEO of the airline manufacturer.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the flight attendant on the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust
Control Condition

Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, the pilot comes on the intercom and tells you the altitude of flight and how long it will be before you land.

Please rate your trust in the automation that operates the oxygen masks.
- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane’s auto-pilot system.
- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane’s flaps.
- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the automation that operates the airplane’s landing gear.
- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust
Please rate your trust in the automation that operates the airplane's video screens on the backs of the seats.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the pilot that operates the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the co-pilot that operates the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the maintenance manager for the airline.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the CEO of the airline manufacturer.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust

Please rate your trust in the flight attendant on the airplane.

- Extremely Trust
- Quite Trust
- Slightly Trust
- Neither Trust nor Distrust
- Slightly Distrust
- Quite Distrust
- Extremely Distrust
Appendix B

Questions measuring affect

Failure Condition

Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, an alarm goes off throughout the cabin and oxygen masks fall from the compartments above passenger seats. Following this, the pilot comes on the intercom and says that there was a mistake and the automation that operated the oxygen masks failed. He says that there is no actual emergency and not to worry. The pilot then tells you the altitude of flight and how long it will be before you land.

How does this make you feel?
- Extremely Unfavorable
- Quite Unfavorable
- Slightly Unfavorable
- Neutral
- Slightly Favorable
- Quite Favorable
- Extremely Favorable

How does this make you feel?
- Extremely Negative
- Quite Negative
- Slightly Negative
- Neutral
- Slightly Positive
- Quite Positive
- Extremely Positive

How does this make you feel?
- Extremely Uncomfortable
- Quite Uncomfortable
- Slightly Uncomfortable
- Neutral
- Slightly Comfortable
- Quite Comfortable
- Extremely Comfortable
Control Condition

Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, the pilot comes on the intercom and tells you the altitude of flight and how long it will be before you land.

How does this make you feel?
- Extremely Negative
- Quite Negative
- Slightly Negative
- Neutral
- Slightly Positive
- Quite Positive
- Extremely Positive

How does this make you feel?
- Extremely Uncomfortable
- Quite Uncomfortable
- Slightly Uncomfortable
- Neutral
- Slightly Comfortable
- Quite Comfortable
- Extremely Comfortable

How does this make you feel?
- Extremely Unfavorable
- Quite Unfavorable
- Slightly Unfavorable
- Neutral
- Slightly Favorable
- Quite Favorable
- Extremely Favorable