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Measuring the perceived attributes of innovation: A study of capacitive switch technology in industrially designed user interface controls

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Measuring the Perceived Attributes of Innovation: A Study of Capacitive Switch Technology in Industrially Designed User Interface Controls

by

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Dedication

I dedicate this work to those who are still trying to answer the hardest question in the academic community: What do you want to be when you “grow up”? This age-old question perplexes the young and old. May those who identify the answer have the strength to move outside of their comfort zone to live the answer no matter how old they are.

Acknowledgements

Over ten years ago Dr. Jule D. Scarborough planted the seed of pursuing a doctoral degree in my head. A few downsizings, job changes, and a bad economy provided the rain and sunshine to germinate the doctoral degree concept into an actionable plan and for that I thank you.

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Abstract

The purpose of this research was to test the applicability of Rogers' theory of innovation diffusion as it relates to measuring the perceived attributes of innovations of capacitive switch technology in user interface controls. This study used a Likert scale to collect data on the following perceived attributes of innovation including relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005). Results indicated whether a consumer is willing to accept capacitive switch innovation in industrially designed user interface controls.

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CHAPTER I. Introduction

Introduction

Technology is everywhere in our lives today: where we shop, travel, spend our leisure time, or work (Lin, 1999). New models with improvements and innovations are issued almost daily and present purchasing challenges to consumers who either embrace new innovations or are reluctant to learn how a new model operates; they are apprehensive about that change.

Innovations with unique modern features are definitely major components in every new automotive model year. Thus the automotive industry has the challenge of determining what innovations are desired by consumers, and what they are willing to pay for when purchasing new models. This dissertation research project attempted to measure the perceived attributes of innovations in capacitive switch technology in an automotive application.

Statement of the Problem

There is not a practical strategy that allows companies to accurately predict consumer adoption of new technologies such as innovative capacitive switch technology in industrial designed automotive user interface controls.

Nature and Significance of the Problem

The automotive industry is dynamic. "As the industry becomes ever more competitive, the process of identifying consumer needs and creating innovative products to fill those changing requirements becomes more important and complex" (Smith, B. C. & Gerth, R. J., 2006, p. 4). The product development process is complex and is changing at an alarming rate. In order to compete in today's marketplace, original equipment manufacturers

(OEMs) are introducing impressive production and model changes very quickly just to survive (Zielinski, 2008, n.p.).

Impressive production and model changes involving new products involve considerable risk. “It is estimated that up to one third of new products fail at the launch stage” (Cooper & Kleinschmidt, 1987). “Getting a new product adopted, even when it has obvious advantages, is often very difficult” (Rogers, 1995, p. 1). The introduction of BMW’s iDrive is an example of a product failing at the launch stage due to consumer adoption issues. The iDrive is the large round knob as shown in Figure 1.

Figure 1. BMW iDrive. (2007). Source: BMW Spain.

This single knob operates like a joystick and allows the vehicle user to control more than 700 functions of the navigation, entertainment, and temperature (Summerskill, Porter, & Burnett, 2004, p. 287). “The idea behind the system is to reduce the visual clutter and distraction in the cockpit. Unfortunately, contrary to the systems objective, it is a case study of a Human Computer Interface (HCI) gone wrong” (Smartdust, 2007). Day (2004) also said the following about the iDrive:

> BMW's 2001 introduction of iDrive, its pioneering driver information/entertainment system, was arguably the biggest corporate disaster since Coca-Cola Co. decided to tinker with the formula for its eponymous beverage. To say that the automotive trade press and nearly every contributor to a Web discussion of the system hated iDrive is a huge understatement. (n.p.)

One potential way a company can reduce the risk of a product failing at the launch stage is by understanding what consumers are willing to accept. Companies hold consumer clinics to interface with consumers and understand their preferences (Amend, 2008, n.p.). "Automotive consumer clinics have been around for more than three decades, since the early 1960s. They were a natural outgrowth of the automobile manufacturers' interest in conducting consumer research on current and future vehicles" (Curtis, 1996, n.p.). Emerging technology can be introduced and assessed by people who currently use or may use similar products.

Continental AG held an automotive consumer clinic to review capacitive switching. The results of the clinic were as follows:

1. Of the consumers surveyed, 60 percent rated the switches favorably.
2. "Outside of the luxury segment, consumers at Continental's clinic say they are not willing to pay for capacitive switches" (Amend, 2008, n.p.).
3. "…ironically, the new technology scored overwhelmingly better with participants over 40 than with younger people (Amend, 2008, n.p.).

The Interior Electronics Solutions Group "focuses on linking consumer electronics with automobile interiors" (Amend, 2008, n.p.). Frank Homann, vice president of the North American Interior Electronics Solutions Group, said, "That was interesting, because we

always thought the older generation was so used to mechanical buttons they would want to keep that (feature). But it was actually the opposite" (Amend, 2008, n.p.). The results from Continental AG's feature clinic can help OEMs like BMW avoid another iDrive disaster by increasing the chance of a product's successful introduction through segmenting the potential market (Fell, Hansen, & Becker, 2003, p. 347). The results of this proposed research project will allow companies to start the process of pinpointing the segment of the market that wants and is willing to pay for capacitive switch technology in overhead consoles in automobiles.

This research investigated whether a wide range of consumers could be narrowed down into specific segments of people who would adopt innovative capacitive switch technology in industrial designed automotive user interface controls.

A need exists to further research consumers and their intent to purchase capacitive switch technology in user interface controls beyond the Continental AG study. There appears to be a lack of published empirical research pertaining directly to the automotive industry. To maintain a competitive advantage, most automotive companies do not publish results of their consumer clinics and studies. In addition to adding to the vacant body of knowledge, this research can be the catalyst for creating a theoretical framework for this and other emerging technologies.

Objective of the Research

The objective of this research was to explore those factors that could become inputs into a theoretical framework based on a consumer's perception of using capacitive switch technology in industrially designed user interface controls. This is an attempt to "identify significant predictors or relationships that could provide new tools for the development of services and marketing campaigns" (Munnukka, 2007, p. 720). If a certain consumer segment

is willing to accept capacitive switch innovation in industrial designed user interface controls, it is possible that using the instruments could increase sales of capacitive switches and new vehicles. Also, due to the competition for development budgets at an organizational level, research such as this can be used to help justify the allocation of resources for developing better switches (Wellings, Williams & Tennant, 2009, p. 8). The gathered information was analyzed to answer the questions below.

Research Questions

Through data collection, this research project explored and answered the following questions:

1. Is there a relationship between relative advantage, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
2. Is there a relationship between compatibility, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
3. Is there a relationship between trialability, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
4. Is there a relationship between demonstrability, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

5. Is there a relationship between visibility, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
6. Is there a relationship between ease of use, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
7. Is there a relationship between image, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
8. Is there a relationship between voluntariness, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
9. Is there a relationship between perceived risk, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
10. Is there a relationship between perceived resources, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
11. Is there a relationship between combining the following perceived attributes of innovations - relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources as outlined by Rogers (1995), Moore and Benbasat (1991), Dupagne and Driscoll (2005) - and

consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

Delimitations

The results of this study were specifically limited to capacitive switches in the overhead console of an automobile. In order to ensure that the data collected were manageable, a Likert scale was used and open-ended questions were not included.

Assumptions

It is assumed that all Likert data collected are ordinal.

Limitations

As this study was constrained on time, budget, and resources, the sample size was small. Due to a smaller sample size, there is a chance that the sample will not represent the population accurately. In addition, all participants were likely to be persons who worked for an automotive related company; this may influence how they responded to the questions being posed.

Definition of Terms

Capacitive switch. "Located under an overlay with a foil layer in between" (Amend, 2008), "a capacitive touch switch detects the presence or absence of a conductive object, such as a finger, by measuring changes in capacitance" (Wilson-Hurd, 2009); see Figure 3.

Haptics. It is the science of applying sensations felt through the sense of touch when interacting with human-machine interface controls. By using special input/output devices, users can receive vibrotactile feedback from switches, buttons, joysticks, data gloves, or other devices in the form of felt sensations in the hand or other parts of the body such as

detents, limit stops, friction, and vibration (Haptics, 2000; Rydström, Broström, & Bengtsson, 2009).

Human-Machine Interface (HMI). This interface provides a connection between the person and the device. This person-device intercept is literally where the person interacts with the device for input or output. An example that has multiple human-machine interfaces is the TV. The buttons on the remote and set (hand), the TV screen (eyes) and the speakers (ears) (Francis, Rash, & Russo, 2009) are the multiple human-machine interfaces.

Innovation. This "is an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11).

Overhead console (OHC). "Overhead consoles are commonly provided in the passenger compartment of a vehicle such as an automobile, boat or airplane." "The overhead console is mounted to the lower surface of the headline to provide additional storage space for items such as sunglasses, garage door openers and compact discs" U.S. Patent No. 7159920 B2 (2007). OHC's may have map lights and sunroof controls integrated into them.

Rate of adoption. The "rate of adoption is the relative speed with which an innovation is adopted by members of a social system. It is generally measured as the number of individuals who adopt a new idea in a specified period, such as each year. So the rate of adoption is a numerical indicator of the steepness of the adoption curve for an innovation" (Rogers, 1995, p. 206).

Tier one vendor. This is a vendor that can be a manufacturer and/or a value-added reseller. Their primary customer is an original equipment manufacturer (Bigelow, 2007).

Summary

This chapter discussed overall technology innovation adoption in society today, supplied a brief introduction about research pertaining to automotive interface controls, and described a need for this study to further research consumers and their intent to purchase capacitive switch technology in user interface controls. A statement of the problem was presented, and the significance of the problem was included. The objective of the research was stated and the research questions were listed. Delimitations, assumptions, limitations, and definition of terms were related. In Chapter Two, an in-depth review of the literature will explain diffusion theory and the perceived attributes of innovations as presented by several notable researchers in the field.

CHAPTER II. Background and Review of Literature

Introduction

A review of all relevant literature regarding capacitive switching is included in this chapter plus work by various scholars of diffusion theory and innovation adoption.

Background

Technology pervades society today. It is behind the scenes in nearly every aspect of our lives. One just has to think of something and generally technology has affected it at some point. Something as simple as a piece of fruit in the grocery store is unable to escape technology and is still affected by it. The development of the strain of fruit, the machines that plant, pick, and transport, the tools and equipment that make the machines, the chemicals that are applied to the fields, the machines that take one to the store and the machines that take one's money, and the money itself are all part of the technological world in which we live.

The more complex an item, the more chances are technology is involved. The automobile is an example of a complex product that is saturated by technology; technology is utilized throughout the product development process. Consumers get a chance to experience technology firsthand as they drive an automobile today.

Before technology shows up in an automobile, studies are performed to determine consumer preferences. Previous human-machine interface interaction studies have focused on safety (Isaksson, Nordquist, & Bengtsson, 2003; Bengtsson, Grane, & Isaksson, 2003), emotions, and affection (Schütte & Eklund, 2005) as well as haptic visual and cross modal perception of visual information (Rydström, & Bengtsson, 2007); this study is a follow-up to all of these previous studies. After a company has taken into consideration all of the above

factors, who they will market their product to is important to know. So it will be useful for Original Equipment Manufacturers (OEM's) to know if their customers share a common preference for switches.

"In today's vehicles the Human-Machine Interaction (HMI) is changing rapidly. The HMI is becoming increasingly complex with a growing number of advanced driving assistance functions and comfort functions" (Bengtson, Grane, & Isaksson, 2003, p. 25). Capacitive switches are one way that automakers can change the visual appearance of the interior without increasing the complexity. This change in visual appearance is one way that manufacturers can differentiate their interiors and vehicles (Amend, 2008).

> Today, consumers are more sophisticated than in the past, expecting more content in their vehicle with higher levels of quality and design. They are demanding features that are smarter, better crafted and easier to use. Due to the customers' demands automakers are increasingly focusing on design, interior content and layout in this competitive industry. (Lövsund, & Wiberg, 2007, p. 1)

Capacitive switch technology offers just that, a needed change to the interior content of the vehicle. One example of switch technology not changing in automobiles is the Jaguar XJS Power Window/Sunroof Switch. According to Direct Automotive Products, Jaguar used the same rocker switch for the window and sunroof starting in 1976 and ending in 1992 as shown in Figure 2. This style of rocker switch is not uncommon in the auto industry. Many other automakers use designs similar to this example.

Figure 2. Jaguar XJS Power Window/Sunroof Switch. (2010). Source: Direct Automotive Products.

After 16 years of using the same switch, Jordan's (2000) basic take-away from Maslow's hierarchy of needs appears to be applicable: "…when people get used to having something, they start looking for something more" (p. 5). That "something more" could be capacitive switches.

A new design aesthetic is now possible with capacitive switches as the shape of the switch is no longer dictated by the switch technology (actuating button). "Unlike mechanical switches, capacitive switches contain virtually no moving parts" (Amend, 2008). The touch point or area that a user would contact is now a graphic design: see Figure 3.

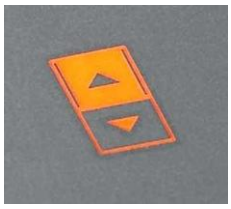

Figure 3. Capacitive Rocker Switch. (2007). Source: Johnson Controls.

The touch point area can now be designed to enhance the overall look of the interior by having the switch integrated into the overall design of the OHC and achieve greater harmony within a vehicle. The decorative visual part of a capacitive switch is part of the overlay layer shown in Figure 5.

One example of having a capacitive switch integrated into the overall design is the 2009 Jaguar XF that utilizes JaguarSense™ for the opening of the glove box. JaguarSense™ uses a capacitive switch to allow the driver touch operation of the opening of the glove box. Having touch operation removes the issue of looking for the switch while focusing on the road or in the dark. The JaguarSense™ glove box switch is shown in Figure 4.

Figure 4. JaguarSenseTM glove box capacitive switch. (2009). Source: CarReview.com-bustamove.

"Located under an overlay with a foil layer in between" (Amend, 2008), "a capacitive touch switch detects the presence or absence of a conductive object, such as a finger, by measuring changes in capacitance" (Wilson-Hurd, 2009) see Figure 5. The presence of the finger is detected in the capacitance field. This field is represented in Figure 5 as Cp on both the front and back sides of the switch.

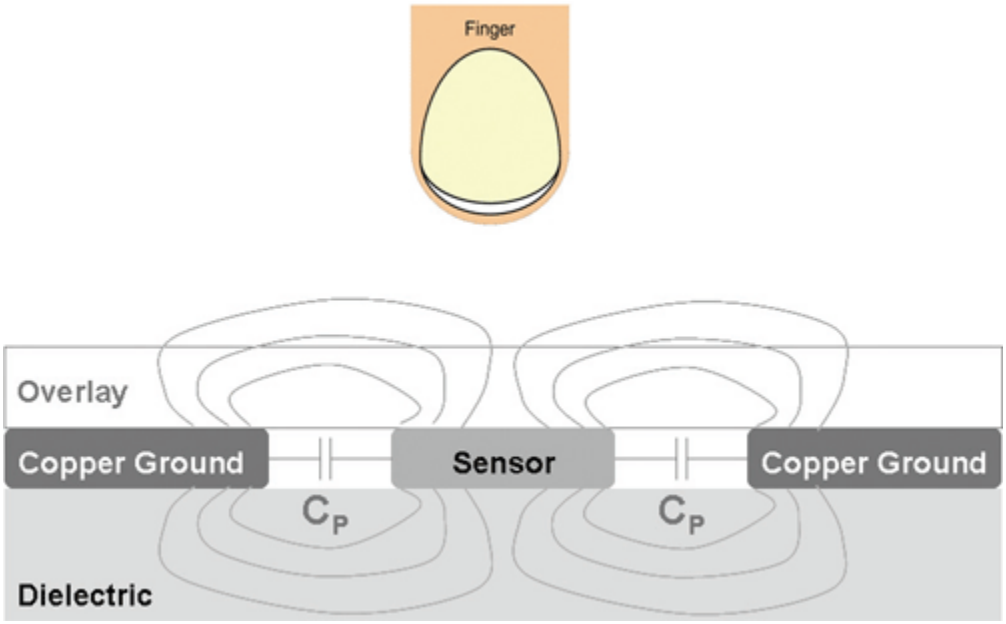

Figure 5. Cross-sectional view of a capacitive sensing button. (2007). Source: Connecting Industry.

Capacitive switches allow the auto industry greater flexibility in layout due to the reduced package space required to mount the switch. Reduction in package space can allow several in-vehicle functions to be integrated together for an aesthetically and ergonomically improved console (Bengtson, Grane, & Isaksson, 2003, p. 25).

According to Wilson-Hurd (2009), some of the benefits of using a capacitive switch are reduction in the switch cost, "easy integration of multiple functions, including LED

drivers and backlighting," and a "variety of non-conductive overlay materials can be used (plastic, acrylic and glass)." Also "there are no mechanical components within the switch—eliminating any potential mechanical failure of the switch." This mechanical elimination increases reliability and durability.

In light of all of the mentioned benefits, one potential cause for concern related to the adoption of capacitive switches is the lack of feedback the switch provides the user. Feedback is important as it helps provide reassurance and confirmation and helps govern a user's expectation (Norman, 2007, p. 141). The traditional switch research by Wellings, Williams, and Tennant (2009) linked the "perceptions of usability, visual appearance, and sound quality" to switch-feel (p. 8). In traditional switches "59% and 71% of the total variance" of "the perceived characteristics of switch haptics" "can be defined as 'Image', 'Build Quality', and 'Clickiness'" (p. 9). This study took into account a user's expectation of feedback through the purposeful selection of utilizing the capacitive switch for the map/reading light in the OHC. The user received confirmation that the switch was activated when the light immediately illuminated.

Background of Diffusion Theory

The launch of the BMW iDrive, the Continental AG consumer clinic, and this proposed research project share a common theoretical framework, the diffusion of innovation. "The most widely recognized source for diffusion theory is Everett M. Rogers' seminal work, Diffusion of Innovations" (Vanderslice, 2000, p. 23). "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas" (Rogers, 1995, p. 5).

An example of diffusion theory at work can be seen in the rapid rate of diffusion of the Apple iPod and iTunes (online song and movie sales) that "took the world by storm." Schmitt (2007) referenced Figure 6 as proof that Apple is well on its way to becoming the "ubiquitous consumer media platform" due to its rapid rate of diffusion.

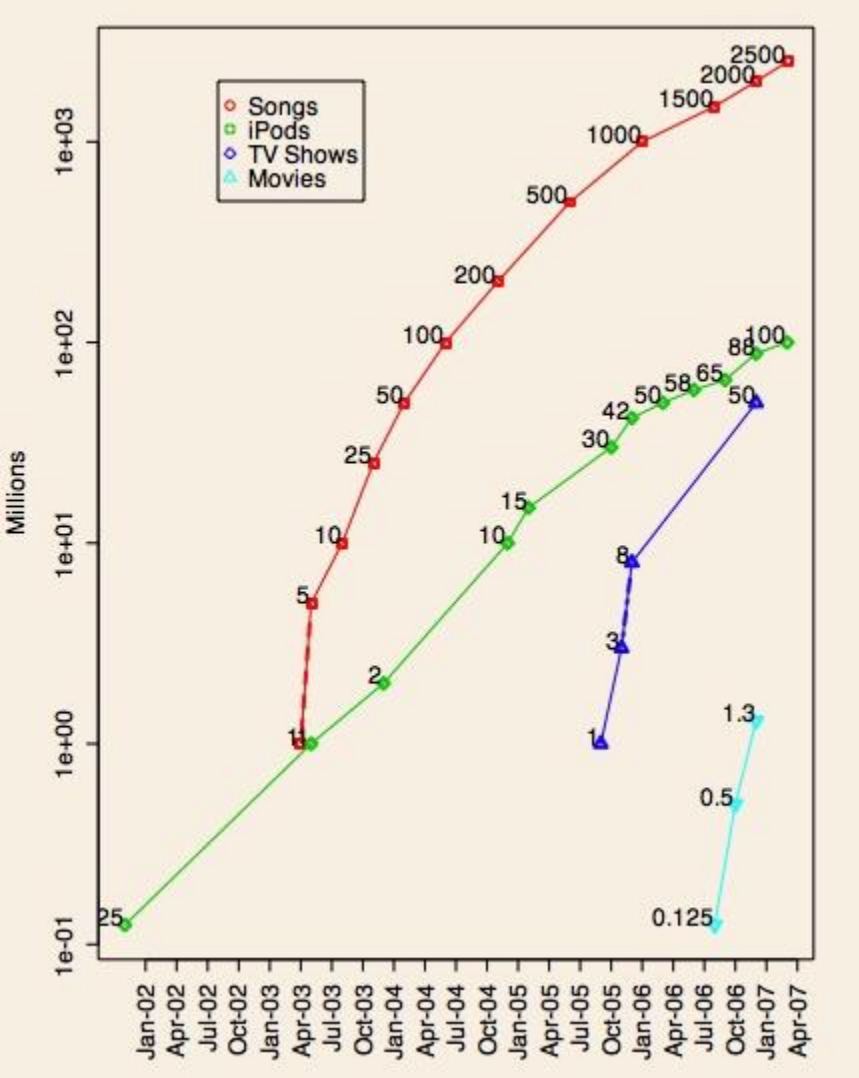

Figure 6. Log plot of iTunes and iPod sales 2002-2007. (2007). Source: Blackfriars (as cited in Schmitt, 2007).

Diffusion theory is composed of four main elements: "the innovation, communication channels, time, and the social system" (Rogers, 1995, p. 10). Each one of these main elements and subparts are broken down in Figure 7 and discussed in further detail below.

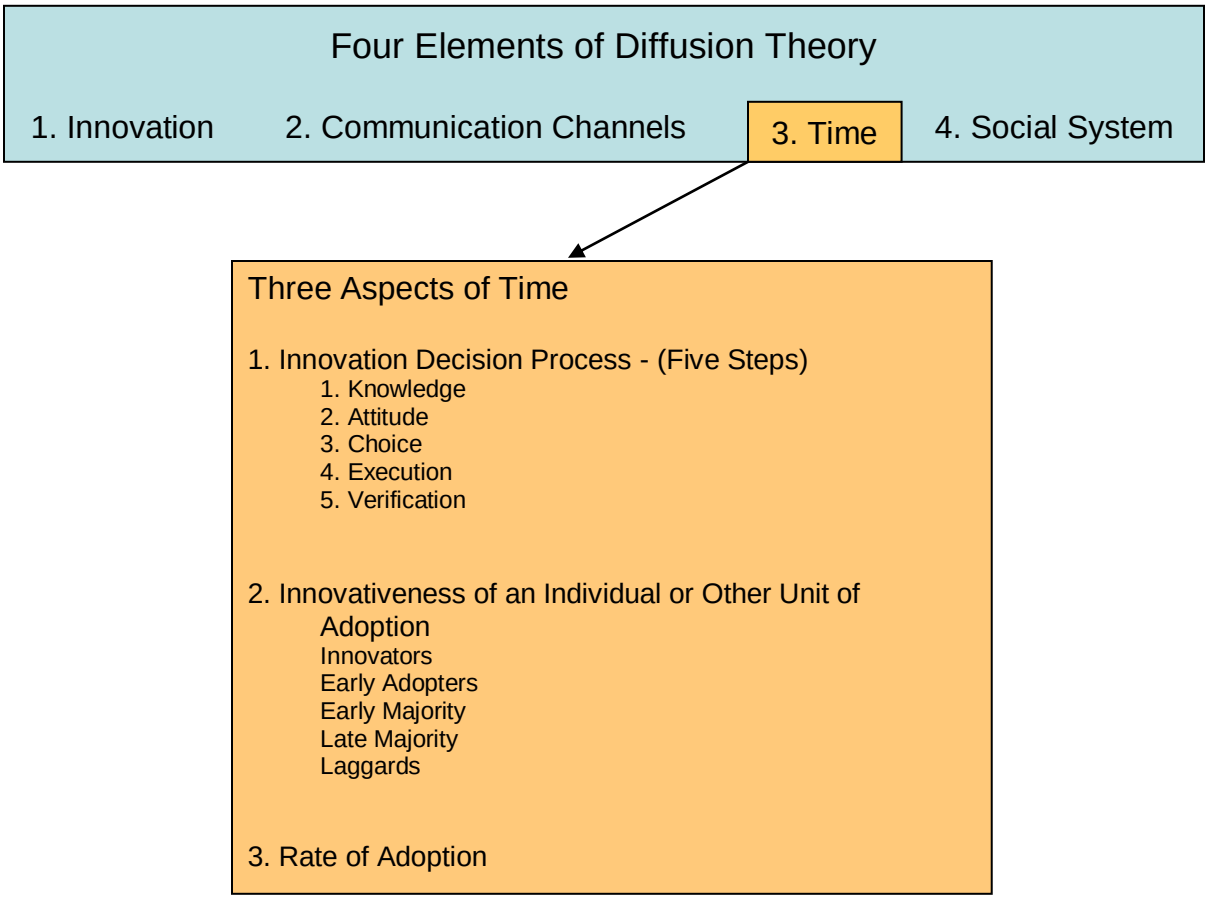

Figure 7. Breakdown of the elements, aspects and steps of diffusion theory, based on the work by Rogers (1995).

"An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11). This study looked at capacitive switch technology in overhead consoles (OHC) in an automobile. OHC's are not new; what

will be perceived as an innovation to a consumer is the use of capacitive switch technology incorporated in the OHC.

The second element of diffusion of innovation is communication channels. "A communication channel is the means by which messages get from one individual to another. The nature of the information-exchange relationship between a pair of individuals determines the conditions under which a source will or will not transmit the innovation to the receiver, and the effect of the transfer." This idea of a communication channel makes diffusion a very social process (Rogers, 1995, p. 18).

> Mass media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea. Most individuals evaluate an innovation, not on the basis of scientific research by experts, but through the subjective evaluations of near-peers who have adopted the innovation. (Rogers & Scott, 1997)

Time dimension is the third element composed of three main aspects: "innovation-decision process," "the innovativeness of an individual or other unit of adoption," and the "rate of adoption" (Rogers & Scott, 1997). Each of these aspects is described below.

The first aspect of time is the innovation-decision process. This is a mental process by which an individual passes from first knowledge (Step 1) of an innovation, then forming an attitude (Step 2) toward the innovation, next to a choice (Step 3) to adopt or reject, to execution (Step 4) of the new concept, and to verification (Step 5) of this decision (Rogers, 1995, p. 20; Rogers & Scott, 1997). Figure 8 identifies the five main steps in the innovation-decision process.

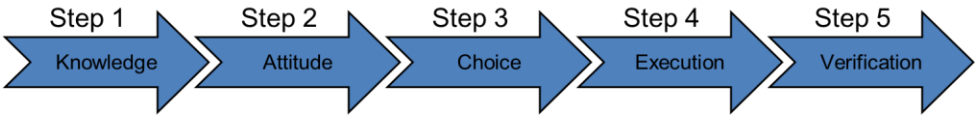

Figure 8. The five main steps in the innovation-decision process based of the work of Rogers (1995).

The second aspect of time is the innovativeness of an individual or other unit of adoption. "That is, the relative earliness/lateness with which an innovation is adopted-compared with other members of a system" (Rogers, 1995, p. 20). Individuals can be placed into five adopter categories based on their innovativeness: "(1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards" (Rogers, 1995, p. 22). These adopter categories are shown in Figure 9.

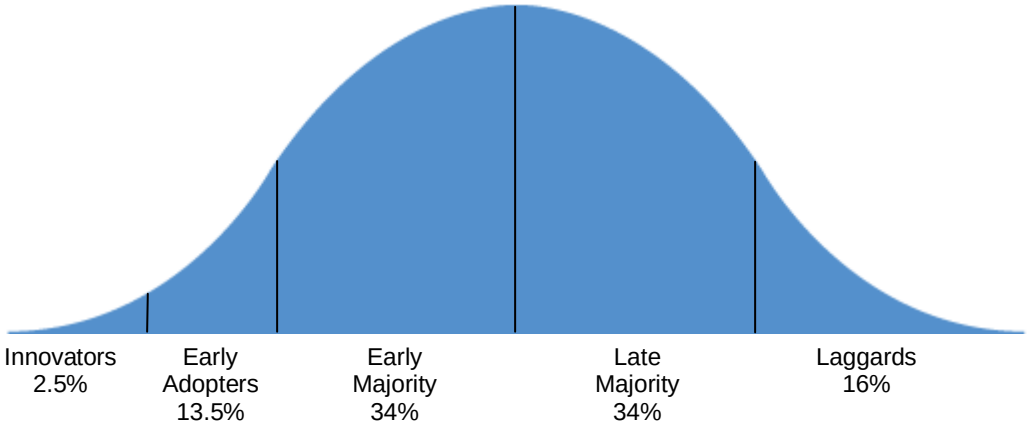

Figure 9. Adopter categorization on the basis of innovativeness by Rogers (1995).

Innovators - These people are considered the most venturesome of the five adopter categories. This desire to be venturesome leads them to join social groups outside of their local area. They share communication patterns and friendships with other innovators despite

their geographic locations. Fiscal and mental resiliency to potential setbacks and losses due to an adoption of innovation that is unsuccessful are also binding traits with "a desire for the rash, the daring, and the risky" (Rogers, 1995, p. 263-264). The most important role of all of the adopter categories is held by the innovators. That role is the introduction of new ideas into the system.

As the 2.5% of the system that make up innovators should be considered cosmopolitan, the next category of adopters, the early adopters, are considered localites. The early adopters are the opinion leaders for the system. Those potential innovation adopters look to the 13.5% of the system that make up the early adopters for their valued opinion as they are the "embodiment of successful, discrete use of new ideas" (Rogers, 1995, p. 264). To reduce their uncertainties, they adopt the innovation, review it, and subjectively evaluate it and share their evaluation with their peers.

The Early Majority - This third adopter category is a critical link that connects those who adopt early and those who adopt innovations late. This group contains a substantial critical mass as it contains 34% of the system's members. They are very much connected with their peers but rarely hold leadership roles. They do take time in considering the adoption of innovation, but when they do, they adopt it deliberately (Rogers, 1995, p. 264-265). This group is the target of those marketers outside of the system looking to push their innovation through the system.

The Late Majority - These people should be considered the skeptics of the system. This group also contains 34% of the entire system so they are also a large critical mass. They wait till others have adopted as they are cautious and skeptical and want to feel that it is safe

to adopt. At times it is an economic necessity as well as mounting peer pressure from the system that causes them to adopt (Rogers, 1995, p. 265).

The Laggards - The fifth and last group to adopt innovation is the laggards. The remaining 16% of the system populations made up of Laggards who have traditional values and are rooted in the past with suspicion of change and innovation. They socialize with like-minded individuals who, due to their economic condition, must be certain that the innovation that they adopt will not fail (Rogers, 1995, p. 265-266).

The last aspect of time is the Rate of Adoption in a system; this is the number of members in a system that adopt an innovation over a given time period (Rogers, 1995, p. 20). "The rate of adoption is usually measured by the length of time required for a certain percentage of the members of a system to adopt an innovation" (Rogers, 1995, p. 23). Just like an individual has an effect on the rate of adoption, the system also has an effect.

The fourth element of diffusion theory is a social system. The social system creates the border from which the innovation will diffuse. "A social system is defined as a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal. The members or units of a social system may be individuals, informal groups, organizations, and/or subsystems" (Rogers, 1995, p. 23). Due to the multitude of variables in the system, the rate of adoption might not be identical for the same innovation in two different social systems.

The adopters of innovation (innovators, early adopters, early majority, late majority, and laggards) utilize the various aspects and individual elements (the innovation, communication channels, time, and the social system) of diffusion theory when they are involved in the innovation-decision process.

Literature Related to the Research Design

One important aspect in the rate of adoption is the perceived attributes of an innovation. "…49 to 87 percent of the variance in the rate of adoption is explained by five attributes: relative advantage, compatibility, complexity, trialability, and observability" (Rogers, 1995, p. 206). These attributes are displayed visually in Figure 10.

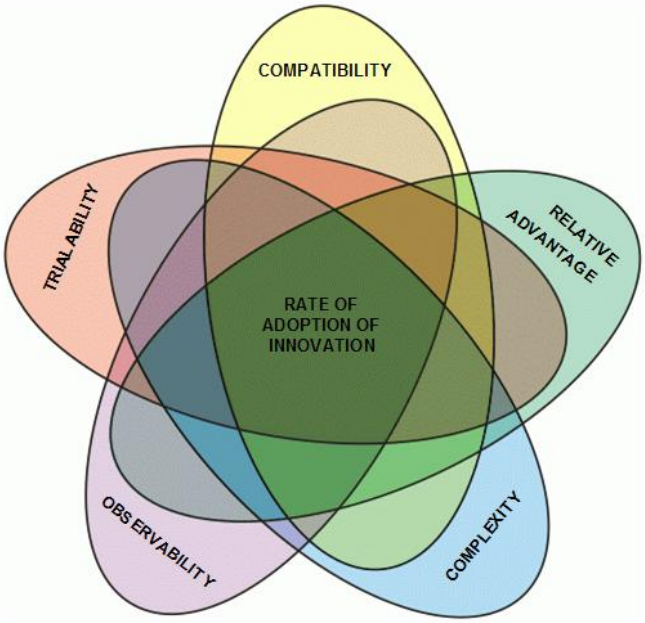

Figure 10. Based on perceived attributes of innovations by Rogers (1995).

Rogers (1995) conceived of the five attributes in the following ways:

"Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. The degree of relative advantage is often expressed as economic profitability, social prestige, or other benefits" (Rogers, 1995, p. 212).

"Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. An idea that is more

compatible is less uncertain to the potential adopter, and fits more closely with the individual's life situation. Such compatibility helps the individual give meaning to the new idea so that it is regarded as familiar" (Rogers, 1995, p. 224).

"Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 1995, p. 242). The more simplistic and less complex the innovation is, the easier it is for someone to adopt.

"Trialability is the degree to which an innovation may be experimented with on a limited basis" (Rogers, 1995, p. 243). A trial is a way for a potential user to alleviate any hesitancy or doubt that they might have. A potential consumer would be able to try an OHC with the capacitive switch at a car dealership or even a rental car that was equipped with the technology.

The fifth attribute that can help explain the rate of adoption is observability. "Observability is the degree to which the results of an innovation are visible to others" (Rogers, 1995, p. 244). In addition to the user, other people who were in the automobile containing the OHC with the capacitive switch would be able to observe it.

Dupagne and Driscoll (2005) developed a pilot study based off of Rogers' (1995) work that developed a reliable and nonspecific scale that measured seven perceived attributes of consumer communication technology adoption and had the following to say:

> Despite the voluminous diffusion literature spanning decades and multiple disciplines, little research has focused on developing reliable and valid scales to measure the five traditional perceived innovation attributes: relative advantage, compatibility, complexity, trialability, and observability. One notable exception is the work by Moore and Benbasat who constructed an instrument to measure potential

> adopters' perceptions of an information technology innovation within organizations. (p. 2)

Moore and Benbasat (1991) modified observability, which is one of five traditional constructs from Rogers (1995). In the developmental steps of creating the instrument, "Observability as originally defined by Rogers seemed to be tapping two distinctly different constructs" (p. 210). Due to this discovery, demonstrability and visibility were used as constructs instead of observability.

The Moore and Benbasat (1991) study also dropped complexity from Rogers' (1995) scale and used ease of use, image, and voluntariness. The final outcome of the Moore and Benbasat (1991) study was "a parsimonious, 38-item instrument comprising eight scales which provides a useful tool for the study of the initial adoption and diffusion of innovations" (p. 192-193). The instrument is located in Appendix A. This tool has the reliability and validity that previous instruments lacked (p. 194). Figure 11 displays a Venn diagram of their scales.

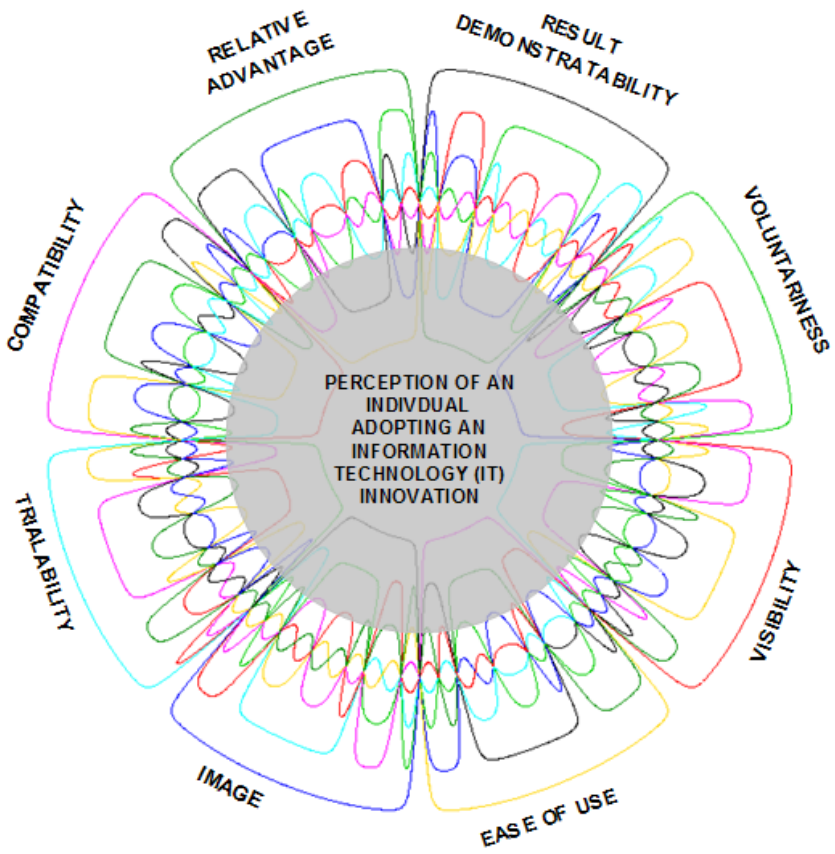

Figure 11. Based on perception of innovation adoption by Moore and Benbasat (1991).

Like Moore and Benbasat (1991), Dupagne and Driscoll (2005) built off of Rogers' (2003) work. Dupagne and Driscoll (2005) kept all of Rogers's (1995) attributes intact and added perceived risk and perceived resources in their pilot study of "constructing reliable scales to measure seven perceived innovation attributes for adoption of aggregated consumer communication technologies" (p. 3). The Venn diagram in Figure 12 displays the seven measured attributes.

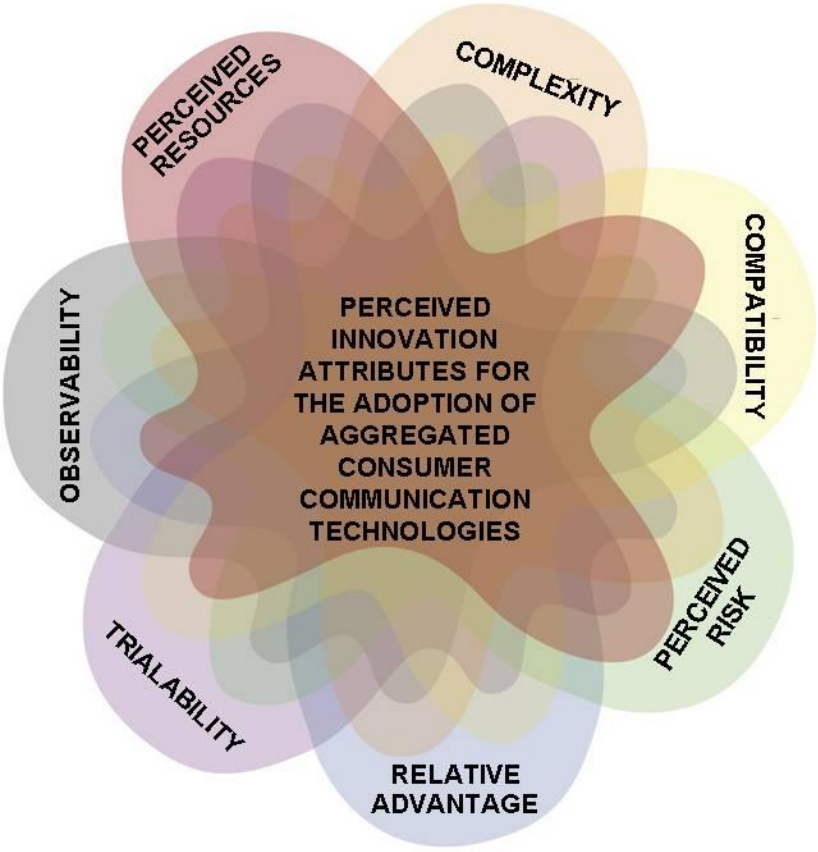

Figure 12. Based on perceived attributes of innovations by Dupagne and Driscoll (2005).

Perceived risk as described in the Dupagne and Driscoll (2005) pilot study is the sixth attribute.

> It refers to the degree to which risks are perceived as associated with the innovation. The economic cost is not the only element of perceived risk. The uncertainty of the purchasing process can also produce psychological risks (e.g., unhappiness) [e.g., consumer adopted the innovation and they are frustrated with the performance of the innovation] and opportunity costs (e.g., loss of time) [e.g., time spent researching before adopting, time spent trying to learn the innovation] (p. 5).

The seventh attribute of innovation as used by Dupagne and Driscoll (2005) is perceived resources.

> It refers to the evaluation of financial resources available for purchase, judged more from one's perception of the product's intrinsic value than from its actual monetary cost. The emphasis of this construct is on the self-perceived financial wherewithal of the potential adopter when s/he considers adopting an innovation (e.g., "Can I afford this item?"). Perceived resources are hypothesized to be positively related to rate of adoption or innovativeness (p. 5-6).

"Four of the seven scales (compatibility, complexity, trialability, and perceived resources) were significant predictors of adoption in the expected direction, although their collective contribution to the explained variance was somewhat modest" (Dupagne & Driscoll, 2005, p. 14).

Researchers have to maximize the return on their projects while working around the constraints of time and resources. "Experimenters are usually limited in the amount of time they can demand of their subjects, the funds available for handling data once it is collected, and so on" (Osgood, Suci, & Tannebaum, 1975, p. 80). This makes choosing the correct number of items or concepts in a chosen instrument equally as important to choosing the correct instruments to collect data. Miller and Salkind (2002) stated:

> Social scientists have often elected to construct new measures even when scales of high reliability and validity have been available. This practice is wasteful of time, energy, and money. In addition, it makes replication and accumulation of research findings difficult if not impossible. (p. 449)

This study was mindful of Miller and Salkind (2002) and utilized the work that Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005) invested in instrument creation; see Appendix A for Moore and Benbasat (1991) and Appendix B for Dupagne and Driscoll (2005). "It should be noted that Rogers' definitions are based on perceptions of the innovation itself, and not perceptions of actually using the innovation" (Moore and Benbasat, 1991, p. 196).

> Innovations diffuse because of the cumulative decisions of individuals to adopt them. Thus, it is not the potential adopters' perceptions of the innovation itself, but rather their perceptions of using the innovation that are key to whether the innovation diffuses. (Moore and Benbasat, 1991, p. 196)

This is why this study was based on the perceptions of using the innovation.

Summary

In this chapter, various elements of capacitive switching and diffusion theory were stated. The literature review presented information as a framework regarding product differentiation via capacitive switching, an overview of how capacitive switching works and the benefits of these switches. The main elements of diffusion theory were reviewed, as well as attributes that have the potential to explain the majority of the variance in the rate of adoption.

CHAPTER III. Methodology

Introduction

The focus of this study was to measure the perceived attributes of innovations of capacitive switch technology in industrially designed user interface controls. Data related to relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk and perceived resources were collected.

Research Design

Survey research was the descriptive design methodology. Leedy and Ormrod (2005) defined it as the following:

> Survey research involves acquiring information about one or more groups of people—perhaps about their characteristics, opinions, attitudes, or previous experiences—by asking them questions and tabulating their answers. The ultimate goal is to learn about a large population by surveying a sample of that population; thus, we might call this approach a descriptive survey or normative survey. (p. 185)

Participants reviewed overhead console samples with and without capacitive switch technology and provided feedback via a Scantron sheet to capture their responses to a multi-item survey.

Relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources were the independent variables. The dependent variable was the consumer acceptance of the capacitive switch technology in the industrial designed user interface controls. These variables are shown graphically in Figure 13.

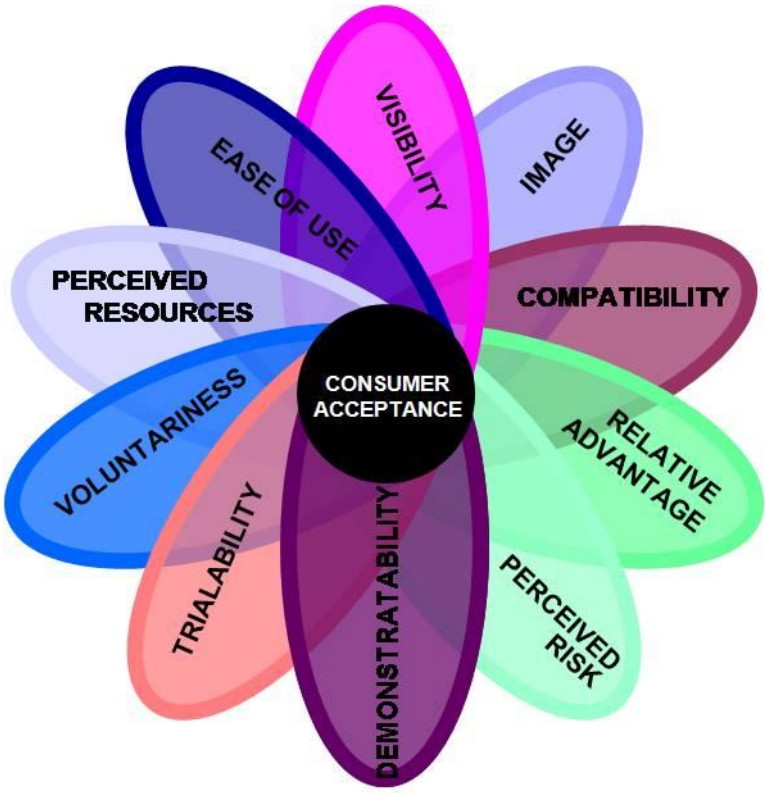

Figure 13. Based on, and adapted off the work of Rogers (1995), Moore and Benbasat (1991), Dupagne and Driscoll (2005).

Research Setting

The research took place at multiple sites. One site was located in Milwaukee, Wisconsin, the other two sites were located in Holland and Plymouth, Michigan. The setting was in a high traffic area of a tier one automotive company: this was always a main hallway leading to the facilities cafeteria. Due to the different locations, the settings were not identical. Employees were invited to participate as they passed the location of the data collection.

Population and Sample

The population for the study was licensed male and female drivers who were 18 years of age and older. According to U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, in 2006 there were 202,810,438 licensed drivers in the United States. According to Gay and Airasian (2003, p. 113) as well as Leedy and Ormond (2005, p. 207) a sample size of 400 participants is adequate for a population of 5,000 units or more.

Cost and time constraints generally prohibit using a sample size of 400 participants. Researchers in the automotive industry default to their customers when establishing the sample size for their research studies. Due to the constraints of cost and time industrial studies that require subjects to look and touch samples generally contain 30-60 subjects.

The subjects in this study were gathered via convenience sampling; all participation was completely voluntary. By using a convenience sample, a subset of the population was not identified ahead of time as it uses people who are readily available or arrive by mere happenstance (Leedy & Ormond, 2005, p. 206). The location for the study has been sampled before and has yielded participation numbers around 75 participants. This study gathered data for two days in Milwaukee, Wisconsin, two days in Holland, and a half day in Plymouth, Michigan, to obtain a sample size of 402 participants.

Human subjects approval. There was minimum risk to the participants in this research project. After the proposal was approved, the researcher completed a Request for Human Subjects Approval Form (6-2008) and obtained authorization from the university before proceeding with data collection from any human subjects.

Data Collection

There was one main instrument used for the collection of data in this study. It was the intent of Moore and Benbasat (1991) to create an instrument that was "applicable to a wide variety of innovations" (p. 194). They did so by removing the items that were only applicable to their study. This study combined the work of Moore and Benbasat (1991) shown in Appendix A, and Dupagne and Driscoll (2005) shown in Appendix B, to create an instrument to capture the above mentioned constructs that was based off the work of Rogers (1995). The combined instrument is shown in Appendix C. Appendix E contains the actual instrument complete with demographic questions that were used.

Participants were asked to review two working models of an automotive OHC. The models were mounted in-vehicle position on a stand (See Figure 14). Participants sat in chairs below the models shown in Figure 15. The first model had a traditional switch in it (switch A). The second model utilized a capacitive switch (switch B) displayed in Figure 16. After the participants had a chance to touch and interact with the two models they were asked to mark on the survey instrument their responses to various questions regarding what they just experienced.

Figure 14. Automotive OHC shown in-vehicle position, shown with snacks.

Figure 15. Automotive OHC shown with chairs.

Figure 16. Switch A and switch B shown in grey.

The survey questions utilized a rating scale more commonly called a Likert scale to assess the opinions of participants (Leedy & Ormrod, 2005, p. 185). Likert scales measure the level of agreement or disagreement with the statement presented. The participants read a statement and then indicated their responses on a paper Scantron form rating their own level of disagreement or agreement. There was no right or wrong answer. The survey was used to capture beliefs about the following constructs: relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources. The survey also captured the demographic information of gender, age, level of education, race/ethnicity, income, marital status, and number of children of the participants. Traditionally demographic information such as the previously mentioned items has been used to aid in the segmentation of buyers in doing automotive studies. An educated, young, single, male with high income has often been used as a market predictor in this industry.

Data Analysis

After the data were collected, they were analyzed using Excel and SPSS statistical software. Some of the data that were collected were nominal such as the participants' gender and age. The core of the data was gathered from the Likert scaled statements. Allen and Seaman (2007) said the "…initial analysis of Likert scalar data should not involve parametric statistics but should rely on the ordinal nature of the data."

The first step in the data analysis was to code the responses in an Excel spreadsheet so that the data could easily be exported to SPSS. The scale was 1 to 5 and used the following: 1 = A (strongly disagree), 2 = B (disagree), 3 = C (not sure), 4 = D (agree), and 5 = E (strongly agree). Once the data were imported into SPSS, questions were reviewed and it was determined that the following questions needed to be reverse coded: 1, 2, 3, 15, 16, 21, 23, 33, 34, 36, 37, 38, and 42. During the review process, questions 11 and 26 were deemed unusable due to the inclusion of the word "capacitive." The researcher realized after the fact that the population would not know if switch A or switch B was the capacitive switch. Question 49 also contained a flaw in the answers. The income levels in the answer choices were not continuous and left $100 holes in the response range between A, B, C, D, and E. This was not deemed a critical error for respondents and was noted in the table reporting these data. After coding, the next step was to calculate the median, interquartile range and mode of the constructs (Motulsky, 1995).

Cronbach's alpha measured how well the set of statements measured the constructs. See Appendix C for a list of the constructs with underlying statements. Cronbach's alpha determines reliability. Santos (1999) determined that,

> Reliability comes to the forefront when variables developed from summated scales are used as predictor components in objective models. Since summated scales are an assembly of interrelated items designed to measure underlying constructs, it is very important to know whether the same set of items would elicit the same responses if the same questions are recast and re-administered to the same respondents. Variables derived from test instruments are declared to be reliable only when they provide stable and reliable responses over a repeated administration of the test. (n.p.)

The questions that comprised each construct were added together using SPSS to create the concept of the construct.

To create the constructs of relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources, the related questions were summarized into a composite score. For example, Appendix F shows the survey divided by construct. The relative advantage construct composite score is created by adding the subjects coded scores from the questions numbered 1-8. Because there were 8 questions that were coded with a scale of 1 to 5, the lowest composite relative advantage score could be 8 if the subject scored a 1 on each question and the maximum score could be 40 if each question had a score of 5. This composite score result was divided into fifths to stay congruent with the responses available for each question: *strongly disagree*, *disagree*, not *sure*, *agree*, and *strongly agree*. The *strongly disagree* and *disagree* results were grouped together and coded 1. *Agree* and *strongly agree* results were grouped together and coded 2. The remaining results for not sure were coded 0. The variables that were coded 1 and 2 were used as the groups for the independent variables.

The next step in data analysis was to calculate an independent-samples t-test. Question 42 was used as the test/dependent variable. Each of the constructs was used for the grouping/independent variables.

Personnel

Contrasting sample prototype products were available to use for the purpose of completing this study. Employees from the tier 1 prototype department mounted the samples to a frame that simulated an in-car position. The human factors liaison provided consultation on an as needed basis to make sure the research was grounded in the real world. These personnel were in addition to the researcher and doctoral committee.

Timeline

The timeline shown was the proposed rough estimate for the major work packages. These times are approximate and due to events out of the researcher's control were subject to change as the research progressed.

1. Review prospectus with corporate partner.	1 month
2. Review prospectus with chair.	1 week
3. Review and make changes.	2 weeks
4. Present dissertation proposal to committee.	1 month
5. Research and analysis	7 months
6. Writing, editing and proofing	5 months

Summary

This chapter offered a review of the research design, research setting, population, and sample. Various elements of the data collection and data analysis were presented. An overview of the personnel needed and a timeline to complete this research was covered.

CHAPTER IV. Data Presentation and Analysis

Introduction

This chapter will present data that were gathered during this survey research and an analysis of that data that were gathered by the methodology described in Chapter III. The survey instrument collected data for each of the constructs as well as demographic information about the participants in the study. To answer the following questions:

1. Is there a relationship between relative advantage, as outlined by Rogers (1995), and Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
2. Is there a relationship between compatibility, as outlined by Rogers (1995), and Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
3. Is there a relationship between trialability, as outlined by Rogers (1995), and Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
4. Is there a relationship between demonstrability, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
5. Is there a relationship between visibility, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

6. Is there a relationship between ease of use, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
7. Is there a relationship between image, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
8. Is there a relationship between voluntariness, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
9. Is there a relationship between perceived risk, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
10. Is there a relationship between perceived resources, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?
11. Is there a relationship between combining the following perceived attributes of innovations - relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources as outlined by Rogers (1995), Moore and Benbasat (1991), Dupagne and Driscoll (2005) - and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

Findings

Demographics of the pilot study.

This section presents statistical responses to the seven demographic questions that addressed the variables of Gender, Age, Level of Education, Marital Status, Number of Children in Household, Level of Income, and Race/Ethnicity. There were 402 participants in this pilot study. Two hundred fifty-nine (64%) of the participants were male and one hundred forty (35%) were female. Table 1 below shows the gender information of the pilot study participants in terms of frequency (*N*) and percentage.

Table 1

Frequency and Percent on Gender

Gender	*N*	Percent
Male	259	64
Female	140	35

About the frequency and age of the participants, thirty-one (8%) were between the ages of 18-26, eighty-nine (22%) participants were between the ages of 27-35 and one hundred thirty-six (34%) of them were between the ages of 36-44. In addition, one hundred seven (27%) of the participants were 45-54 years old, thirty-four (9%) participants were between the ages 55-64 and 1 (.251%) of the participants were 65 or over. Frequency and percent on age are presented in Table 2.

Table 2

Frequency and Percent on Age

Age	*N*	Percent
18-26	31	8
27-35	89	22
36-44	136	34
45-54	107	27
55-64	34	9
65 or over	1	.251

Regarding the frequency and level of education of the participants, zero (0%) of them had only a grade school/middle school education, twenty-three (6%) of the participants had a high school level of education. Forty-two (11%) of the participants had an Associate degree, one hundred ninety-five (49%) of them had a Bachelor level of education and one hundred twenty (30%) of them had a Master's degree level of education. In addition, nine (2%) of the participants had a Doctorate level of education and eight (2%) had some other level of education such as a DD or several years of college. Frequency and percent on level of education are presented in Table 3.

Table 3

Frequency and Percent on Level of Education

Level of Education	*N*	Percent
Grade School/Middle School	0	0
High School	23	6
Associate Degree	42	11
Bachelor's Degree	195	49
Master's Degree	120	30
Doctorate	9	2
Other – DD, Several college years	8	2

Participants were asked their marital status and eighty-six (22%) of those that responded were single while two hundred seventy-nine (70%) were married. Five (1%) were widowed and twenty-nine (7%) were divorced. Frequency and percent on marital status is located in Table 4.

Table 4

Frequency and Percent on Marital Status

Marital Status	*N*	Percent
Single	86	22
Married	279	70
Widowed	5	1
Divorced	29	7

Participants were asked a question regarding the number of children in their household, one hundred forty-five (36%) had no children, seventy-one (18%) had one child. In addition, one hundred sixteen (29%) had two children and sixty-eight (17%) had three or more children. Frequency and percent of number of children in the participant's household can be found in Table 5.

Table 5

Frequency and Percent on Number of Children in Household

Number of Children in Household	*N*	Percent
No Children	145	36
One Child	71	18
Two Children	116	29
Three or More Children	68	17

Respondents were asked their level of income. Fourteen (4%) had a level of income less than $34,900, thirty-seven (10%) had $35,000 - $49,900 and ninety-six (25%) had a level of income of $50,000 - $74,900. Plus, one hundred seventeen (31%) had an income level of $75,000 - $99,000 and one hundred nineteen (31%) had $100,000+ level of income. Table 6 reflects the frequency and percent on level of income.

Table 6

Frequency and Percent on Level of Income

Level of Income	*N*	Percent
<$34,900*	14	4
$35,000 - $49,900*	37	10
$50,000 - $74,900*	96	25
$75,000 - $99,000*	117	31
$100,000+	119	31

Note: *There is an unaccounted for gap between levels of income.

Finally respondents were asked to note their race/ethnicity. Six (2%) responded that they were American Indian or Alaska Native (not Hispanic or Latino) a person having origins in any of the original peoples of North or South America (including Central America), and who maintains tribal affiliation or community attachment. Thirty-seven (10%) of participants responded that they were Asian (not Hispanic or Latino) a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam. Eighteen (5%) respondents revealed that they were Black or African American (not Hispanic or Latino) a person having origins in any of the black racial groups

of Africa. One (.261%) person responded that they were native Hawaiian or other Pacific Islander (not Hispanic or Latino) a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands. Three hundred one (79%) participants responded that they were White (not Hispanic or Latino) which was defined as a person having origins in any of the original peoples of Europe, the Middle East, or North Africa. Seventeen (4%) of the participants indicated that they were a Hispanic or Latino which is a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. Three (.783%) people indicated that they were two or more races (Not Hispanic or Latino). The frequency and percent of race/ethnicity is displayed in Table 7.

Table 7

Frequency and Percent on Race/Ethnicity

Race/Ethnicity	*N*	Percent
American Indian or Alaska Native (Not Hispanic or Latino) a person having origins in any of the original peoples of North or South America (including Central America), and who maintains tribal affiliation or community attachment.	6	2
Asian (not Hispanic or Latino) a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.	37	10
Black or African American (not Hispanic or Latino) a person having origins in any of the black racial groups of Africa.	18	5

Native Hawaiian or Other Pacific Islander (Not Hispanic or Latino) a person having origins in Any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.	1	.26
White (not Hispanic or Latino) a person having origins in any of the original peoples of Europe, the Middle East, or North Africa.	301	79
Hispanic or Latino a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.	17	4
Two or More Races (Not Hispanic or Latino) all persons who identify with more than one of the above races.	3	.78

Response rate.

Many people were asked to participate in the survey as they walked pass the data collection site. They were offered a snack for their participation in the study. Every person who took the survey completed and turned it in for a one hundred percent response rate from this sample of convenience.

Reliability.

This section presents statistical reliability results for the following constructs; relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, perceived resources, and consumer acceptance. The target level of minimum reliability for this research was .70 to .80 (Moore and Benbasat, 1991, p. 205). The relative advantage subscale consisted of 8 items (α=.87), the compatibility subscale consisted of 5 items (α=.86) and the trialability subscale consisted of 3 items (α=.75). Additionally, the demonstrability subscale consisted of 4 items (α=.61), the visibility subscale consisted of 2 items (α=.50) and the ease of use subscale consisted of 3 items

(α=.74). The Image subscale consisted of 3 items (α=.90), the voluntariness subscale consisted of 2 items (α=.51) and the perceived risk subscale consisted of 3 items (α=.73). Lastly, perceived resources subscale consisted of 5 items (α=.72) and consumer acceptance subscale consisted of 3 items (α= -.71). The statistical reliability results are located below in Table 8.

Table 8

Reliability Results of the Constructs

Attributes	*N*	Cronbach's Alpha
Relative Advantage	8	.87
Compatibility	5	.86
Trialability	3	.75
Demonstrability	4	.61
Visibility	2	.50
Ease of Use	3	.74
Image	3	.90
Voluntariness	2	.51
Perceived Risk	3	.73
Perceived Resources	5	.72
Consumer Acceptance	3	-.71

Responses of the Perceived Attributes of Innovations

This section presents statistical responses for relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources.

1. **Is there a relationship between <u>relative advantage</u>, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of those who scored high on the relative advantage construct to those that scored low on relative advantage. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=3.62, SD=1.11) and the combined results of *agree* and *strongly agree* (M=2.14, SD=0.99); t (255.48)=11.66, p = 0.00. These results suggest that relative advantage does have an effect on consumers' acceptance of capacitive switches. Specifically, consumers perceived that there was an advantage to the capacitive switch over the traditional switch.

2. **Is there a relationship between <u>compatibility</u>, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the compatibility of traditional switches and capacitive switches. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=3.78, SD=1.10) and the combined results of *agree* and *strongly agree* (M=2.46, SD=1.07); t (330)=10.06, p = 0.00. These results propose that compatibility does have an effect on consumer acceptance of capacitive switches. Specifically, consumers perceived that there was a familiarity to the capacitive switch when compared with the traditional switch.

3. **Is there a relationship between <u>trialability</u>, as outlined by Rogers (1995), Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the trialability of traditional switches and capacitive switches. There was not a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (*M*=3.16, *SD*=1.24) and the combined results of *agree* and *strongly agree* (*M*=3.01, *SD*=1.35); *t* (147)=.67, $p = 0.50$. These results urge that trialability does not have an effect on consumer acceptance of capacitive switches. Specifically, consumers perceived that trying out the capacitive switch when compared with the traditional switch would not help alleviate any hesitancy or doubt.

4. **Is there a relationship between <u>demonstrability</u>, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the demonstrability of traditional switches and capacitive switches. There was not a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (*M*=3.23, *SD*=1.07) and the combined results of *agree* and *strongly agree* (*M*=2.84, *SD*=1.26); *t* (314)=1.54, $p = 0.12$. These outcomes suggest that demonstrability does not have an effect on consumer acceptance of capacitive switches. More specifically, consumers were not able to distinguish the degree to which the results of the capacitive switch could be demonstrated to others.

5. **Is there a relationship between visibility, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the visibility of traditional switches and capacitive switches. There was not a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (*M*=3.05, *SD*=1.37) and the combined results of *agree* and *strongly agree* (*M*=2.92, *SD*=1. 20); *t* (338)=.820, $p = 0.41$. These outcomes suggest that demonstrability does not have an effect on consumer acceptance of capacitive switches. More specifically, consumers were not able to distinguish the degree to which the results of the capacitive switch would be visible to others.

6. **Is there a relationship between ease of use, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the ease of use of traditional switches and capacitive switches. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (*M*=4.25, *SD*=0.71) and the combined results of *agree* and *strongly agree* (*M*=2.76, *SD*=1.18); *t* (7.90)=5.77, $p = 0.00$. These results suggest that ease of use has an effect on consumer acceptance of capacitive switches. Specifically, consumers perceived that trying out the capacitive switch when compared with the traditional switch would make it easier to use.

7. **Is there a relationship between image, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the image of traditional switches and capacitive switches. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=3.15, SD=1.27) and the combined results of *agree* and *strongly agree* (M=2.23, SD=1.04); t (70.23)=5.04, p = 0.00. These results suggest that image does have an effect on consumer acceptance of capacitive switches. Specifically, consumers perceived that the capacitive switch was more of a status symbol with higher profile users over the traditional switch users.

8. **Is there a relationship between voluntariness, as outlined by Moore and Benbasat (1991), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?**

An independent-samples t-test was conducted to compare consumer acceptance of the voluntariness of use of traditional switches and capacitive switches. There was not a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=2.72, SD=1.29) and the combined results of *agree* and *strongly agree* (M=2.75, SD=1.34); t (162)=-.13, p = 0.90. These results propose that voluntariness of use does not have an effect on consumer acceptance of capacitive switches. Specifically, consumers did not perceive their ability to adopt or reject the capacitive switch when compared with the

traditional switch was mandated or discouraged by an outside force such as a corporate policy.

9. Is there a relationship between perceived risk, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

An independent-samples t-test was conducted to compare consumer acceptance of the perceived risk of traditional switches and capacitive switches. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=3.52, SD=1.29) and the combined results of *agree* and *strongly agree* (M=2.79, SD=1.19); t (224)=4.05, p = 0.00. These results propose that perceived risk does have an effect on consumer acceptance of capacitive switches. Specifically, consumers perceived that the associated economic, psychological as well as opportunity cost/risk of the capacitive switch was minimal when compared with the traditional switch.

10. Is there a relationship between perceived resources, as outlined by Dupagne and Driscoll (2005), and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

An independent-samples t-test was conducted to compare consumer acceptance of the perceived resources of traditional switches and capacitive switches. There was not a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=2.57, SD=1.32) and the combined results of *agree* and *strongly agree* (M=3.06, SD=1.39); t (79)=-1.52, p = 0.13. These results propose that perceived resources do not have

an effect on consumer acceptance of capacitive switches, specifically, consumers' perception of the intrinsic value of the capacitive switch when compared with the traditional switch.

11. Is there a relationship between combining the following perceived attributes of innovations - relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources as outlined by Rogers (1995), Moore and Benbasat (1991), Dupagne and Driscoll (2005) - and consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls?

An independent-samples t-test was conducted to compare consumer acceptance of the combined constructs of: relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources of traditional switches and capacitive switches. There was a significant difference in the scores for the combined results of *strongly disagree* and *disagree* (M=4.00, SD=1.14) and the combined results of *agree* and *strongly agree* (M=2.24, SD=1.02); t (142)=9.73, p = 0.00. These results propose that the combination of relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk and perceived resources does have an effect on consumer acceptance of capacitive switches.

Summary

In this chapter, the data collected during the survey research was presented and an analysis was made as it related to the perceived attributes of innovations. In Chapter 5 the results, conclusions and recommendations will be presented.

CHAPTER V. Results, Conclusions, and Recommendations

Introduction

The summarized results of this pilot study are found within this chapter. Also included is an overview of the study, summary of findings, practical or theoretical implications, limitations of the study, and finally recommendations for future research.

Overview of Study

This study examined the relationship between the perceived attributes of innovations and a consumers' willingness to accept capacitive switch innovation in industrially designed user interface controls. The attributes that were examined included relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources. The research was conducted in three different locations in two different mid-western states to obtain a sample size of 402 participants. One version of the survey was used to obtain feedback from the participants. SPSS statistical software was utilized to perform the statistical calculations. The data were reviewed and reported.

Summary of Findings

Figure 17 shows a composite view of the individual responses for each of the following constructs relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources. Those constructs in green had results that were statistically significant and were not likely to occur due to chance, but were due to the independent variable. The constructs shown in red were not statistically significantly different; it is more likely that these results were due to chance than

the manipulation of the independent variable. For the purpose of clarity, Figure 17 does not reflect the results of combining all of the constructs together.

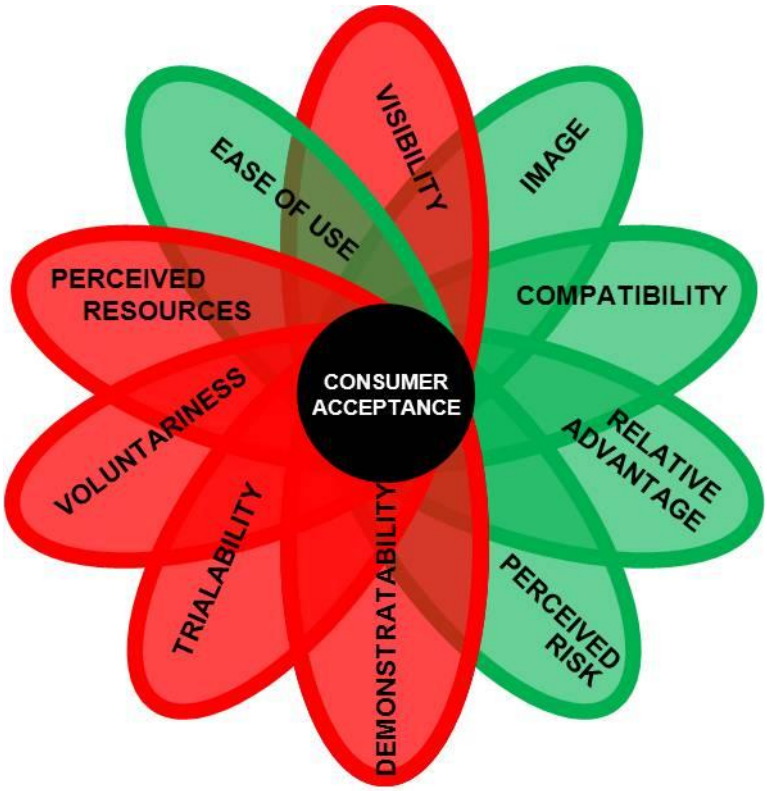

Figure 17. Composite View of Individual Results.

The result of combining all of the constructs together is displayed in the Figure 18 Venn diagram. With half of the constructs yielding individual results that were not in the range of being statistically significant it was surprising that the result of combining them all together would result in statistically significant results probably from the manipulation of the independent variable.

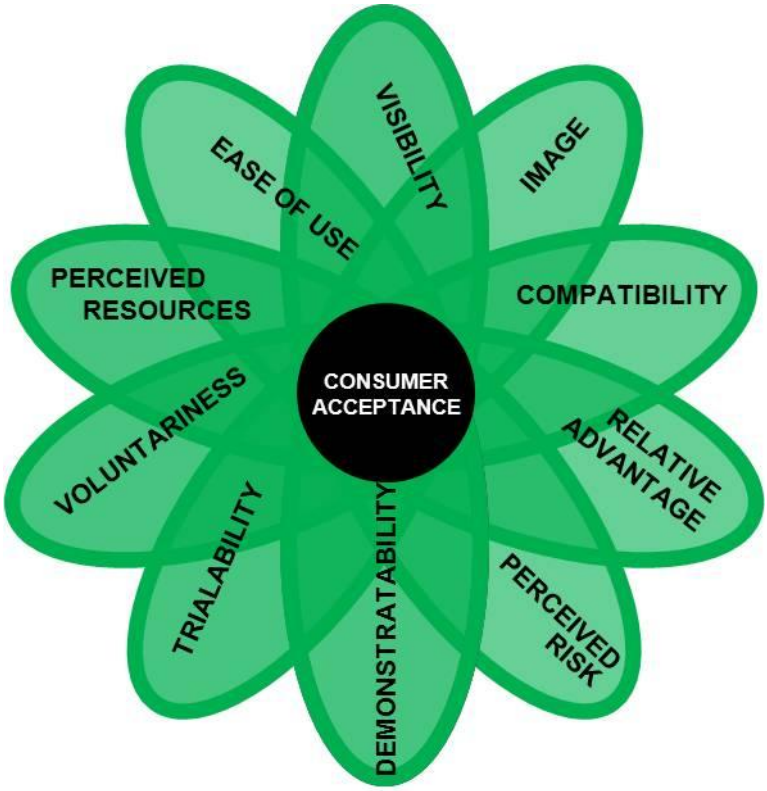

Figure 18. Venn Diagram of Combined Construct Results.

The results for relative advantage, compatibility, ease of use, image, and perceived risk were statistically significant enough to indicate that a consumer is willing to accept capacitive switch innovation in industrially designed user interface controls. The results indicated that for voluntariness, trialability, demonstrability, visibility, and perceived resources did not indicate the same. However, all of the attributes of relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources combined would also end up being statistically significant enough to indicate that a consumer is willing to accept capacitive switch innovation.

Theoretical and Practical Implications

This dissertation adds theoretical knowledge on the diffusion of innovation. This compliments the many studies built off of Rogers (1995) original work. This study contributed to the field of consumer research by combining Rogers work with his successors, Moore and Benbasat (1991), and Dupagne and Driscoll (2005), and then disseminating it which is rarely done in the automotive world. By combining the work of the previous researchers, this study provided some insight on consumer acceptance of innovative capacitive switch technology in industrial designed user interface controls.

The practical implications of this dissertation research are based on the empirical findings that illustrate the ability for the perceived attributes of an innovation to indicate if a consumer segment is willing to accept capacitive switch innovation in industrially designed user interface controls. This is important as Rogers indicated that "…49 to 87 percent of the variance in the rate of adoption is explained by five attributes…" (1995, p. 206).

Market segmentation and better utilization of expensive prototypes are a few of the benefits of this study. These benefits are in addition to a better understanding of the automotive consumer segmentation as it relates to capacitive switch technology innovations in industrial designed user interface controls.

Limitations of Study

There are several limitations to this study. The first limitation of this study was the consumer acceptance construct which had a Chronbach's Alpha of -.711. The negative Chronbach's Alpha reflects the lack of construct development. The other constructs used in this study had undergone extensive development by prior researchers. This is also noted in recommendations for further research.

An additional limitation of this study was the sample. The sample was only pulled from three locations in two states, all from within one company. Single, 18-26 year olds earning less than $35,000 with an education level between grade school and an Associate Degree is under represented in this sample. Sampling a different company's blue collar, hourly paid, production work force at a different location might have been one way to address this void in the sampling data.

The data are also under represented in the diversity of race/ethnicity. One of the seven categories, White (not Hispanic or Latino) made up 79% of the respondents. The next highest category only had 10%. Sampling in other geographic regions across the United States might be one way to help address this void in diversity data.

Recommendations for Further Research

The purpose of this research was to examine the relationship between the perceived attributes of innovations and a consumer's willingness to accept capacitive switch innovation in industrially designed user interface controls. Based on the negative reliability results of this study regarding consumer acceptance, the first recommendation is for a robust consumer acceptance construct. A thorough review of existing work should be performed. If one does exist then the appropriate items should be chosen, new items added as needed, then the scale development should be finalized.

Instrument reduction would be the second recommendation. The number of constructs being measured could be reduced. Reducing the number of constructs would reduce the number of questions on the survey. In general more people are willing to take a shorter survey. This could reduce the length of time to gather data in future studies.

A variety of options exist for future research. One option to keep aligned with this research would be to investigate switches with haptic (vibrotactile) feedback in OHC's. These haptic switches provide a small vibration when the switch has been activated. This confirmation feedback lets the user know that the switch has been activated. Instead of an OHC for the automotive user interface, the center stack console could be used.

Current automotive research is investigating user interface controls that do not require touch and are not voice activated. These controls are activated by using gestures (Doring, et al., 2011). An example of this could be as follows. The user might move their hand past the user interface control in a left to right movement. This movement would be recognized by the user interface that the user wanted to proceed to the next song in the playlist.

Future research would not have to be limited to the automotive industry. The expanding consumer products industry offers many products with user interface controls. A cell phone or a dishwasher could be utilized to test the applicability of consumer segmentation of other products that have industrial designed user interface controls.

Lastly future research could look at placing subjects into the five adopter categories (innovators, early adopters, early majority, late majority, and laggards) rather than using the perceived attributes of innovation such as relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk, and perceived resources as outlined by Rogers (1995), Moore and Benbasat (1991), Dupagne and Driscoll (2005).

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Appendices

Appendix A: Survey Questions from Moore and Benbasat (1991) Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation

Voluntariness

My boss does not require me to use a Personal Work Station (PWS).

Although it might be helpful, using a PWS is certainly not compulsory in my job.

Relative advantage

Using a PWS enables me to accomplish tasks more quickly.

Using a PWS improves the quality of work I do.

Using a PWS makes it easier to do my job.

Using a PWS enhances my effectiveness on the job.

Using a PWS gives me greater control over my work.

Compatibility

Using a PWS is compatible with all aspects of my work.

I think that using a PWS fits well with the way I like to work.

Using a PWS fits into my work style.

Image

People in my organization who use a PWS have more prestige than those who do not.

People in my organization who use a PWS have a high profile.

Having a PWS is a status symbol in my organization.

Ease of use

My interaction with a PWS is clear and understandable.

I believe that it is easy to get a PWS to do what I want it to do.

Overall, I believe that a PWS is easy to use.

Learning to operate a PWS is easy for me.

Result demonstrability

I would have no difficulty telling others about the results of using a PWS.

I believe I could communicate to others the consequences of using a PWS.

The results of using a PWS are apparent to me.

I would have difficulty explaining why using a PWS may or may not be beneficial.

Visibility

In my organization, one sees PWS on many desks.

PWS are not very visible in my organization.

Trialability

Before deciding whether to use any PWS application, I was able to properly try them out.

I was permitted to use a PWS on a trial basis long enough to see what it could do.

Appendix B: Survey Questions from Dupagne and Driscoll (2005) First Phase of a Scale Development Project for Consumer Communication Technologies

1. Complexity

I have a difficult time understanding how new communication technologies work.

I believe that new communication technologies are easy to learn.

The challenges of learning how to use new communication technologies overwhelm me.

New communication technologies are easy to operate.

I feel intimidated by new communication technologies.

I believe that new communication technologies are simple to use.

I find new communication technologies complex.

Learning about new communication technologies is second nature for me.

2. Perceived Resources

New communication technologies cost too much.

The cost of buying new communication technologies is too high.

The price of new communication technologies is beyond my financial means.

I have the financial resources to purchase new communication technologies.

New communication technologies are affordable.

3. Compatibility

I feel that new communication technologies can help me maintain my lifestyle.

I feel that new communication technologies meet my social needs.

New communication technologies are compatible with my day-to-day needs.

4. Relative Advantage

New communication technologies are no better than old communication technologies.

Old communication technologies work just as well as new communication technologies.

New communication technologies are less valuable than old communication technologies.

5. Observability

I feel that I cannot really see how new communication technologies function in a store.

The benefits of new communication technologies can be easily observed in a store.

I know where I can go to see a demonstration of new communication technologies.

6. Trialability

Experimenting with a new communication technology product before purchasing is very important.

It is important to ask questions about a new communication technology product before buying it.

I do not need to see a new communication technology before I buy it.

7. Perceived Risk

Acquiring new communication technologies is risky because they may not work correctly. (RSK1)

I am afraid that new communication technologies will break down frequently.

I have no doubt that new communication technology products will work as expected.

Appendix C: Modified Survey Questions From Moore and Benbasat (1991) and Modified Survey Questions From Dupagne and Driscoll (2005) Based off the Work of Rogers (1995) to Measure Consumer Adoption of Capacitive Switch Technology in Industrially Designed User Interface Controls

- The statements below with the suffix of (D&D) are modified survey questions from Dupagne and Driscoll (2005).
- The statements below with the suffix of (M&B) are modified survey questions from Moore and Benbasat (1991).
- All of the statements listed below the constructs had the following Likert scale

  ____strongly disagree

  ____disagree

  ____not sure

  ____agree

  ____strongly agree

1. Relative Advantage

New capacitive switches are no better than old switches. (D&D)

Old switches work just as well as new capacitive switches. (D&D)

New capacitive switches are less valuable than old rocker switches. (D&D)

Using a capacitive switch enables me to accomplish tasks more quickly. (M&B)

Using a capacitive switch improves the quality of the outcome compared to a traditional switch. (M&B)

Using capacitive switch makes it easier to do the task. (M&B)

Using a capacitive switch enhances my effectiveness to complete the task. (M&B)

Using a capacitive switch gives me greater control over the task. (M&B)

2. Compatibility

I feel that the new capacitive switch can help me maintain my lifestyle. (D&D)

I feel that the new capacitive switch meets my social needs. (D&D)

Capacitive switches are compatible with my day-to-day needs. (D&D)

Using a capacitive switch is compatible with the way I operate an automobile. (M&B)

I think that using a capacitive switch fits well with the way I like to complete a task. (M&B)

Using a capacitive switch fits into the way I operate an automobile. (M&B)

3. Trialability

Experimenting with a new switch technology in a vehicle before purchasing is very important. (D&D)

It is important to ask questions about a new switch technology before buying a vehicle with it. (D&D)

I do not need to see a new switch technology before I buy a vehicle with it. (D&D)

~~Before deciding whether to use any capacitive switches, I was able to properly try them out. (M&B)~~ *Subjects were required to try out the switches, so this statement was not applicable to this proposed research.*

~~I was permitted to use a capacitive switch on a trial basis long enough to see what it could do. (M&B)~~ *Subjects were required to try out the switches, so this statement was not applicable to this proposed research.*

4. Result demonstrability

I would have no difficulty telling others about the results of using a capacitive switch. (M&B)

I believe I could communicate to others the consequences of using a capacitive switch. (M&B)

The results of using a capacitive switch are apparent to me. (M&B)

I would have difficulty explaining why using a capacitive switch may or may not be beneficial. (M&B)

5. Visibility

In my vehicle, one sees switches on the overhead console. (M&B)

Capacitive switches are not very visible in my vehicle. (M&B)

6. Ease of use

My interaction with a capacitive switch is clear and understandable. (M&B)

I believe that it is easy to get a capacitive switch to do what I want it to do. (M&B)

Overall, I believe that a capacitive switch is easy to use. (M&B)

Learning to operate a capacitive switch is easy for me. (M&B)

7. Image

People in my circle of friends who use a capacitive switch have more prestige than those who do not. (M&B)

People in my circle of friends who use a capacitive switch have a high profile. (M&B)

Having a capacitive switch is a status symbol among my friends. (M&B)

8. Voluntariness

Nobody requires me to use a capacitive switch. (D&D)

Although it might be helpful, using a capacitive switch is certainly not compulsory in my life. (M&B)

9. Perceived Risk

Acquiring new capacitive switches is risky because they may not work correctly. (D&D)

I am afraid that new capacitive switch will break down frequently. (D&D)

I have no doubt that new capacitive switch products will work as expected. (D&D)

10. Perceived Resources

New capacitive switches cost too much. (D&D)

The cost of buying capacitive switch is too high. (D&D)

The price of new capacitive switch is beyond my financial means. (D&D)

I have the financial resources to purchase new capacitive switches. (D&D)

New capacitive switch are affordable. (D&D)

Appendix D: Human Subjects Review Committee Approval Letter and Related Documentation

Informed Consent

Project Title: Consumer Adoption of Capacitive Switch Technology in Industrially Designed User Interface Controls: A Pilot Study Using Perceived Attributes of Innovations

Investigator: Aaron Stachewicz, Eastern Michigan University
Co-Investigator: Polly Buchanan, PhD – Professor, Dissertation Chair, Eastern Michigan University

Purpose of the Study: The purpose of this research study is to gain a better understanding of the relationships between of a consumer's perception of using capacitive switch technology in industrially designed user interface controls. This is an attempt to look at predictors or relationships that could provide new tools for the development of marketing campaigns. If a certain consumer segment is willing to accept capacitive switch innovation in industrial designed user interface controls, it is possible that using the instruments could increase sales of capacitive switches and new vehicles. Also, due to the competition for development budgets research such as this can be used to help justify the allocation of funds and human resources for developing better car interiors.

Procedure:

1. The researcher will verbally cover the informed consent form and answer any questions.
2. Subjects will be asked to sign the informed consent form while the researcher witnesses your signature to this consent form. (Those subjects under the age of 18, must be at least 16 years old with parental consent to take part in this study).
3. The subject will be asked to interact with two automobile overhead consoles that are sitting on a table top. One overhead console has a traditional switch in it and the other will have a capacitive switch.
4. After the reviewing and interacting with the models the subject will be asked to respond to statements either on a computer or paper. The questionnaires are about your demographic information and relative advantage, compatibility, trialability, demonstrability, visibility, ease of use, image, voluntariness, perceived risk and perceived resources as they relate to capacitive switches in overhead consoles in automobiles. The approximate total time to complete the questionnaires should be about 10 minutes.
5. Upon completing the questionnaire, you will be given a duplicate copy of this informed consent, which includes follow-up contact information, if needed.

Confidentiality: Only a code number will identify your questionnaire responses. The results will be stored separately from the consent form, which includes your name and any other identifying information. At no time will you name be associated with your responses to the questionnaires. All information will be kept in locked file cabinets of the study investigator.

Expected Risks: There are no foreseeable risks to you by completing this survey, as all results will be kept completely confidential.

Expected Benefits: Subjects are not to anticipate any benefits from participating in this research.

Voluntary Participation: Participation in this study is voluntary. You may choose not to participate. If you do decide to participate, you can change your mind at any time and withdraw from the study without negative consequences. No rights may be denied to you before, during or after this research.

Use of Research Results: Results will be presented in aggregate form only. No names or individually identifying information will be revealed. Results may be presented at research meetings and conferences, in scientific publications, and as part of a dissertation research being conducted by the principal investigator.

Future Questions: If you have any questions concerning your participation in this study now or in the future, you can contact the principal investigator, Aaron Stachewicz, at (414-702-8721) or via e-mail (astachew@emich.edu)

This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from June 2010 to December 2010. If you have questions about the approval process, please contact Dr. Deb de Laski-Smith (734-487-0042, Interim Dean of the Graduate School and Administrative Co-Chair of UHSCR, human.subjects@emich.edu or Dr. Karen Saules, 734-487-4988).

Consent to Participate: I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and take part in the study.

PRINT NAME _____

Signatures:

Participant _____ Date_____
(your signature)

Investigator or Specified Designee _____

Date_____

Appendix E: Actual Survey Instrument

1. Switch B is not any better than switch A.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

2. Switch A works just as well as switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

3. Switch B is less valuable than switch A.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

4. Using switch B enables me to accomplish tasks more quickly.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

5. Using switch B improves the quality of the outcome compared to a switch A.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

6. Using switch B makes it easier to do the task.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

7. Using switch B enhances my effectiveness to complete the task.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

8. Using switch B gives me greater control over the task.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

9. I feel that switch B can help me maintain my lifestyle.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

10. I feel that switch B meets my social needs.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

11. Capacitive switches are compatible with my day-to-day needs.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

12. Using switch B is compatible with the way I operate an automobile.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

13. I think that using switch B fits well with the way I like to complete a task.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

14. Using switch B fits into the way I operate an automobile.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

15. Experimenting with switch B in a vehicle before purchasing is very important.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

16. It is important to ask questions about switch B before buying a vehicle with it.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

17. I do not need to see switch B before I buy a vehicle with it.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

18. I would have no difficulty telling others about the results of using switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

19. I believe I could communicate to others the consequences of using switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

20. The results of using switch B are apparent to me.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

21. I would have difficulty explaining why using switch B may or may not be beneficial.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

22. In my vehicle, one sees switches on the overhead console.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

23. Switch B is not very visible in my vehicle.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

24. My interaction with switch B is clear and understandable.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

25. I believe that it is easy to get switch B to do what I want it to do.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

26. Overall, I believe that a capacitive switch is easy to use.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

27. Learning to operate switch B is easy for me.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

28. People in my circle of friends who use switch B have more prestige than those who do not.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

29. People in my circle of friends who use switch B have a high profile.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

30. Having switch B is a status symbol among my friends.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

31. Nobody requires me to use switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

32. Although it might be helpful, using switch B is certainly not compulsory in my life.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

33. Acquiring switch B is risky because they may not work correctly.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

34. I am afraid that new switch B will break down frequently.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

35. I have no doubt that switch B products will work as expected.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

36. Switch B cost too much.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

37. The cost of buying switch B switch is too high.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

38. The price of new switch B is beyond my financial means.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

39. I have the financial resources to purchase switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

40. Switch B is affordable.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

41. I do not have a preference between switch A and switch B.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

42. I would prefer to have switch B only if it did not increase the cost of the automobile.
    A. strongly disagree
    B. disagree
    C. not sure
    D. agree
    E. strongly agree

43. I would be willing to pay extra for an automobile with switch B.
    A. strongly disagree
    B. disagree
    C. not sure

D. agree
E. strongly agree

44. What is your gender?
A. Male
B. Female

45. What is your age group?
A. 18-26
B. 27-35
C. 36-44
D. 45-54
E. 55-64
F. 65 or over

46. What is the highest level of education that you have completed?
A. Grade School/Middle School
B. High School
C. Associate Degree
D. Bachelor's Degree
E. Master's Degree
F. Doctorate
G. Other – DD, Several college years

47. What is your marital status?
A. Single
B. Married
C. Widowed
D. Divorced

48. Number of children in household?
A. No Children
B. One Child
C. Two Children
D. Three Or More Children

49. What is your level of income?
A. <$34,900
B. $35,000 - $49,900
C. $50,000 - $74,900
D. $75,000 - $99,000
E. $100,000+

50. What is your race/ethnicity?

A. American Indian or Alaska Native (Not Hispanic or Latino) a person having origins in any of the original peoples of North or South America (including Central America), and who maintains tribal affiliation or community attachment.

B. Asian (not Hispanic or Latino) a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

C. Black or African American (not Hispanic or Latino) a person having origins in any of the black racial groups of Africa.

D. Native Hawaiian or Other Pacific Islander (Not Hispanic or Latino) a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

E. White (not Hispanic or Latino) a person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

F. Hispanic or Latino a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.

G. Two or More Races (Not Hispanic or Latino) all persons who identify with more than one of the above races.

Appendix F: Survey Instrument Divided by Construct

Relative Advantage

1. Switch B is not any better than switch A.

2. Switch A works just as well as switch B.

3. Switch B is less valuable than switch A.

4. Using switch B enables me to accomplish tasks more quickly.

5. Using switch B improves the quality of the outcome compared to a switch A.

6. Using switch B makes it easier to do the task.

7. Using switch B enhances my effectiveness to complete the task.

8. Using switch B gives me greater control over the task.

Compatibility

9. I feel that switch B can help me maintain my lifestyle.

10. I feel that switch B meets my social needs.

11. Capacitive switches are compatible with my day-to-day needs.

12. Using switch B is compatible with the way I operate an automobile.

13. I think that using switch B fits well with the way I like to complete a task.

14. Using switch B fits into the way I operate an automobile.

Trialability

15. Experimenting with switch B in a vehicle before purchasing is very important.

16. It is important to ask questions about switch B before buying a vehicle with it.

17. I do not need to see switch B before I buy a vehicle with it.

Demonstrability

18. I would have no difficulty telling others about the results of using switch B.

19. I believe I could communicate to others the consequences of using switch B.

20. The results of using switch B are apparent to me.

21. I would have difficulty explaining why using switch B may or may not be beneficial.

Visibility

22. In my vehicle, one sees switches on the overhead console.

23. Switch B is not very visible in my vehicle.

Ease of Use

24. My interaction with switch B is clear and understandable.

25. I believe that it is easy to get switch B to do what I want it to do.

26. Overall, I believe that a capacitive switch is easy to use.

27. Learning to operate switch B is easy for me.

Iimage

28. People in my circle of friends who use switch B have more prestige than those who do not.

29. People in my circle of friends who use switch B have a high profile.

30. Having switch B is a status symbol among my friends.

Voluntariness

31. Nobody requires me to use switch B.

32. Although it might be helpful, using switch B is certainly not compulsory in my life.

Perceived Risk

33. Acquiring switch B is risky because they may not work correctly.

34. I am afraid that new switch B will break down frequently.

35. I have no doubt that switch B products will work as expected.

Perceived Resources

36. Switch B cost too much.

37. The cost of buying switch B switch is too high.

38. The price of new switch B is beyond my financial means.

39. I have the financial resources to purchase switch B.

40. Switch B is affordable.

Consumer Acceptance

41. I do not have a preference between switch A and switch B.

42. I would prefer to have switch B only if it did not increase the cost of the automobile.

43. I would be willing to pay extra for an automobile with switch B.

Demographics

44. What is your gender?

45. What is your age group?

46. What is the highest level of education that you have completed?

47. What is your marital status?

48. Number of children in household?

49. What is your level of income?

50. What is your race/ethnicity?