2014

Consumers' acceptance of wearable technology: Examining solar-powered clothing

Chanmi Hwang
Iowa State University

Consumers' acceptance of wearable technology:
Examining solar-powered clothing

by

Chanmi G. Hwang

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Apparel, Merchandising, and Design

Program of Study Committee:
Eulanda A. Sanders, Major Professor
Telin Chung
Chunhui Xiang
Sumit Chaudhary

Iowa State University

Ames, Iowa

2014

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I want to express my sincere gratitude to my advisor, Dr. Sanders, for her patience and guidance throughout my master's program. A special thanks to her for calming me down and encouraging me whenever I was in 'panic' mode.

I also want to thank my exceptional committee members, Dr. Chung, Dr.Chaudhary, and Dr. Xiang, for their enthusiasm and insightful suggestions on this research.

This study was also possible because of the financial support from the Department of Apparel, Events, and Hospitality Managements at Iowa State University.

Words cannot express how much I thank my parents for supporting me with love and prayers and teaching me the purpose of life. I also want to thank my younger brother, Daniel, who always pinpoints my incorrect grammar.

A special thanks to Deokyong for always being with me. With him, my life here in Ames was truly blissful.

But above all, I am grateful to confess God's unconditional grace and love, even if I often take it for granted.

ABSTRACT

Unlike mere technological devices, wearable technology is complex, since it is considered both a device and a garment, integrating attributes of clothing and technology with the human wearer. Thus, the purpose of this study was to examine the effects of various factors that influence acceptance of wearable technology, specifically, solar-powered clothing. Solar-powered clothing was chosen as the topic of this research due to the increasing focus and development of the product by researchers (Cho, 2010; Schubert & Merz, 2009) and the pro-environmental attributes of the product.

Based on the Technology Acceptance Model (TAM), this study extended the model and examined the effects of seven consumer-oriented variables on consumers' attitudes towards purchase intentions for solar-powered clothing: TAM variables (perceived usefulness and perceived ease of use), perceived performance risk, Functional, Expressive, Aesthetic (FEA) elements of clothing (perceived comfort, perceived compatibility, and perceived aesthetic attributes), and environmental concerns. Further, this study examined the differences between Gen Y and Baby Boomer on their perceptions and attitudes towards purchasing solar-powered clothing; these two groups were selected, because both groups have been of significant interest to social psychologists as well as marketers in the past (Morris & Venkatesha, 2000).

A convenience sample of college students and faculty at one of the United States mid-western universities was recruited for the web-based survey with both open and closed-ended questions. The sample for this study consisted of 18-33 year olds and of 50-65 year olds, both male and female, who were in the bracket of targeted ages for Gen Y and Baby Boomer generations. A total of 720 useable responses was selected from the returned questionnaires based on the completion of the questionnaire for data analysis. Multiple linear regression, simple

linear regression, and independent samples *t*-test were used to test the research hypotheses along with a thematic analysis of open-ended responses.

The results revealed that both dimensions of technology acceptance and clothing attributes are important factors influencing acceptance of solar-powered clothing. Specifically, perceived usefulness and perceived performance risk from the dimensions of technology acceptance significantly influenced consumers' attitudes towards purchasing solar-powered clothing. From the FEA dimensions of clothing, perceived comfort and perceived compatibility showed significant positive effects. Further, environmental concerns also positively influenced consumers' attitudes towards purchasing solar-powered clothing. Contrary to expectations, the perceived ease of use and perceived aesthetic attributes did not have significant effects on attitude. In terms of comparing Baby Boomers and Gen Y, all of the variables except perceived ease of use and perceived performance risks showed significant differences.

Examining the effects of various consumer-oriented variables contribute to the growing body of research on development of wearable technology and bridge the gap in understanding consumers' perceptions of and purchase intentions for solar-powered clothing. The research also confirmed the important influences of multiple dimensions on wearable technology and further validated the TAM model in explaining new technology adoption in the context of solar-powered clothing.

CHAPTER I. INTRODUCTION

Integrating smart technology for textiles and clothing continues to expand in industry and academic literature. The function of clothing has evolved from the means of protecting human beings to the "instrument of augmenting human capabilities" as ubiquitous environments demand digital lifestyles (Jeong & Yoo, 2010, p.89). According to Just-style.com (2008), the performance apparel market has been forecasted to grow from $6.4 billion in 2008 to $7.6 billion by the end of 2014, and this market continues to expand into the military, health and medical care, and leisure industries (Cho, 2010). However, while the technology-integrated clothing offers conveniences and competitive advantages to wearers, Rogers (1995) states that the newer an innovation, the higher the uncertainty associated with this newness is among users. An *innovation*, according to Rogers (1995), is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p.11).

Solar-powered clothing, within a context of wearable technology, is an innovative product still in its introductory stage (Macguire, 2011). Solar-powered clothing gained popularity from researchers and industry due to its functionality and pro-environmental attributes, since it uses a solar cell as an alternative energy source to generate electricity. Solar energy is "the first long-term energy source for human beings," and one of the most potentially important sources of energy recognized by present scientists (Jeon & Cho, 2010, p. 251). Since the major problem of wearable electronics is the necessity to rely on conventional power supplies (e.g., batteries) which are usually physically heavy and have a short lifetime (Jeon & Cho, 2010), solar-powered energy sources that are flexible and light can be incorporated into clothing without being a burden to the wearer. Thus, most solar-powered clothing offers a universal

socket for portable electronic devices, such as mobile phones and mp3 players, ultimately a solution to the constant problem of encountering limited battery life.

Specifically, mobile phone usage has become an integral part of digital activity among consumers of all ages. Mobile subscribers increased from 5.4 billion in 2010 and to 6.8 billion in 2012, and users have expressed numerous complaints about limited battery life when using mobile phones (International Telecommunication Union, 2013). To better serve consumers, researchers working from a multidisciplinary approach, including the disciplines of computer science, engineering, and design, have actively dealt with textile development, commercialization possibilities, and product development (Jeon & Cho, 2010; Schubert & Werner, 2006; Zou, Wang, Chu, Lv, & Fan, 2010).

To understand the user's adoption of innovative technology, the Davis' Technology Adoption Model (TAM) (1989) was adopted and validated by numerous studies in a variety of contexts. The contexts include banking technologies (Lee, 2009), smartphones (Park & Chen, 2007), online shopping (Vijayasarathy, 2004; Ha & Stoel, 2009), and smart clothing (Chae, 2010). TAM suggests the casual relationship of belief–attitude–intention–behavior is used to explain and predict technology acceptance among potential users; perceived usefulness and perceived ease of use are the key determinants for users' attitudes and intentions for using technology-based products (Davis, 1989). These studies also found that variables such as perceived risks (e.g., economic, performance, time), enjoyment, and complexity significantly influenced consumers' acceptance of innovative technology.

Unlike mere technological devices, wearable technology is complex, because it is considered both a device and a garment, integrating characteristics of clothing (e.g., aesthetics, comfort, durability) and electronic devices (e.g., usability, safety) at the same time (Gepperth,

2012). In this regard, incorporating a consumer needs model, such as Lamb and Kallal's FEA Consumer Needs Model (1991) that combines functional, expressive, and aesthetic considerations for the inherent nature of wearable technology, is an important aspect from consumers' perspectives. Furthermore, with the increasing motivation of humans to recognize "Green Energy" as a means to counteract the scarcity of the Earth's energy resources (Cho, 2010), solar-powered clothing may attract consumers with environmental concerns, because of its pro-environmental attributes. The convergence of technology and clothing brings new opportunities as it draws great attention from various fields.

Purpose

Despite the increasing attention to the development and commercialization of wearable technology, only few studies on consumer response and acceptance of wearable technology with entertainment functions (e.g., MP3 player jackets and Music-Prism T-Shirt) have been conducted. To date, this study's researcher was not able to find any published studies that specifically examined consumers' acceptance of solar-powered clothing. Studies on such technology-integrated clothing are needed to fill a gap in the literature on consumers' acceptance of the multi-disciplinary nature of wearable technology. Studies on responses, attitudes, and consumer acceptance levels are necessary to aid the commercialization strategies for solar-powered clothing developers so the apparel industry can better serve potential consumers. It is critical to gain knowledge on potential adopters' perceptions and attitudes towards solar-powered clothing, since it is expected to be a major item for the future fashion industry (Cho, 2010).

Thus, the purpose of this study was to examine factors affecting consumers' attitudes towards and purchase intentions for solar-powered clothing based on the Technology Adoption Model (TAM). Along with two original constructs of TAM, perceived usefulness and perceived

ease of use, this study aimed to identify other factors contributing to the acceptance of solar-powered clothing (i.e., perceived risks, perceived aesthetic attributes, perceived comfort, perceived compatibility), since, depending on the specific technology context, other explanatory variables may be needed beyond the two original constructs of TAM (Moon & Kim, 2001). In addition, this study compared Gen Y and Baby Boomer consumers' attitudes and purchase intentions, because these age groups have been of significant interest to social psychologists as well as marketers in the past (Morris & Venkatesha, 2000). Both generations will heavily influence markets in the near future due to their large purchasing power and distinct characteristics (Smith & Clurman, 2007; Community Banker, 2000; Solomon, 2007).

This study can provide important implications to both academia and industry. Due to the limited amount of research on consumers' attitudes towards and purchase intentions for wearable technology, this study addresses the gap in the literature. Through this study, TAM can be extended and validated in the context of solar-powered clothing and may provide a theoretical framework for technology-integrated clothing, as well as suggest directions for future research. In addition, by providing insights on consumers' attitudes and purchase intentions, this study may aid the future growth of development and promotion of solar-powered clothing in the apparel industry. It can also provide important information to apparel retailers about the nature of Baby Boomer and Gen Y consumers, which would help retailers in devising strategies for sales. Thus, this study may provide guidelines to marketers in the solar-powered clothing business for how to increase positive attitudes and purchase intentions and how to approach customers across the two different age cohorts. The results may also show if there are any similarities or differences between these two generations and their attitudes towards solar-powered clothing. Understanding

factors affecting consumers' adoption of solar-powered clothing is imperative in light of increasing technology and the sustainability movement in the apparel industry.

Objectives of the Study

The overall objective of the study was to examine factors affecting consumers' purchase intentions for solar-powered clothing. Specific objectives were to examine:

1. the effects of TAM variables (e.g., perceived ease of use and perceived usefulness) on consumers' attitudes towards and purchase intentions for solar-powered clothing,

2. the effects of perceived performance risk on consumers' attitudes towards and purchase intentions for solar-powered clothing,

3. the effects of FEA elements of clothing (e.g., perceived comfort, perceived compatibility, and perceived aesthetic attributes) on consumers' attitudes towards and purchase intentions for solar-powered clothing,

4. the effects of environmental concerns on consumers' attitudes towards and purchase intentions for solar-powered clothing; and

5. the differences between Gen Y and Baby Boomers on their perceptions and attitudes towards purchasing solar-powered clothing.

Definitions of Terms

Attitude: The "degree to which a person has a favorable or unfavorable evaluation of a behavior in question" (Ajzen & Madden, 1986, p.454). In this study, attitude refers consumers' general evaluation towards purchasing solar-powered clothing.

Baby Boomers: A group born between the years 1946 and 1964, with the youngest being 50 years old and the oldest being 68 years old as of 2014 (Howden & Meyer, 2011).

Environmental concern: A general attitude or value orientation towards protecting the

environment (Ajzen, 1989; Minton & Rose, 1997).

Gen Y: A group born between the years 1980 and 1994, with the youngest being 20 years old
and the oldest being 34 years old as of 2014 (Howden & Meyer, 2011).

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

Perceived aesthetic attributes: This study refers to aesthetic attributes as the human desire for
beauty and relate to "the use of elements such as line, form, color, texture, and pattern to
create a pleasing design" (Lam & Kallal, 1992, p.43).

Perceived ease of use: The "degree to which a person believes that using a particular system
would be free of effort" (Davis, 1989, p. 320).

Perceived usefulness: The "degree to which a person believes that using a particular system
would enhance his or her job performance" (Davis, 1989, p. 320).

Perceived comfort: A "mental state of physical well-being expressive of satisfaction with
physical attributes of a garment such as air, moistures, heat transfer properties, and
mechanical properties such as elasticity, flexibility, bulk, weight, texture, and
construction" (Sontag ,1985, p. 10).

Perceived compatibility: "Consistency with one's existing wardrobe and appropriateness
for one's current needs and lifestyles" (Ko, Sung, & Yun, p. 261).

Perceived performance risk: The "loss incurred when a brand or product does not perform as
expected" (Forsythe & Shi, 2003, p. 869).

Smart clothing: "Garment-integrated devices which augment the functionality of clothing, or
which impart information-processing functionality to a garment" (Dunne, Ashdown, &
Smyth, 2005, p.2).

Solar cell: It is an energy generator that converts solar energy to electrical energy (Jeon & Cho, 2010).

Sustainability: The successful meeting of present social, economic, and environmental needs without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

Wearable technology: "Wearable technology is a term used to describe many different forms of body mounted technology, including wearable computers, smart clothing, and functional clothing" (Dunne, 2004).

CHAPTER 2. LITERATURE REVIEW

This chapter reviews relevant literature linked to the important aspect of solar-powered clothing. The chapter first provides background on the concept of wearable technology and, specifically, solar-powered clothing, along with in-depth information on characteristics of Gen Y and Baby Boomers. Next, possible factors affecting consumers' acceptance of solar- powered clothing are examined based on perceived attributes of an innovation, acceptance factors of innovative technology, and the Functional-Expressive-Aesthetic (FEA) consumer needs model. Lastly, the chapter extends the TAM framework and concludes with hypotheses developed based on the research framework.

Wearable Technology

Wearable technology describes "many different forms of body mounted technology, including wearable computers, smart clothing, and functional clothing" (Dunne, 2004, p.5). As shown in Figure 2.1, the term wearable technology is broader than other forms of body mounted technology, since it includes devices which may or may not "compute," and have been constructed with set tasks to fulfill one or more needs of a specific target group (Malmivaara, 2009; Dunne, 2004). A more specific classification of wearable technology in relation to clothing is called smart clothing, or interactive or digital clothing, and is defined as a "garment-integrated device which augment[s] the functionality of clothing, or which impart[s] information-processing functionality to a garment" (Dunne et al., 2005, p.2). Researchers agree that "intelligent," or "smart," means an ability to sense stimuli from the environment, and then react or adapt behavior to the circumstances (Baurley, 2004). Thus, science has combined with fashion where the property of clothes and various information technology (IT) functions coexist together in this new conceptual wear.
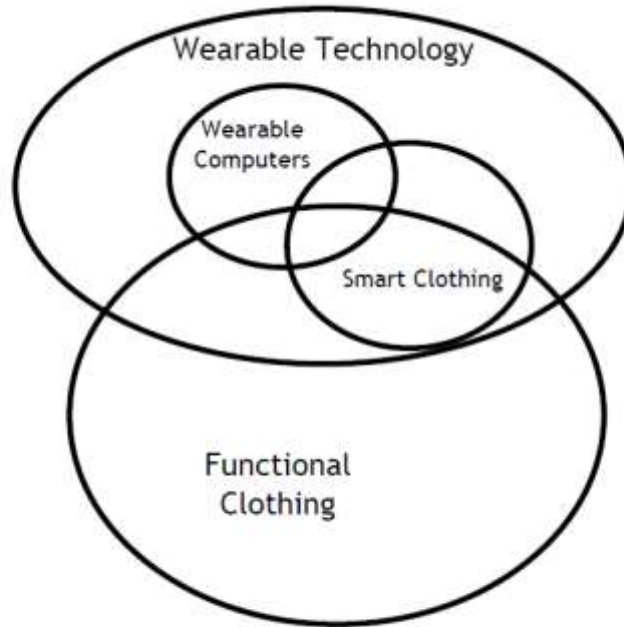
Figure 2.1. Forms of body-mounted technology (Dunne, 2004).

The concept of smart clothing has been initiated from the idea of the wearable computer, actually a portable rather than wearable device, from the 1980s. In the late 1990s, collaboration with professionals in the areas of electronic engineering, and clothing and textiles rapidly increased (see Table 2.1). For example, the collaboration between Phillips Electronics and Levi Strauss in 1999 allowed wearers to use a remote-controlled microphone embedded in the collar for use with mobile phones and digital MP3 players, an invention which was considered to be the very first commercial wearable electronic garment (Ko et al., 2009). Soon after 2001, the number of smart clothes available on the market increased dramatically, such as The North Face's MET5 jacket that generates heat (Best Inventions of 2001, 2001) and the Hug Shirt with electronic sensors that gauge body temperature and heart rate (Voigt, 2007). Prototypes were developed that concentrated on consumer-oriented design (Rantanen, Alfthan, Impio, Karinsalo, Malmivaara, Matala, & Vanhala, 2000) and smart clothing is now being developed for everyday life (G. Cho & Cho, 2007). Smart

clothing and wearable technology have to consider many factors which must be "collaborative between end-users, textile specialists, electronics, fashion and clothing designers and manufacturers all the way from the concept for new garment or wearable device through to point of sale" (McCann & Bryson, 2009, p.28). Thus, the convergence of technology and clothing has brought both opportunities and challenges as it draws great attention from various fields.

Table 2.1.

History of Smart Clothing in R&D and Market (Ariyatum et al., 2005; Suh, Carrol, & Cassill, 2010)

	1980	1997	2001	2005
	1st STAGE	**2nd STAGE**	**3rd STAGE**	**4th STAGE**
R&D	●Steve Mann, Cyberman project ●MIT Media Lab., Lizzy project ●Sensatex, US military project ●Bristol Univ., Sensory Fabric project	●Alexandra Fede with Du Pont and Mitsubishi ●SoftSwitch, Softswitch technology ●Tampere Univ., Intelligent textiles survey ●Georgia Tech., Wearable Motherboard ●Eleksen, Fabric keyboard	●Infineon Technologies, MP3 player jacket ●Tokyo Univ., Transparent Clothes project ●Information Society Technologies, Wealthy project	●Konarka Technologies and Textronics, Wearable power generator ●Idaho National Laboratory, Solar energy fabric
Smart Textile Market		●SoftSwtich, Fabric Keyboard	●Eleksen, *Logitech Keycase*	●Fibretronic, *ConnectedWear*
Smart Clothing Market		●Philips & Levis, *ICD+Jacket*	●Sensatex, *Smartshirt* ● North Face, Self-heating Jacket ●Vivometrics, *LifeShirt* ● Burton, *MD Jacket* ●Burton, *Amp Jacket* ●GapKid, FM radio shirt ●Adidas, Self-adapting shoes	●Levis, iPod jean ●Zegna, Bluetooth I Jacket ●Zegna, Solar Jacket ●Metallica, *Metallica M4 Jacket* ●Oakley, Solar beach tote

A few empirical studies have examined variables that influence consumers' purchase intentions for technology-integrated clothing. First, Ko et al. (2009) viewed smart clothing as an innovation product stating, "it [smart clothing] is still at the introduction stage of the product life cycle" (p.260). She used smart clothing such as iPod Nike + shoes and an outdoor jacket manipulated by researchers to examine perceived risks, perceived attributes,

attitudes, and purchase intentions regarding smart clothing, and the relationship among the variables based on Rogers' (1995) innovation-decision process. The study confirmed the innovation-decision process and found that attitude towards purchase intention was positively influenced by relative advantage/compatibility and negatively influenced by perceived complexity. In addition, perceived complexity was positively influenced by psychological factors, time loss, and performance risks.

Another study conducted by Chae (2009) used extended the Technology Acceptance Model (TAM) by Davis (1989) to confirm the acceptance model in a context of smart clothing. The study viewed smart clothing as "innovative technology" where the aspect of clothing and an electronic product "allows the clothing [to] reveal innovation both in technology and in fashion" (Chae, 2009, p.24). Chae used MP3 player jackets, sensor clothing, and optical fiber clothing to study smart clothing. Along with the original variables of TAM, perceived usefulness and perceived ease of use, the researcher extended the model by adding a third variable, clothing involvement. Clothing involvement, or fashion involvement, is "the degree of acceptance for new fashion style of product with strongly fashionable aspects like clothing" (Chae, 2009, p. 26). The results of this study confirmed the validity of TAM and showed that perceived usefulness was the key variable that influenced consumer attitudes in accepting smart clothing. In addition, the results illustrated that perceived ease of use had indirect positive effects on consumer attitudes, but clothing involvement was not significantly related to consumer attitudes. Along with these variables, other studies indicated that some barriers to users' acceptance of wearable technology can involve the physical comfort of wearable devices, and the psychosocial implications of wearing technology (Dunne, Ashdown, & Smyth, 2005).

Solar-Powered Clothing

Currently, researchers of wearable technology have shifted their primary interests to solar-powered clothing that can create renewable and wearable energy sources from solar cells (Suh, et al., 2010). The desirable features include being "small, lightweight, flexible, and rechargeable with high capacity and output" (McCann & Bryson, 2009, p.38). Among the alternative energy sources (e.g. wind, waves), and due to the increased concern about dependence on oil and coal, the sun became the greatest potential, because it can directly generate electrical energy with the aid of solar cells (Mather & Wilson, 2006). Since a solar cell produces electricity directly from sunlight, it is also called a photovoltaic cell, meaning "light electricity;" in this term, the word "photo" means "light" and the word "voltaic," originating from the name of an electrical engineer, Alessandro Volta, means electricity (Cho, 2010, p.250). Solar-powered clothing uses the solar cell as an alternative energy source to generate electricity. Thus, integration of photovoltaic materials into clothing can provide power for portable electronic devices and opens a wealth of opportunities for technology-based fashion.

The first photovoltaic phenomena began in 1839 with a discovery of the photovoltaic effect by the French physicist, Antoine-Cesar Becquerel, prompting many researchers to develop working solar cells with better power conversion efficiency (Cho, 2010). Especially, development of solar cells based on flexible substrates became a focus followed by traditional cells, which have many restrictions due to their thickness and solid substrates. Thus, as early as 1967, flexibilization of silicon solar cells was proposed to replace traditional solid substrates, and silicon-based thin-film solar cells became very popular (Zou et al., 2010). Currently, many studies focus on integrating flexible solar clothes that are

lightweight, have good flexibility, and have low production costs (Schubert & Merz, 2010; Wang & Zhe, 2010). Solar flexible panels are made and attached to appropriate parts of garments in order to collect solar energy. To strengthen the performance and functionality, research continues to develop flexible cells, such as photovoltaic textiles and fiber-optic solar cell, that can generate electricity (Zou et al., 2010).

Even though solar-powered clothing is not widely commercialized, currently the marketplace (e.g., Silver Lining, Noon, Xunlight, Scottevest Inc.) includes apparel with integrated solar cell, such as sporting jackets, pants, handbags, and caps with, detachable solar panels. Solar-powered clothing offers much functionality, such as the photovoltaic jacket made by Maier Sports, which has the ability to power a mp3 player after three hours charging under the full sun, resulting in more than 40 hours of music play time (Schubert & Werner, 2006). Along with personal use, this innovative product is particularly useful for people who participate in lots of outdoor activities, such as athletes and soldiers who spend a lot of time outside under the sun. Even though, solar-powered clothing relies heavily on sunlight and harnesses energy only during daylight hours under direct access to the sun's rays, the clothing would charge devices and store enough energy for future use without being exposed to the sunlight (Cross, 2013). As researchers develop newer thin-film cells with higher efficiency and at reduced costs, solar-powered clothing provides great opportunities for technology-integrated smart clothing in the apparel industry.

Perceived Attributes of an Innovation

According to Rogers (1995), an innovation-decision process (involving knowledge, persuasion, decision, implementation, and confirmation) shows how an individual adopts an innovation. This process suggests that an individual obtains initial knowledge about the

innovation, forms an attitude towards it, decides to adopt or reject, implements the new idea, and confirms the decision made (Rogers, 2003). Especially in the persuasion stage, an individual develops positive or negative attitude towards an innovation based on perceived attributes acquired in the knowledge stage.

Rogers (1995) states that there are five perceived attributes of an innovation: relative advantage, compatibility, complexity, triability, and observability. These attributes influence the innovation's rate of adoption, the relative speed with which an innovation is adopted by members of a social system, and the formation of a favorable or unfavorable attitude towards an innovation (Rogers, 1995).

Relative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229). The greater degree to which the individual perceives the advantages of an innovation, the more rapid its rate of adoption will occur. The relative advantage of an innovation is critical to enhance the probability of adoption of an innovation (Littrell & Miller, 2001), and scholars have found it to be one of the strongest predictors of an innovation's rate of adoption (Rogers, 1995).

Compatibility is "the degree to which the innovation is perceived as consistent with the existing values, needs, and past experiences of potential adopters" (Rogers, 2003, p. 240). As one has more compatibility with the new idea, the potential experiences less uncertainty and can regard it as more familiar. Thus, compatibility can be viewed as consistency with one's existing wardrobe and appropriateness for one's current needs and lifestyles. Previous studies suggest that compared to relative advantage, compatibility may be less important in enhancing the probability of adoption, even though it is positively related to its rate of adoption (Rogers, 2003).

Complexity is "the degree to which an innovation is perceived as relatively difficult to understand or use" (Rogers, 2003, p. 257). New ideas that are easy to comprehend are adopted more rapidly than those that require new skills. Thus, the complexity of an innovation perceived by users is negatively related to its rate of adoption. Littrell and Miller (2001) state that perceived complexity would be high if one is not familiar with the garment and requires additional knowledge of garment construction.

Trialability is "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258). The trial provides individuals with less uncertainty and gives them the opportunity to learn and practice by doing, thereby helping to reduce uncertainty about the product. Thus, the trialability of an innovation perceived by the users is positively related to its rate of adoption.

Observability is "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258). This suggests that some new ideas are more easily observed and communicated to other people. Thus, the visibility of positive results of the innovation enhances the possibility that it will be adopted.

A few studies have used Rogers' attributes to examine consumers' acceptance and purchase intentions for innovative clothing such as UV-protective clothing (Sung & Slocum, 2004), India-inspired garments (Littrell & Miller, 2001), and smart clothing (Ko et al., 2009). Specifically, Ko et al. (2008) found that compatibility and relative advantage were significant predictors for purchase intentions for smart clothing.

User Acceptance of Technology

The term technology is often used interchangeably with innovation (Rogers, 1983). The most frequently validated factors that influence consumers' attitudes towards and

purchase intentions for technology and innovative products are perceived usefulness and perceived use of ease from TAM. According to Davis (1989), consumer perception of usefulness directly influences attitudes towards technology adoption. Perceived usefulness in TAM is defined as "the degree of which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). Perceived usefulness has been consistently proven as the most powerful predictor for intentions to use and the technology adoption and related literature (Venkatesh, Morris, Davis, & Davis, 2003). Concepts similar to perceived usefulness include relative advantage and outcome expectation where it relates to users' perceived value of improving their job performance (Venkatesh et al., 2003).

Rogers (1989) states that the degree of considering the innovation is a better alternative of the applied object, and thus, the greater degree to which the individual perceives the advantages of an innovation, the more rapid its rate of adoption will be. Prior to the work of Davis (1986), several studies found that perceived usefulness provided a reliable prediction for self-predicted use of a decision model and confirmed that a high correlation existed between perceived usefulness and system usage (Chuttur 2009). Perceived usefulness significantly influences attitude towards an online retailer and had a significant impact on intentions to use the online retailer (Chen, Gillenson, & Sherrell, 2002; Vijayasarathy, 2004). Further, Ko et al. (2010) adopted Rogers' innovation-decision process (Rogers, 1995) and confirmed that relative advantage influences purchase intention for smart clothing.

Another factor, perceived ease of use (PEOU) in TAM, is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989,

p. 320). This construct in TAM, perceived ease of use, coincides with complexity in Innovation and Diffusion Theory (Rogers, 1995), but in the opposite direction. Complexity is "the degree to which an innovation is perceived as difficult to understand and use" (Rogers, 2003, p. 16). Some innovations are more readily comprehended and adopted more rapidly than those that are more complicated and require new skills.

Perceived ease of use was shown to be the direct determinant of behavior intention in TAM and evidence supports this as a direct determinant of usage behavior (Davis 1989; Lee, Fiore, & Kim, 2006). Few studies also showed that perceived ease of use positively influences consumers' attitude and purchase intention for smart clothing (Chae, 2009; Ko et al., 2010).

Along with these two variables, perceived risk is "the uncertainty consumers face when they cannot foresee the consequences of their purchase decisions" (Schiffman & Kanuk, 2000, p.153). Apparel has been regarded as a product category having multi-dimensional risks (e.g. performance risk, socio-psychological risk, aesthetic/fashion risk, product care risk, time-related risk, financial risk) and in general, perceived risk has a negative influence on attitudes towards innovative technology (Ko et al., 2009; Park & Stoel, 2005; Sjoberg, 2000). Rogers (1995) states that the newer an innovation and the higher the uncertainty associated with this newness may prevent consumers from adopting the product. Thus, uncertainty related to an innovation can be conceptualized by perceived risk, and it plays an important role in the formation of an attitude towards new products and the purchase intention for those products (Park & Stoel, 2005; Sjoberg, 2000).

Specifically, product performance risk is "the possibility that the product will not function as expected and/or will not provide the desired benefits'' (Grewal, Gotlieb, &

Marmorstein, 1994, p. 145). Thus, perceived risk can be a significant obstacle preventing

consumers from selecting a product, as previous studies examining perceived performance

risk confirmed a negative relationship with purchase intention for smart clothing (Ko et al.,

2010). The high level of uncertainty would prevent consumers from adopting smart clothing,

even though the customers may have a favorable attitude towards it.

Functional, Expressive, Aesthetic (FEA) Consumer Needs

Along with usability and functionality, smart clothing must satisfy user needs with

regard to fashion, self-representation, and style (Sonderegger, 2013). Lamb and Kallal

(1992) suggest three dimensions of clothing useful in assessing consumer needs and wants:

functional, expressive, and aesthetic (FEA). This design framework was proposed for

multipurpose intentions in apparel design and suggests that all three dimensions should be

taken into consideration while addressing consumer wants and needs for innovative design

(Lamb & Kallal, 1992). This framework was originally developed to study functional

clothing for consumers with special needs. The researchers proposed that this framework can

be applied to all types of apparel design. Thus, in the FEA model, the functional dimension

of clothing includes fit, mobility, protection, and comfort that relates to its utility. The

expressive clothing dimension proposes symbolic communicative characteristics, such as

values, roles and self-esteem that establish identity. Aesthetic considerations, in regards to

clothing, deal with the use of elements such as design principles, and the body/garment

relationship. This user-centered model has been applied to functional clothing design

research such as needs for hospital gowns (Cho, 2006) and adolescent girls with disabilities

(Stokes & Black, 2012). Even though the FEA model was developed to aid the apparel

design process, Lamb and Kallal (1992) state that the concept of FEA can be used in product

assessment where "the target consumer (intended user) is at the core of the model" (p. 42).

Functional Aspects of Wearable Technology

First, functional considerations for clothing include satisfaction with comfort, fit, and mobility, as shown in Figure 2.2. According to Sontag (1985), physical comfort is "a mental state of physical well-being expressive of satisfaction with physical attributes of a garment such as air, moistures, heat transfer properties, and mechanical properties such as elasticity, flexibility, bulk, weight, texture, and construction" (p. 10). In addition Frost (1988) refers to comfort as the way a garment feels on the body. Thus, the demands of the body were highlighted for functional clothing, and physical comfort results in subjective assessments of garment fit along with tactile properties resulting from skin contact (Sontag, 1985).

Figure 2.2. The FEA consumer needs model (Lamb & Kallal, 1992).

Previous studies show that physical comfort, as recognized in the FEA model, was an important factor influencing overall evaluation of the product (Frith & Glesson, 2004; Sontag, 1985). Specifically, Sontag (1985) found that physical comfort was highly correlated with overall evaluation before participants wore the garment. In addition, research indicates that uncomfortable clothing will not be worn by consumers (Shanley, Slaten, & Shanley, 1993). Suh, Carroll, and Nancy (2010) suggest that smart clothing should maintain the comfort and usability of ordinary clothes. As the focus of smart clothing has shifted from a technical concern to a user-centered one for marketability, researchers have tried to achieve greater mobility and comfort (Ariyatum & Holland, 2003). The features of a technological component (e.g., solar panels) add extra weight and pressure on a human body (Dunne et al., 2005), and the wearer should not be limited in comfort as a result of intelligent adaptation in clothing (Dunne et al., 2005; Suh et al., 2010).

Expressive aspects of wearable technology

Along with functional considerations, consumers are also concerned about expressive considerations (Stokes & Black, 2012). Expressive considerations relate to the "communicative, symbolic aspects" of clothes and are based on the socio-cultural and psychological aspects of the dress (Lamb & Kallal, 1992, p. 43). Through the communicative functions of clothing, meanings and values are produced and exchanged (Lăzăroiu, 2012). Thus, the product should be compatible with the wearer's status and self-image, as the dress communicates various messages about the wearer and makes visual statements about their individuality (Damhorst, 1990). This leads to an importance of compatibility, also mentioned in perceived attributes of an innovation from Rogers (2003), where compatibility is defined as "the degree to which the innovation is perceived as

consistent with the existing values, needs, and past experiences of [the] potential adopter" (p. 240).

Previous studies show that perceived compatibility affects attitudes towards the product, along with one's purchase decisions (Shim & Kotsiopulos, 1994). Another study that examined attributes of smart clothing by Ko et al. (2009) viewed compatibility as "consistency with one's existing wardrobe and appropriateness for one's current needs and lifestyles" (p. 261). The study combined compatibility with relative advantage and found that they are positively related to attitudes towards buying smart clothing.

Aesthetic aspects of wearable technology

Lastly, aesthetic criteria are central to consumers' evaluations of apparel (Chattaraman, 2006; Eckman, Damhorst, & Kadolph, 1990; Holbrook, 1986). These criteria in FEA take into account the human desire for beauty. Specifically, researchers have used intrinsic attributes related to textiles and apparel to investigate overall judgments made by consumers. Intrinsic cues refer to product attributes that are inherent in the product (e.g., fiber content, style, color, design, appearance). Previous studies show that these aesthetic attributes were important criteria in women's decisions in apparel selection during the interest phase of their purchase, because apparel is an important means of visual communication (Eckman et al., 1990; Fiore & Damhorst, 1992).

Previous studies show that aesthetic attributes of apparel such as color, styling, and fabric were the most important criteria for women when purchasing clothing (Eckman et al., 1990; Fiore & Damhorst, 1992). In terms of technology-integrated clothing, Malmivaara (2009) argues that aesthetic considerations are vital factors influencing the acceptability and wearability of the final product. Such clothing should have "an appropriate balance of

aesthetic concerns" (e.g., colour, fabrication, cut, proportion and detail) that contribute to the satisfaction of the wearer (McCann, 2009 p. 49). Thus, the distinct aesthetic features of the solar panel may be perceived as "awkward in style" and may not attract users' attention, since consumers prefer using advanced technology without losing their fashion sense (Suh et al., 2010, p. 10). Interrelating functional, expressive, and aesthetic considerations can be helpful in assessing the suitability of solar-powered clothing as an apparel product. Along with viewing solar-powered clothing as an innovation and technology-integrated product, the three dimensions of clothing would provide a full spectrum of consumer needs.

Environmental Concerns

Environmental concern refers to a general attitude or value orientation towards protecting the environment (Ajzen, 1989). According to Antil (1984), consumers' environmental attitudes are expressed through their concerns for the environment and these attitudes are likely to be an important motive influencing consumers' behavior and purchase decisions. Kim and Damhorst (1998) maintain that individuals with positive environmental attitudes are more likely to engage in environmentally responsible behaviors in general.

Environmental attitudes were found to influence intentions to behave responsibly in apparel consumption and have shown that an individual's concern for the environment influences decisions related to apparel consumption (Butler & Francis 1997; Yan, Hyllegard, & Blaesi, 2012). Thus, environmental consumerism is "individuals looking to protect themselves and their world through the power of their purchase decisions" (Ottman, 1992, p.3). Dickson (2000) found that environmental attitudes influence intentions to behave responsibly in apparel consumption (Butler & Francis, 1997) and environmentally responsible manners of clothing disposal (Shim 1995).

Age Cohorts

Age is used widely as a demographic variable that characterizes the adoption of technologies between two or more consumer groups (Morris & Venkatesh, 2000). Generational Cohort Theory states that individuals born in the same period would have similar preferences and attitudes in their adult years, since they had similar experiences (Petroulas, Brown, & Sundin, 2010). Especially, due to their size and purchase power, Baby Boomers and Gen Y are two generations that arouse scholars' interest. Since both generations had different types of experiences during their coming-of-age years, they have different values and attitudes towards technology-integrated clothing (Parment, 2013).

Baby Boomer Consumers

Baby Boomers are those born between the years 1946 and 1964, with the youngest being 50 years old and the oldest being 68 years old as of 2014 (Howden & Meyer, 2011). There are more than 78 million Baby Boomers in the United States of America who have the highest disposable income on average (Paul, 2003), and they control half of the wealth of the nation (Matorin, 2003). Thus, the improved health status with this economic prosperity led older adults to participate in diverse leisure and social activities (Carrigan, Szmigin, & Wright, 2004).

Traditionally, older people were considered vulnerable consumers and they were treated as dependents that should be taken care of by others (Institute for the Future, 2002). However "a substantial portion of aging Baby Boomers who will become the 'New Elderly' do not fit these traditional perceptions" (Kim, Jolly, & Kim, 2007, p.316), and will change conventional notions about what it means to age in America. Baby Boomers appear to be experienced users of modern technologies and they are more open to new media and

technologies than previous generations (Kumar & Lim, 2008). According to eMarketer (2013), nearly eight in ten, or 59.9 million, Baby Boomers were regular Internet users in 2012 including the 66.7 million who are mobile phone users. Interestingly, a study conducted by Yang and Jolly (2008) showed that the effect of perceived usefulness on attitudes towards use of mobile data services appeared greater for the Baby Boomer cohort than the younger generations. Moreover, Baby Boomers are becoming more affluent than other age cohort groups and tend to respond to changing trends (Yang & Jolly, 2008).

Furthermore, Baby Boomers are a generation with high moral priorities, and environmental issues are one of their priorities (Smith & Clurman, 2007). In particular, they are becoming more environmentally aware and interested in health and wellness as the older cohort of this generation is approaching retirement (Worsley, Wang, & Hunter, 2011). Thus, for retailers pursuing solar-powered clothing, it is critical to understand the growing influence of this new aging group.

Gen Y Consumers

Gen Y, the children of the Baby Boomers, are those born between the years 1980 and 1994, with the youngest being 20 years old and the oldest being 34 years old as of 2014 (Howden & Meyer, 2011). This generation includes about 72 million people and has attracted both marketers and retailers due to its size and purchase power (O'Donnell, 2006). Gen Y is one of the most coveted consumer markets, because of their: "1) spending power, 2) ability to be trendsetters, 3) receptivity to new products, and 4) tremendous potential for becoming lifetime customers" (Bush, Martin & Bush, 2004, p. 109). This cohort has been studied foremost from the consumer behavior perspective. Gen Y is important for marketers, because of the impact that members of this age group have on their families' purchase

decisions (Renn & Arnold, 2003). In addition to this, Gen Y has grown up with ubiquitous electronic technologies (e.g., televisions, computers) and its members are often known as early adopters of new technologies (Kumar & Lim, 2008).

Previous findings suggest that perceived usefulness and perceived risks were significant factors that affect young consumers' purchase intention for smart clothing (Chae 2010; Ko et al., 2009). In regards to potential adopters of wearable technology, Gen Y has been characterized as technologically savvy, fashion trendsetters, and receptive to new products (Bush et al., 2004). Specifically, this generation is one of the most informed age groups in terms of environmental issues (IBM, 2009), and they are taking their environmental values with them into the consumer marketplace (Brosdahl & Carpenter, 2010).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) is considered the most validated model to explain the acceptance and usage intention for information technology (Lu, Liu, & Yao, 2003). This model is an adaptation of a theory in social psychology, the Theory of Reasoned Action (TRA), proposed by Ajzen and Fishbein (1980) that was developed to explain the relationships between beliefs, attitudes, intentions, and behavior. According to the TRA, an individual's behavior is determined by one's intention to perform the behavior, and this intention is influenced by one's attitude and subjective norms. Attitude towards a behavior refers to a person's positive or negative feeling about performing that behavior and subjective norms are related to a person's perceptions of social pressure in performing the behavior (Ajzen & Fishbein, 1980). Attitude towards a behavior is determined by beliefs, where it is the individual's subjective probability

that performing a given behavior will result in a given consequence (Ajzen & Fishbein, 1980). By applying TRA, the TAM provides a basis for investigating the impact of external factors on internal beliefs, attitudes, and intentions to use technology-based products and services (Davis et al., 1989).

Adopting Azjen and Fishbein's TRA (1980), TAM replaces attitudinal determinants with two variables about beliefs, perceived usefulness, and perceived ease of use as shown in Figure 2.3. TAM defines a causal relationship between ease of use and perceived usefulness, suggesting that intention to use a system is determined by perceived usefulness and perceived ease of use (Davis et al., 1989). Perceived usefulness is "the extent to which a person believes that using the system will enhance his or her job performance" and perceived ease of use is "the extent to which a person believes that using the system will be free of effort" (Venkatesh & Davis 2000 p. 187). Thus, the TAM explains users' technology adoption behavior based on perceived usefulness and perceived ease of use as the key determinants (Davis et al., 1989). TAM also assumes that perceived usefulness is related to perceived ease of use (Davis et al., 1989), because "the easier the system (technology) is, the more useful it can be" (Venkatesh & Davis 2000 p. 187).
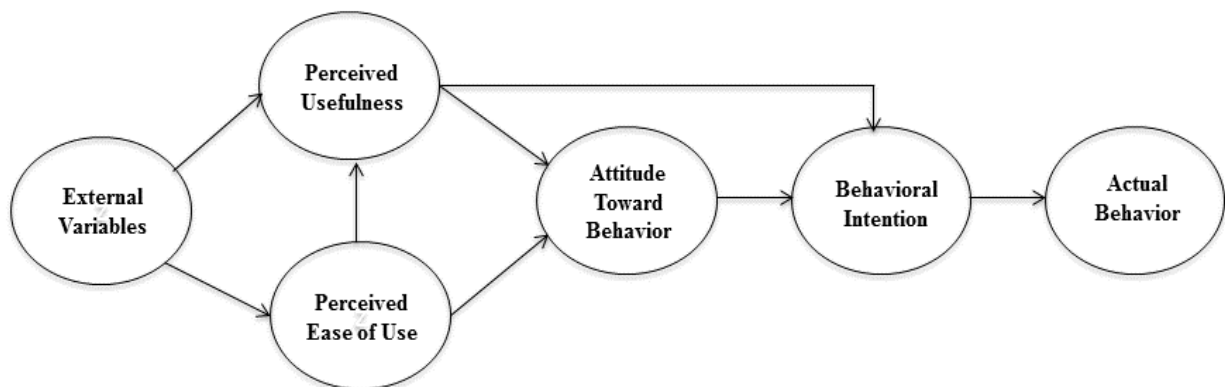
Figure 2.3. Technology acceptance model (Davis et al., 1989).

Prior studies have validated TAM as a parsimonious framework for understanding the user's adoption of technology in a variety of contexts, including banking technologies (Lee, 2009), smartphones (Park & Chen, 2007), online shopping (Ha & Stoel, 2009; Vijayasarathy, 2004), and smart clothing (Chae, 2009). TAM has been extended by introducing additional constructs, such as perceived enjoyment, to predict hedonic acceptance and usage of technology (Davis et al., 1992). The application of TAM has been valuable in explaining the acceptance of a variety of innovative processes and services based on information technologies. To both age cohorts (Baby Boomers and Gen Y), solar-powered clothing is an innovative technology-based product; thus, the TAM provides a useful framework for this study.

Research Framework

TAM is particularly attractive, because of its parsimony and consistently good predictive record with regard to explaining technology adoption in a variety of contexts. However, for the adoption and use of smart clothing, a number of other relevant factors besides ease of use and perceived usefulness (perceived risks, perceived attributes) have been suggested (Chae 2010; Ko et al, 2009). In addition, the literature notes TAM's parsimony as a key limitation (Venkatesh, 2000; Vijayasarathy, 2004). Therefore, the original TAM variables may not adequately capture key beliefs influencing consumers' attitudes and, depending on the specific technology context, additional explanatory variables may be needed beyond the ease of use and usefulness constructs. Thus, this study seeks to extend the original TAM by adopting five additional constructs along with perceived usefulness and perceived ease of use to fit the context of solar-powered clothing: perceived performance risk, perceived comfort, perceived compatibility, perceived aesthetic attributes, and

environmental concerns.
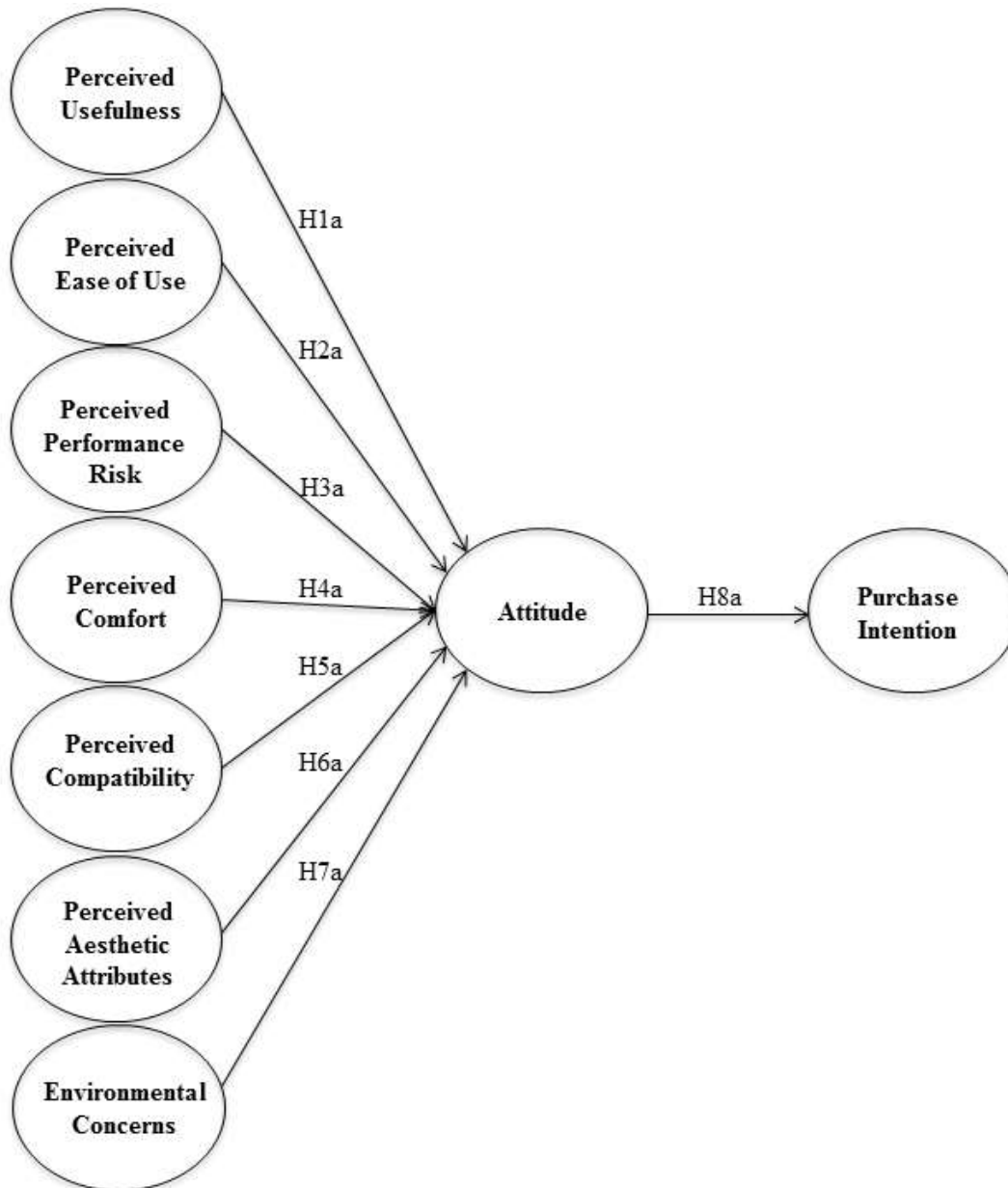
Figure 2.4. Research framework.

Research Hypotheses

Based on the research framework, the following eight hypotheses (*H1-H8*), relating to solar-powered clothing, were proposed:

H1a.　Perceived usefulness will have positive effects on attitude towards purchasing solar-powered clothing.

H1b.　There will be differences in perceived usefulness towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H2a.　Perceived ease of use will have positive effects on attitude towards purchasing solar-powered clothing.

H2b.　There will be differences in perceived ease of use towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H3a.　Perceived performance risk will have negative effects on attitude towards purchasing solar-powered clothing.

H3b.　There will be differences in perceived performance risk towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H4a.　Perceived comfort will have positive effects on attitude towards purchasing solar-powered clothing.

H4b.　There will be differences in perceived comfort towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H5a.　Perceived compatibility will have positive effects on attitude towards purchasing solar- powered clothing.

H5b.　There will be differences in perceived compatibility towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H6a. Perceived aesthetic attributes will have positive effects on attitude towards purchasing solar-powered clothing.

H6b. There will be differences in perceived aesthetic attributes towards solar-powered clothing between Gen Y and Baby Boomer consumers.

H7a. Environmental concerns will have positive effects on attitude towards purchasing solar- powered clothing.

H7b. There will be differences in environmental concerns between Gen Y and Baby Boomer consumers.

H8a. Attitude towards purchasing solar-powered clothing will positively influence purchase intention.

H8b. Gen Y and Baby Boomers will have different attitudes towards purchasing solar-powered clothing.

CHAPTER 3. METHOD

To examine factors affecting attitudes towards and purchase intentions for solar-powered clothing, a quantitative research approach was used. A web-based survey with both open and closed-ended questions and demographic information was distributed to faculty and students at a mid-western university. This chapter includes descriptions of a preliminary study along with the sample, online survey design and procedures, pretest, and instruments. Data were analyzed with preliminary descriptive analysis, independent samples t-test, and linear regression analysis along with a thematic analysis of open-ended responses.

Sample

A convenience sample of college students and faculty at a United States mid-western university was recruited for the web-based survey. The sample for this study consisted of 18-33 year olds and of 50-65 year olds, both male and female, who were in the bracket of the targeted age for Gen Y and Baby Boomers. After receiving Institutional Review Board (IRB) approval, the researcher obtained a list of 31,190 e-mail addresses of students and 6,400 e-mail addresses of faculty from the Registrar's Office. The sample was recruited through invitation e-mails distributed to the students and faculty, along with a letter of research introduction with the survey URL and informed consent forms that assured confidentiality. All participants, above age 18, were able to voluntarily participate. The respondents were asked to answer as many questions as possible, as long as they felt comfortable with the particular question.

Survey Design and Procedures

An online survey including both open and close-ended questions, as well as demographic information, was conducted. Prospective participants received an invitation

letter (see Appendix B) with a web-link including a short web-based questionnaire (see Appendix C) that would take about 15 minutes to complete. The Human Subject Review Committee/ Institutional Review Board evaluated and approved the data collection questionnaire and the invitation letter. The invitation letter included the purpose and the significance of the study, a request for participation, and a guarantee of confidentiality of information. By clicking the URL for the questionnaire website, participants consented to participate in the survey.

To give participants a clear understanding of solar-powered clothing, a detailed information page describing solar-powered clothing, as shown in Appendix C, was provided at the beginning of the survey. This page link was presented on each page of the survey so participants were able to click the link and view the information page whenever he or she needed throughout the survey. This page included various images of solar-powered clothing (e.g., Colon Jacket, Zegna Sports, Scottevest) with a description of solar cells and instructions on how to use the product. A total of 29 close-ended questions and two open-ended questions were asked along with nine demographic questions. The close-ended questions were developed to measure consumers' perceptions and purchase intentions for solar-powered clothing, and were based on relevant literature. Measures included perceived ease of use, perceived usefulness, perceived comfort, perceived compatibility, perceived aesthetic attributes, perceived performance risk, environmental concerns, attitudes, and purchase intentions. At the end of the survey, participants were invited to anonymously participate in a drawing of three $15 gift cards. Participants' responses were not linked to their names and they could skip questions or leave the survey at any time.

Instrument Development

Based on multiple-item measurement scales from the literature, a self-administered

questionnaire was developed to fit the solar-powered clothing context. The instrument

contained eight parts:(a) Perceived ease of use, (b) perceived usefulness, (c) perceived

comfort, 4) perceived compatibility, 4) perceived aesthetic attributes, 5) perceived

performance risk, 6) environmental concerns, 6) attitudes, 7) purchase intentions, and 8)

demographic information.

Perceived Usefulness

Davis' (1989) usefulness scale was adapted to measure perceived usefulness. This

measure originated from Davis' (1989) usefulness scale of information technology; it was

adapted by Childers et al. (2001) to the online shopping context. The Cronbach's *alpha* of

the scale reported by Childers et al. (2001) ranged from .92 to .93. The items were assessed

on a 7-point Likert-type scale ranging from *Strongly Disagree* (1) to *Strongly Agree* (7).

Perceived Ease of Use

Three items assessed consumers' perceived ease of use based on Davis' (1989) scales.

The scale became very popular and has been adjusted by researchers over time for varying

contexts; it was adopted by Childers, Carr, Peck, and Carson (2002) to measure the degree to

which the process involved in using a technological device or system is viewed by a person

as understandable and easy, particularly in this case, in the technology-assisted shopping

context. The reliabilities of the scale reported by Childers et al. (2001) were .989.

Cronbach's coefficient *alpha* is widely used to estimate the internal reliability of multi-items.

The items were assessed on a 7-point Likert-type scale ranging from *Strongly Disagree* (1) to

Strongly Agree (7).

Perceived Performance Risk

Perceived performance risk was measured by adapting three items with a seven-point

scale from Grewal, Gotlieb and Marmorstein (1994). Their scales are based on Shimp and Bearden's (1982) with a Cronbach's *alpha* of .90. These items closely relate to uncertainty and consequences, and for this study, the scales were reversed to fit with the rest of the construct items (e.g., *Strongly Disagree* (1) to *Strongly Agree* (7).): *Not confident at all (1)/ Very confident (7); Uncertain (1)/ Certain (7); Do not feel sure (1)/ Do feel sure (7).*

Perceived Comfort

Since there is no validated measurement for perceived comfort, the study developed four items with bipolar adjectives, each measured on a seven-point scale. The adjectives were adapted from a wearer acceptability scale developed by Huck, Maganga, and Kim (1997). Four bipolar adjectives include *Uncomfortable (1)/ Comfortable (7), Rigid (1)/ Flexible (7), Hard to move in (1)/ Easy to move in (7)/, and Heavyweight (1)/ Lightweight (7)*. Face validity on the instrument was conducted by several researchers in the areas of textiles, clothing, and merchandising to confirm the clarity of the items.

Perceived Compatibility

Three items measuring perceived compatibility were adapted from Ko et al. (2009). The study measured perceived compatibility of smart clothing on a five-point Likert-type scale ranging from *Strongly Disagree* (1) to *Strongly Agree* (5) with a Cronbach's *alpha* of .83.

Perceived Aesthetic Attributes

Since design is a unique combination of visual elements, it is important to examine consumers' perceived intrinsic aesthetic attributes of innovations of solar-powered clothing. Due to the distinguished design feature of solar panels, the design aspect of the clothing may influence consumer decision-making. However, there is no validated scale for perceived

aesthetic attributes. Thus, the current study developed three, seven-point Likert-type items based on a study by Eckman, Damhorst, and Kadolph (1990). In reviewing the criteria for evaluating women's apparel, the study by Eckman et al. (1990) found that an aesthetic set of intrinsic criteria such as style, color and pattern, fabric, and appearance are important criteria for the consumers. The scales were developed to fit the context of solar-powered clothing as criteria for evaluating the product. Face validity of the instrument was conducted by several researchers in the areas of textiles, clothing, and merchandising to confirm the clarity of the items.

Environmental Concerns

Three items measuring environmental concerns with seven-point Likert-type items were adapted from Fujii (2006). The three items reported a highly reliable index with a Cronbach's *alpha* of .90. This construct measures one's worldview of man's relationship to the environment.

Attitude

Attitudes towards purchasing the product was measured by adapting three items used by MacKenzie, Lutz, and Blech (1986). Three bipolar adjectives-- good, favorable, and wise-- were each measured on a seven-point scale, reporting a Cronbach's *alpha* of .92 for the scale.

Purchase Intention

Purchase intentions were assessed by adapting three seven-point Likert type items from Bower and Landreth (2001) ranging from *Strongly Disagree* (1) to *Strongly Agree* (7). The original scale had six items with a Cronbach's *alpha* of .90, and a conducted confirmatory factor analysis for the scale suggested a good fit. The current study only

adapted three items to fit the context of solar-powered clothing. Bower and Landreth (2001)

also adapted only three of the items with a Cronbach's *alpha* of .80, since the subset is

"amenable for use in a wider variety of situations" (Bruner, Hensel, & James, 2005, p. 444).

Pretest

Prior to the main survey, a pretest was conducted to assess the clarity of the

questionnaires, the website's function, and to determine a participation time. The pretest was

conducted with a convenience sample of 25 graduate students from Apparel, Events, and

Hospitality Management Department at the university. The participants received an email

requesting their participation in the web-based questionnaire and they were asked to note any

problems or difficulties they experienced in completing the questionnaire. Based on the

pretest results and participant recommendations, the questionnaire and web-based survey

procedure were modified.

Data Analysis

Data were analyzed using SPSS version 19.0. Individual exploratory factor analysis,

a confirmatory factor analysis were conducted to determine factor loadings for research

variables. A reliability analysis was conducted to test an internal consistency of measures by

using Cronbach's *alpha*. A minimum value of .70 was adopted for assessing internal

consistency, because a Cronbach's *alpha* value of .70 or higher was considered a sufficient

reliability for an item (Nunnally & Bernstein, 1994). Descriptive statistics were used to

provide respondents' demographic background profiles. Independent sample *t*-tests were

conducted to examine any significant differences between Baby Boomers and Gen Y in

relation to their perceived usefulness, perceived ease of use, perceived risks, perceived

aesthetic attributes, environmental concerns, attitudes, and purchase intentions for solar-

powered clothing. To test remaining research hypotheses, a multiple regression analysis was
conducted.

CHAPTER 4. RESULTS

This chapter reports the results of this study. This includes a sample profile, descriptive statistics of the research variables, and results of the hypothesis testing.

Sample Profile

A total of 37,590 people, including both students and faculty from a large mid-western university in the United States, were invited to complete the online questionnaire used in this study; 870 completed questionnaires were returned for a response rate of 3%. A total of 720 useable responses were selected from the returned questionnaires based on the completion of the questionnaire for data analysis. The demographic characteristics of the sample are illustrated in Table 4.1.

The results showed that 28.6% of the respondents were Baby Boomers and 71% were from Gen Y; more than 71% of the 206 Baby Boomers were between the ages of 54 of 63 while more than 74% of the 514 Gen Y were between the ages of 20 and 24. The majority of the respondents were White/ European American (84.5%), followed by Asian (7.8%), and Hispanic American or Latino (2.9%). The results also showed that 67.9% of the respondents were female and 32.1% were male. Participants' education level ranged from high school graduate to doctoral degree, with the majority being high school graduates and having bachelor's degrees (63.9%) followed by master's degrees (18.4%) and doctoral degrees (9.5%). Nearly 60% of respondents earned less than $25,000 annually and 3.2% earned over $100,000 annually. In terms of participants' awareness of solar-powered clothing, 233 (32.5%) of the 718 participants indicated they had heard about solar-powered clothing before; 68% of the Baby Boomer participants were aware of the clothing compared to only 30% of the Gen Y participants.

Table 4.1.

Demographics of the Sample

Demographics	Frequency	Percentage of Sample
Generational Cohorts (n=720)		
Baby Boomers	206	28.6
Gen Y	514	71.4
Age (n=720)		
1946-1950	15	2.1
1951-1966	73	10.1
1956-1960	73	10.1
1961-1964	45	6.3
1980-1984	49	6.8
1985-1989	84	11.7
1990-1994	381	52.9
Gender (n=719)		
Female	488	67.9
Male	231	32.1
Ethnicity (n=715)		
White/European American	604	84.5
American Indian/Alaska Native	5	0.7
African American/Black	5	0.7
Asian	56	7.8
Hispanic American or Latino	21	2.9
Other	24	3.4
Education (n=706)		
High school graduate, diploma or equivalent	216	30.6
Associate degree	58	8.2
Bachelor's degree	235	33.3
Masters degree	130	18.4
Doctoral degree	67	9.5
Annual Income (n=711)		
Less than $25,000	423	59.4
$25,000-$49,999	87	12.2
$50,000-$74,999	85	12.0
$75,000-$99,999	30	4.3
Over $100,000	23	3.2
Choose not to answer	63	8.9
Heard of solar-powered clothing (n=718)		
Yes	233	32.5
No	485	67.5

Note. The N varies because of missing data

Factor Analysis and Descriptive Statistics

Before examining reliabilities of the constructs for internal consistency of the scales,

an Exploratory Factor Analysis (EFA) was conducted in particular to examine two

constructs: perceived comfort and perceived aesthetic, developed in this study. The other

remaining seven constructs were excluded from this analysis, since they were adopted from

already validated measures. Thus, a principal component method with Varimax rotation was

employed to obtain the factor loadings and to ensure construct validity (Thomas & Nelson,

1996) of the developed constructs. Items were considered to belong to a factor if they had

loadings of .50 or higher (Nunnally, 1978). Factors with eigenvalues of 1.0 or greater were

considered for interpretation of factors. Perceived comfort was measured by four bi-polar

items and the factor loadings ranged from .70 to .88. Perceived aesthetic attributes was

measured on three items and the factor loadings ranged from .90 to .94 with an eigenvalue of

3.94.

A confirmatory factor analysis (CFA) using maximum likelihood estimation was then

conducted to assess the convergent and discrimination validity of all the research constructs.

The standardized factor loadings of each items and the reliability of each construct are

reported in Table 4.2. CFA for the model provided a good fit (CFA$_{tr:}$ $\chi 2 = 727.74$, $df = 314$,

$p < 0.001$, CFI $= 0.97$, TLI $= 0.97$, SRMR $= 0.04$, and RMSEA $= 0.04$) and with the

standardized factor loadings ranging from .56 to .97, convergent validity was satisfied (Hair,

Anderson, Tatham, & Black, 2010).

Table 4.2.

Factor Loading and Reliability of Measurement Items

Constructs and measurement items	Standardized factor loading	Cronbach's *alpha*
Perceived usefulness		.90
Wearing solar powered clothing would improve the quality of my life.	.70	
Wearing solar powered clothing would increase my productivity.	.75	
Overall, I find solar powered clothing useful.	.89	
Perceived ease of use		.82
The use of solar powered clothing is clear and understandable.	.87	
Overall, I find solar powered clothing easy to use.	.84	
Using solar powered clothing would not require a lot of mental effort.	.86	
Perceived performance risk		.92
How confident are you that the product/clothing will perform as described?	.70	
How certain are you that the product/clothing will work satisfactorily?	.85	
Do you feel that the product/clothing will perform the functions that were described in the information page?	.89	
Perceived comfort		.86
Wearing this product would be uncomfortable/ comfortable.	.81	
Wearing this product would be rigid/ flexible.	.86	
Wearing this product would be difficult to move in/ easy to move in.	.88	
Wearing this product would be heavyweight/ lightweight.	.56	
Perceived compatibility		.86
This product would coordinate well with the other clothing I own.	.90	
This product would be more compatible with my current needs than clothing I already have.	.91	
This product would be appropriate for my lifestyle.	.86	
Perceived aesthetic attributes		.94
The appearance of the solar panels is aesthetically appealing to me.	.85	
The designs of solar-powered clothing are aesthetically appealing to me.	.91	
The overall style of solar-powered clothing is appealing to me.	.97	
Environmental concerns		.91
I think environmental problems are very important.	.91	
I think environmental problems cannot be ignored.	.80	
I think we should care about environmental problems.	.97	

Table 4.2. (continued)

Constructs and measurement items	Standardized factor loading	Cronbach's *alpha*
Attitude		.92
Purchasing solar-powered clothing is bad/ good.	.89	
Purchasing solar-powered clothing is unfavorable/ favorable.	.90	
Purchasing solar-powered clothing is foolish/ wise.	.87	
Purchase Intention		.95
I intend to try this type of product.	.90	
It is likely that I will buy this product when it becomes available.	.96	
I would purchase this product.	.93	

After running the factor analyses, the reliabilities for all of the research constructs were analyzed to determine internal consistency of the scales. Cronbach's standardized *alpha* was used in determining the internal reliability of measures. Table 4.2 shows the reliability estimates for each construct. All of the constructs' Cronbach's *alpha* values ranged from .82 to .95, indicating an acceptable internal consistency (Nunnally & Bernstein, 1994). In addition, the adequate *alpha* levels provide further support for creating summed variables from significantly loaded items on perceived comfort and perceived aesthetic attributes.

Specifically, the perceived usefulness measure included three items with a Cronbach's *alpha* of .90, which showed a high internal consistency for this scale. The mean score was 5.53 for perceived usefulness with a standard deviation of 1.19 as shown in Table 4.3, indicating that the respondents demonstrated a high likelihood of perceiving the solar-powered clothing to be useful.

Table 4.3.

Descriptive Statistics of the Constructs

Variable	*Mean*	*SD*	Number of Items
Perceived Usefulness	5.53	1.19	3
Perceived Ease of Use	4.06	1.14	3
Perceived Performance Risk	3.97	1.35	3
Perceived Comfort	3.98	1.13	4
Perceived Compatibility	3.66	1.14	3
Perceived Aesthetic Attributes	3.59	1.55	3
Environmental Concerns	6.17	1.03	3
Attitude	4.81	1.25	3
Purchase Intention	3.39	1.67	3

The perceived ease of use measure included three items with a Cronbach's *alpha* of .82, indicating a good internal consistency for this scale. For perceived ease of use, respondents had a mean score of 4.06 on a seven-point Likert-type scale with a standard deviation of 1.14, showing that respondents demonstrated a relatively high likelihood of perceiving the clothing to be compatible with their own clothing.

For the perceived performance risk, the measure included three items with a Cronbach's *alpha* of .92 that showed a high internal consistency for the scale. The mean score was 3.97 on a seven-point Likert-type scale with a standard deviation of 1.35 where the scales were reversely coded. Thus, this indicates that respondents showed a relatively high likelihood of perceiving the performance and the efficiency of the solar-powered clothing to be uncertain.

The perceived comfort measure contained four items with a Cronbach's *alpha* of .86 that showed a moderately high internal consistency for the scale. The mean score was 3.98 with a standard deviation of 1.13, which illustrated that respondents showed a lower likelihood of perceiving the clothing as comfortable.

The perceived compatibility measure comprised three items with a Cronbach's *alpha* of .86, which also showed a moderately high internal consistency for the scale. The mean score was 3.66 with a standard deviation of 1.14, showing that respondents exhibited a lower likelihood of perceiving the clothing to be compatible with their own clothing.

The perceived aesthetic attribute measures had three items with a Cronbach's *alpha* of .94 showing a high internal consistency for the scale. The mean score was 3.59 with a standard deviation of 1.55, indicating that respondents showed a lower likelihood of perceiving the clothing to be aesthetically appealing.

Environmental concerns measures included three items with a Cronbach's *alpha* of .91 which also showed a high internal consistency for the scale. The mean score was 6.17 with a standard deviation of 1.03. The results showed that participants had very strong environmental concern.

Attitude measures contained three items with a Cronbach's *alpha* of .92 and showed a high internal consistency for the scale. The mean score was 4.81 with a standard deviation of 1.25 on a seven-point Likert-type scale. The results show that the participants had a higher likelihood of showing positive attitudes towards purchasing the product.

Lastly, purchase intention measures involved three items with a Cronbach's *alpha* of .95, and the mean score was 3.40 with a standard deviation of 1.67, showing the respondents reported neutral purchase intentions.

Evaluation of Assumptions for Multiple Regression Analysis

Prior to conducting the multiple linear regression analysis, tests of the regression assumptions and multicollinearity diagnostics were performed. This section evaluates the appropriateness of a multiple regression analysis and shows the current data's performance with regard to assumptions relating to multicollinearity, normality, linearity, homoscedasticity, independence of residuals and outliers.

First, a Pearson correlation coefficient was calculated for the relationship among the research variables. Table 4.4 provides the correlation coefficients of the studied variables. Multicollinearity occurs when one independent variable is so strongly correlated with one or more other variables that its relationship to the dependent variable is likely to be misinterpreted. According to Pallant (2001), correlation values of .70 or higher between the independent variables denote a correlation that is too high, a concept which is referred to as "multicollinearity." Generally, correlations greater than .70 are considered strong, those less than .30 are considered weak, and those between .30 and .70 are considered moderate. Results of correlation analysis revealed that all variables were significantly related to each other. However, the correlations between the independent variables were below .70, indicating that all of the independent variables can be retained in the study and multiple regression analysis can be used.

The correlations of all the variables regarding purchase intentions were from -.39 to .67. The highest correlation (r=.67) was between perceived compatibility and purchase intentions. The results also show that perceived compatibility is highly correlated with perceived usefulness (r=.70). This means if consumers perceive solar-powered clothing to be

more useful, they would perceive the clothing to be more consistent with their existing values
and needs.

Table 4.4.

Correlation Matrix of the Studied Variables

Variable	1	2	3	4	5	6	7	8	9
1. Perceived Usefulness	1								
2. Perceived Ease of Use	.37	1							
3. Perceived Performance Risk	-.38	-.34	1						
4. Perceived Comfort	.33	.34	-.48	1					
5. Perceived Compatibility	.70	.32	-.39	.45	1				
6. Perceived Aesthetic Attributes	.32	.21	-.40	.44	.42	1			
7. Environmental Concerns	.16	.25	-.14	.15	.15	.19	1		
8. Attitude	.54	.32	-.40	.43	.50	.36	.31	1	
9. Purchase Intention	.65	.23	-.39	.40	.67	.52	.23	.64	1

Note. All correlations are significant at the 0.01 level (2-tailed).

Further, the collinearity among the independent variables for both models was also
examined through variance inflation factors (VIF) and eigenvalues, and results are presented
in Table 4.5. The VIF for each independent variable was less than the standard comparison
score of 10, and the variables had low eigenvalues ranging from .01 to .23 with relatively
equal magnitudes, which indicates that multicollinearity is not serious.

Table 4.5.

Variance Inflation and Eigenvalue Analysis

Variable	Variance Inflation (VIF)	Eigenvalue	Condition Index
(Constant)		7.49	1.00
Perceived Usefulness	2.26	.23	5.63
Perceived Ease of Use	1.31	.10	8.38
Perceived Performance Risk	1.51	.06	10.72
Perceived Comfort	1.59	.04	13.38
Perceived Compatibility	2.46	.03	16.33
Perceived Aesthetic Attributes	1.42	.02	17.66
Environmental Concerns	1.11	.01	29.74

Note. Dependent variable is Attitude

Variable	Variance Inflation (VIF)	Eigenvalue	Condition Index
(Constant)		1.96	1.00
Attitude	1.00	.03	7.81

Note. Dependent variable is Purchase Intention

To determine normality, linearity, and homoscedasticity for this study, the normal probability plot of regression standardized residuals and residual scatterplots were run for the dependent variables. The normal probability plot of the regression standardized residuals in Figure 4.1 illustrates that the residuals fell in a straight line. This, according to Pallant (2001), serves as an indication that no major deviation from normality has occurred and a multiple regression analysis can be run. In addition, a scatterplot of the standardized residuals was run, and there was no distinct pattern of the residuals, such as a curvilinear pattern, an indication there is no violation of the assumptions (Pallant, 2001). The

assumption of normality of residuals for both models were met, as also shown by relatively

normal distributions of the residuals in the histogram (see Figure 4.2).
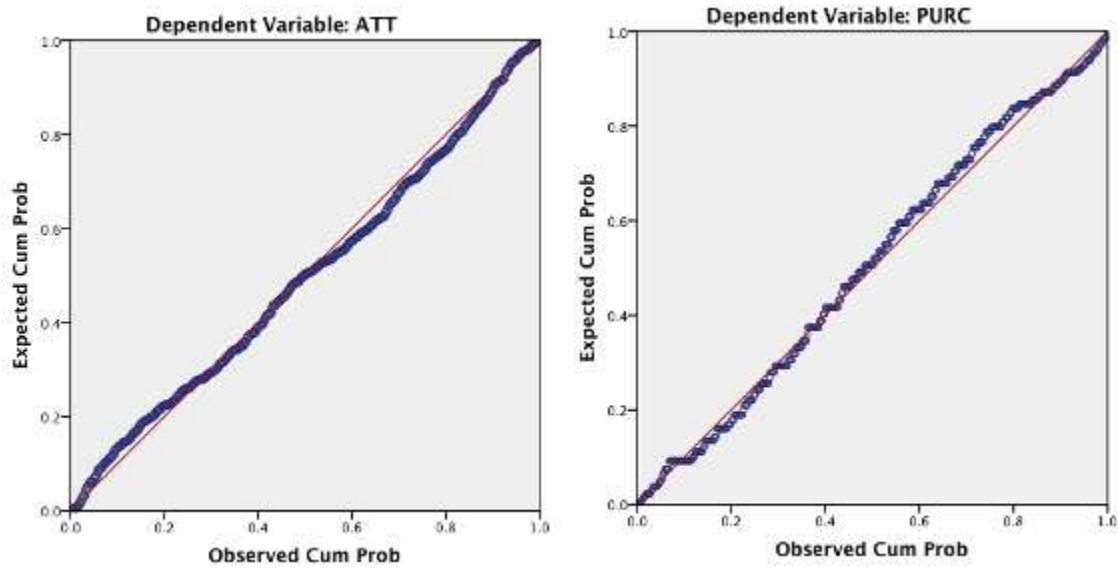

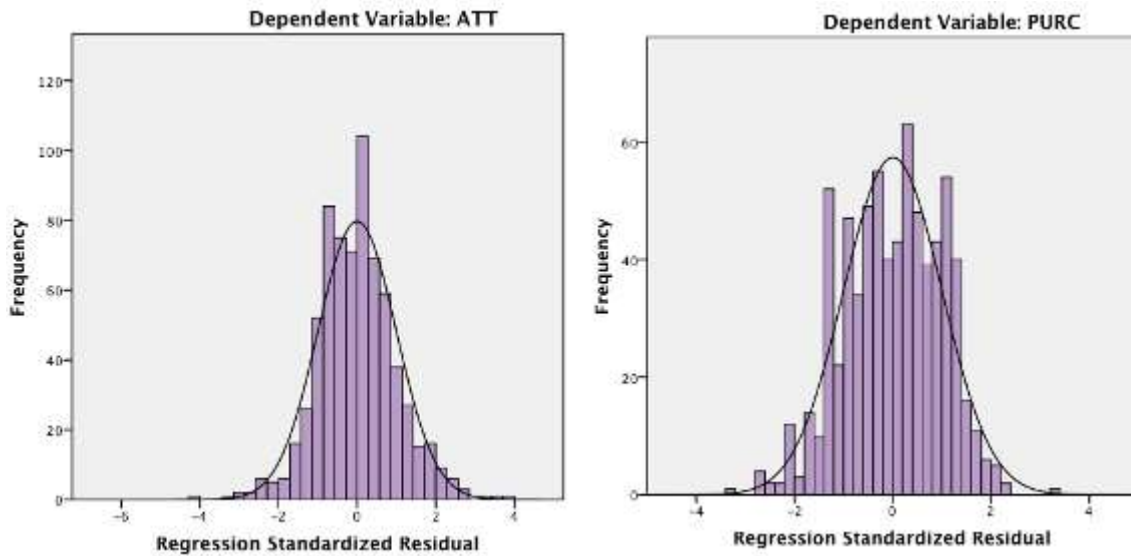*Figure 4.1*. Normal probability plot of standardized residuals.

Figure 4.2. Histogram of standardized residuals.

Regression Analysis

Two linear regression analyses were performed to determine the nature of the relationships between the dependent and independent variables. The first linear regression analysis (Model 1) was used to develop a model for predicting participants' attitude based on their perceived ease of use (PEU), perceived usefulness (PU), perceived compatibility (PCO), perceived comfort (PC), perceived performance risk (PR), perceived aesthetic attributes (PA), and environmental concern (EC). The second linear regression analysis (Model 2) was used to develop a model for predicting participants' purchase intention (PI) based on their attitude (AT).

For the model predicting attitude (Model 1), a significant regression equation was found ($F(7,688)=72.29$, $p<.001$) with an R^2 of .43. Participants' predicted attitude is equal to 1.31 + .27(PU) + .02 (PEU) + .19(PC) + .09(PCO) + .05(PA) - .09(PPR) + .23(EC). Table 4.6 shows the summary of a regression analysis for variables predicting attitudes, and all of the independent variables were significant except PEU and PA.

For the model predicting purchase intention (Model 2), a significant regression equation was found ($F(1,716)=507.28$, $p<.001$) with an R^2 of .42. Participants' predicted purchase intention is equal to -.74 + .86(AT). Table 4.7 shows the summary of regression analysis for variable predicting purchase intention.

Table 4.6.

Summary of Regression Analysis for Variables Predicting Attitudes (N=696)

Variable	Unstandardized coefficients		Standardized coefficients		
	B	*SE*	β	*t*	Sig.
(Constant)	1.31	.35		3.72	.00
Perceived Usefulness	.27	.03	.31	7.08	.00**

Table 4.6. (continued)

Variable	Unstandardized coefficients		Standardized coefficients		
	B	**SE**	**β**	**t**	**Sig.**
Perceived Ease of Use	.02	.03	.02	.46	.64
Perceived Performance Risk	-.09	.03	-.09	-2.81	.00**
Perceived Comfort	.19	.04	.17	4.68	.00**
Perceived Compatibility	.09	.04	.10	2.27	.02*
Perceived Aesthetic Attributes	.05	.02	.06	1.91	.06
Environmental Concerns	.23	.03	.19	6.24	.00**

Note. R^2=.43; adjusted R^2=.42
$F(7,688)$= 72.29, p<.001
*p<.05. **p<.01.

Table 4.7.

Summary of Regression Analysis for Variable Predicting Purchase Intentions (*N*= 718)

Variable	Unstandardized coefficients		Standardized coefficients		
	B	**SE**	**β**	**t**	**Sig.**
(Constant)	-.74	.18		-3.88	.00
Attitude	.86	.03	.64	22.52	.00**

Note. R^2= .42; adjusted R^2= .42
$F(1, 716)$= 507.28, p<.001
**p<.01.

Hypothesis Testing

Multiple regression, simple linear regression, and an independent samples *t*-test were used to test the hypotheses. A multiple regression analysis was conducted to examine the relationship between consumers' perceptions of solar-powered clothing and attitudes towards purchase (hypothesis 1a, 2a, 3a, 4a, 5a, 6a, 7a, 8a). For the rest of hypotheses (1b, 2b, 3b, 4b,

5b, 6b, 7b, 8b), and an independent samples *t*-test was conducted to compare the mean scores of independent variables between Baby Boomers and Gen Y. Table 4.8 shows the summary of an independent samples *t*-test between the two groups.

Hypothesis 1a proposed that perceived usefulness would have positive effects on attitudes towards purchasing solar-powered clothing. The results supported this hypothesis, with resulting values $\beta = .31$, $t = 7.08$, $p < .01$. Hypothesis 1b proposed that there would be differences in perceived usefulness of solar-powered clothing between Gen Y and Baby Boomer consumers. The results found a significant difference between the means of the two groups ($t(710)= -3.58$, $p<.01$). The mean of the Gen Y group was significantly higher ($m= 4.19$, $sd=1.41$) than the mean of the Baby Boomers ($m =3.76$, $sd=1.50$).

Hypothesis 2a proposed that perceived ease of use would have positive effects on attitudes towards purchasing solar-powered clothing. The results showed a non-significant positive effect of perceived ease of use on attitude ($\beta = .02$, $t = .46$, $p= .64$), indicating the lack of support for hypothesis 2a. Hypothesis 2b proposed that there would be differences in perceived ease of use towards solar-powered clothing between Gen Y and Baby Boomer consumers. The results showed no significant difference between the means of the two groups ($t(715)= .001$, $p=.99$) where the means of the Gen Y group ($m= 5.53$, $sd=1.20$) and Baby Boomers ($m= 5.53$, $sd=1.16$) were similar for both groups.

Table 4.8.

Independent Samples T-test for Baby Boomers and Gen Y

Variable	Generation	N	Mean	Levene's Test for Eaulity of Variances		t-test for Equality of Means		
				F	Sig	t	df	*Sig*
Perceived Usefulness	Baby Boomers	203	3.76	2.17	.14	-3.58	710	.00
	Gen Y	509	4.19					
Perceived Ease of Use	Baby Boomers	205	5.53	.69	.41	.00	715	.99
	Gen Y	512	5.53					
Perceived Performance Risk	Baby Boomers	204	4.16	4.71	.03	-1.61	341.78	.11
	Gen Y	511	3.97					
Perceived Comfort	Baby Boomers	204	4.21	.34	.56	3.37	714	.00
	Gen Y	512	3.89					
Perceived Compatibility	Baby Boomers	205	3.38	.43	.51	-3.46	716	.00
	Gen Y	513	3.78					
Perceived Aesthetic Attributes	Baby Boomers	206	3.95	8.27	.00	4.15	428.65	.00
	Gen Y	513	3.45					
Environmental Concerns	Baby Boomers	206	6.39	11.05	.00	3.99	466.75	.00
	Gen Y	513	6.08					
Attitude	Baby Boomers	205	4.96	.03	.86	2.10	716	.03
	Gen Y	513	4.74					
Purchase Intention	Baby Boomers	206	3.48	.54	.46	.91	718	.36
	Gen Y	514	3.35					

Hypothesis 3a proposed that perceived performance risks would have negative effects on attitudes towards purchasing solar-powered clothing. The results showed that perceived performance risks negatively influenced attitudes towards purchase intentions ($\beta = -.09$, $t = -2.81$, $p<.01$), supporting hypothesis 3a. Hypothesis 3b proposed that there would be

differences in perceived risks towards solar-powered clothing between Gen Y and Baby

Boomer consumers. The results showed no significant difference between the means for Gen

Y (*m*= 3.97, *sd*=1.31) and the Baby Boomers (*m*= 4.16, *sd*=1.45), (*t*(341.78)= 1.61, *p*=.11),

indicating a lack of support for hypothesis 3b.

Hypothesis 4a proposed that perceived comfort would have positive effects on

attitudes towards purchasing solar-powered clothing. The results supported this hypothesis,

with resulting values of *β* = .17, *t* = 4.68, *p* < .01. Hypothesis 4b proposed that there would be

differences in perceived comfort towards solar-powered clothing between Gen Y and Baby

Boomer consumers. The results found a significant difference between the means of the two

groups (*t*(714)= 3.37, *p*<.01). The mean of the Gen Y group was significantly lower (*m*=

3.89, *sd*=1.14) than the mean of the Baby Boomers (*m* =4.21, *sd*=1.09).

Hypothesis 5a predicted that perceived compatibility would have positive effects on

attitudes towards purchasing solar-powered clothing. The results supported this hypothesis,

with resulting values of *β* = .10, *t* = 2.27, *p* < .05. Hypothesis 5b proposed that there would

be differences in perceived compatibility towards solar-powered clothing between Gen Y and

Baby Boomer consumers. The results found a significant difference between the means of

the two groups (*t*(716)= -3.46, *p*<.01). The mean of the Gen Y group was significantly

higher (*m*= 3.78, *sd*=1.41) than the mean of the Baby Boomers (*m* =3.38, *sd*=1.37).

Hypothesis 6a proposed that perceived aesthetic attributes would have positive effects

on attitude towards purchasing solar-powered clothing. The results showed a non-significant

positive effect of perceived ease of use on attitude (*β* = .06, *t* = 1.91, *p*= .06), indicating the

lack of support for hypothesis 6a. Hypothesis 6b proposed that there would be differences in

perceived aesthetic attributes towards solar-powered clothing between Gen Y and Baby

Boomer consumers. The results found a significant difference between the means of the two groups ($t(428.65)= 4.15$, $p<.01$). The mean of the Gen Y group was significantly lower ($m=3.45$, $sd=1.59$) than the mean of the Baby Boomers ($m =3.95$, $sd=1.39$).

Hypothesis 7a proposed that environmental concerns would have positive effects on attitudes towards purchasing solar-powered clothing. The results supported this hypothesis, with resulting values of $\beta = .19$, $t = 6.24$, $p < .01$. Hypothesis 7b proposed that there would be differences in environmental concerns between Gen Y and Baby Boomer consumers. The results found a significant difference between the means of the two groups ($t(466.75)= 3.99$, $p<.01$). The mean of the Gen Y group was significantly lower ($m= 6.08$, $sd=1.08$) than the mean of the Baby Boomers ($m =6.39$, $sd=.87$).

Hypothesis 8a proposed that attitudes towards purchasing solar-powered clothing would positively influence purchase intentions. The results supported this hypothesis, with resulting values of $\beta = .64$, $t = 22.52$, $p < .01$. Hypothesis 8b proposed that Gen Y and Baby Boomers would have different attitudes towards purchasing solar- powered clothing. The results found a significant difference between the means of the two groups ($t(716)= 2.10$, $p<.05$). The mean of the Baby Boomers was significantly higher ($m =4.96$, $sd=1.24$) than the mean of the Gen Y ($m= 4.74$, $sd=1.25$).

CHAPTER 5. DISCUSSION AND CONCLUSIONS

This chapter summarizes and provides interpretations of the research findings presented in chapter 4. Conclusions, implications, limitations, and recommendations for future research are also presented.

Summary and Discussion

This study examined factors affecting consumers' attitudes towards purchasing wearable technology, specifically, solar-powered clothing due to the increasing focus and development of the product by researchers (Cho, 2010; Schubert & Merz, 2010) and the pro-environmental attributes of the product. Considering the inherent nature of wearable technology, where technology and clothing attributes coexist together, this present study integrated technology acceptance dimensions such as the TAM variables (perceived ease of use and perceived usefulness) and perceived performance risk, along with FEA elements of clothing (perceived comfort, perceived compatibility, and perceived aesthetic attributes). Environmental concerns were also included, because of the pro-environmental attributes of solar-powered clothing. Thus, based on the TAM, this study extended the model and examined the effects of these seven consumer-oriented variables on consumers' attitudes towards purchasing solar-powered clothing. Further, this study examined the differences between Gen Y and Baby Boomer on their perceptions of and attitudes towards purchasing solar-powered clothing; these two groups were selected, because both groups have been of significant interest to social psychologists as well as marketers in the past (Morris & Venkatesha, 2000). A summary of the results of hypotheses tested is provided in Table 5.1.

Table 5.1.

Hypothesized Relationships and Summary of the Results

Hypothesized Relationships		Result
H1a.	Perceived usefulness will have positive effects on attitude towards purchasing solar-powered clothing.	Supported
H1b.	There will be differences in perceived usefulness of solar-powered clothing between Gen Y and Baby Boomer consumers.	Supported
H2a.	Perceived ease of use will have positive effects on attitude towards purchasing solar-powered clothing.	Not Supported
H2b.	There will be differences in perceived ease of use towards solar-powered clothing between Gen Y and Baby Boomer consumers.	Not Supported
H3a.	Perceived performance risks will have negative effects on attitude towards purchasing solar-powered clothing.	Supported
H3b.	There will be differences in perceived performance risks towards solar-powered clothing between Gen Y and Baby Boomer consumers.	Not Supported
H4a.	Perceived comfort will have positive effects on attitude towards purchasing solar-powered clothing.	Supported
H4b.	There will be differences in perceived comfort towards solar-powered clothing between Gen Y and Baby Boomer consumers.	Supported
H5a.	Perceived compatibility will have positive effects on attitude towards purchasing solar-powered clothing.	Supported
H5b.	There will be differences in perceived compatibility towards solar-powered clothing between Gen Y and Baby Boomer consumers.	Supported
H6a.	Perceived aesthetic attributes will have positive effects on attitude towards purchasing solar-powered clothing.	Not Supported
H6b.	There will be differences in perceived aesthetic attributes towards solar-powered clothing between Gen Y and Baby Boomer consumers.	Supported

Table 5.1. (continued)

Hypothesized Relationships	Result
H7a. Environmental concerns will have positive effects on attitude towards purchasing solar-powered clothing.	Supported
H7b. There will be differences in environmental concerns between Gen Y and Baby Boomer consumers.	Supported
H8a. Attitude towards purchasing solar-powered clothing will positively influence purchase intention.	Supported
H8b. Gen Y and Baby Boomers will have different attitude towards purchasing solar-powered clothing.	Supported

Effects of Technology Acceptance Variables

Hypothesis 1a proposed that perceived usefulness would have positive effects on attitudes towards purchasing solar-powered clothing. The results supported this hypothesis. As proven by many studies (Venkatesh et al., 2003; Davis, 1989), this study found that perceived usefulness significantly influences one's acceptance of a technology and it was proven as the most powerful predictor for intention to use in technology adoption. This finding also aligns with previous research (i.e., Chae, 2009; Ko et al., 2010) where researchers found a positive relationship between perceived usefulness of and attitude towards purchasing smart clothing in general.

When asked about the benefits of using solar-powered clothing in an open-ended question, the majority of participants confirmed that their decision was grounded in perception of the product as useful. Participants expressed a various range of perceived usefulness of the solar-powered clothing. Participants expressed that they perceive the product to be useful since it can charge phones, "Less likely to be unable to use my phone

when I want to, and particularly if there is an emergency. I already carry a charger in my car

for emergencies; to carry one [battery] with me would be nice" (P10); "I could keep all my

devices charged when I am on the go. It would be useful for traveling, especially in foreign

countries where the outlets are different or unavailable" (P 127). Participants also expressed

that being able to charge their phones "could potentially be an added security for safety while

hiking in the woods or rock climbing" (P 384). Further, as a minor benefit, some participants

stated that solar-powered clothing would "encourage people to spend more times outdoor"

(P403). Because perceived usefulness is a key factor that influences attitudes towards

purchasing intentions, informing consumers with detailed product information and benefits

may increase their favorable attitudes and then, correspondingly, increase their purchase

intentions for the product.

Along with perceived usefulness, hypothesis 2a proposed that perceived ease of use

would positively influence consumers' attitudes towards purchasing solar-powered clothing.

Surprisingly, attitude was not significantly influenced by perceived ease of use in this study,

although much literature suggests that perceived ease of use as the direct determinant of

behavior intention in TAM and a direct determinant of usage behavior (Davis, 1989; Lee et

al., 2006). The findings also contradict Chae (2009) who empirically confirmed that

perceived ease of use positively influences consumers' attitudes and purchase intentions

towards smart clothing, such as an embedded MP3 player jacket. Further, Ko et al. (2009)

found a significant negative relationship between perceived complexity and attitudes towards

accepting smart clothing, where complexity coincides with perceived ease of use in the

opposite direction. Perhaps, in the case of solar-powered clothing, perceived ease of use was

considered insignificant since consumers relate the usage of a product to such behaviors as

charging their phones, which may not be perceived to cause any problems to consumers. Hypothesis 3a proposed that perceived performance risk would have negative effects on attitudes towards purchasing solar-powered clothing. The result revealed that consumers perceive the performance of solar-powered clothing to be uncertain. This is also supported by the open-ended questions where some participants expressed their concerns about the performance of the product, implying a negative relationship; "I don't know how well they'll perform in actuality, and I'm concerned about the longevity of the solar-powered clothing" (P740). Some participants also expressed their concerns about wearing technology, since it lies too closely to the human body: "Any type of electrical malfunctions that could be harmful to the human body" (P81), and "The close proximity of my organs (brain, heart, liver, etc.) to photovoltaic electricity generation. It makes me think of wearing a microwave" (P22). Thus, the results confirm previous findings of Ko et al. (2009) that reported that perceived performance risk is negatively associated with attitudes towards purchasing smart clothing. Further, it is noteworthy to examine not only the product performance risk, but also multiple dimensions of perceived risks, including consumers' psychology of wearing technology. Marketers should control perceived risk dimensions to make solar-powered clothing seem more reliable and less complex, generating a favorable attitude towards the clothing.

In terms of comparing Gen Y and Baby Boomers in the technological dimension, hypothesis 1b, 2b and 3b proposed that there would be differences in perceived usefulness, perceived ease of use, and perceived performance risk towards solar-powered clothing between Gen Y and Baby Boomer consumers. Hypothesis 1b was supported, but hypothesis 2b and 3b were not. There were significant mean differences in perceived usefulness

towards solar-powered clothing between Gen Y and Baby Boomer consumers, but no significant differences were found in perceived ease of use and perceived performance risk. For perceived usefulness, the mean of the Gen Y group was significantly higher than the mean of the Baby Boomers. This aligns with the characteristics of Gen Y where previous studies showed Gen Y to be more technologically savvy and early adopters of new technologies than other generational cohorts (Kumar et al., 2008).

Effects of FEA Variables

Hypothesis 4a proposed that perceived comfort would have positive effects on attitudes towards purchasing solar-powered clothing. The results supported this hypothesis. As proven by previous studies (Frith & Glesson, 2004; Sontag, 1985), perceived comfort significantly influenced one's overall evaluation of apparel products. When asked about any concerns about wearing solar-powered clothing in an open-ended question, some participants expressed their concerns about the comfort of wearing the product: "[I am concerned about] the flexibility of the cells and whether it would feel 'stiff'" (P8), and "I don't think it would be very comfortable wearing it" (P45). Thus, the researcher believes that with the help of technology development, once the rigid-looking solar panels are replaced by lightweight and flexible fibers that can be woven into the fabrics, it would increase consumers' acceptance of wearing solar-powered clothing. Not only focusing on a technical concern, improving higher mobility and comfort as a user-centered design is needed for the marketability of wearable technology. Currently, international teams of scientists and engineers are working on making fibers that work like self-contained solar cells, resulting in more wearable clothing that may collect sunlight from many different angles. Current researchers across the United States are developing flexible solar fibers that can be woven to make fabrics that absorb solar-cells

(Treacy, 2012). Thus, these developments may increase consumers' perceived comfort of the product, resulting in a more favorable attitude towards wearing the clothing.

Hypothesis 5a proposed that perceived compatibility would have positive effects on attitudes towards purchasing solar-powered clothing. The results supported this hypothesis just as previous studies also support that perceived compatibility positively influences one's acceptance of technology, including smart clothing (Ko et al., 2009; Shim & Kotsiopulos, 1994). It is also notable that perceived usefulness is highly correlated with perceived compatibility (r=.70), indicating that improving perceived usefulness of the product would increase positive perceptions of its compatibility. Thus, it can be inferred that as consumers view the product to be consistent with their existing wardrobe and appropriate for their current needs, they show higher perceived usefulness of using the product.

Hypothesis 6a proposed that perceived aesthetic attributes would have positive effects on attitudes towards purchasing solar-powered clothing. The results did not support this hypothesis. It is interesting to note that perceived aesthetic attributes do not significantly influence attitude. This means that, unlike the importance of aesthetic attributes in regular clothing supported by other studies (Eckman et al., 1990; Fiore & Damhorst, 1992), wearable technology is viewed differently from regular, everyday clothing. Consumers may expect wearable technology to be more useful rather than being aesthetically pleasing. However, the regression analysis showed that the perceived aesthetic was rejected at the significance level of .06, where the hypothesis can be supported if the significance value is less than .05. Hence, the results showed moderately positive significant effects. The participants' answers from the open-ended questions can help explain such findings. Even though the relation

between perceived aesthetic attributes and attitude was not supported, some participants

expressed their concerns about the look of wearing the product:

> P245: My main concern would be giving up fashion for the functionality of the
>
> intended use of the product. I can only see using this if I was hiking and needed the
>
> clothing for more than one day of being away from an electrical outlet.
>
> P696: I feel like it will look tacky, but I feel the same about all wearable technology.
>
> Realistically, it will become part of the future.
>
> P112: Incorporation of the solar panels into the design of the clothing items -
>
> aesthetics do count. I don't want to walk around looking like a reject from 'Lost in
>
> Space.'
>
> P232: [My major concern is] to make the clothing look fashionable and the solar
>
> panels not noticeable.
>
> P124: The major concern I would have would be to see if the panels could be
>
> incorporated into clothing that would still function for a working professional… the
>
> biggest concern would be maintaining a professional appearance.

Thus, further analysis between perceived aesthetic attributes and attitudes needs to be

examined, since aesthetic attributes such as styles and designs are important factors in

purchasing clothing (Fiore & Damhorst, 1992).

In FEA dimensions, there were significant mean differences in perceived comfort,

perceived compatibility, and perceived aesthetic attributes towards solar-powered clothing

between Gen Y and Baby Boomers (H4b, 5b, and H6b). For both perceived comfort and

aesthetic attributes, Gen Y had lower scores indicating that they perceive the clothing to be

less comfortable and aesthetically appealing. For perceived compatibility, Gen Y showed

that they perceive the clothing to be more compatible compared to Baby Boomers. Similar to perceived usefulness, the results also align with the characteristics of Gen Y, where previous studies showed Gen Y as early adopters of technology due to their lifestyle than other generational cohorts (Kumar et al., 2008). However, since Gen Y consumers are more socially conscious and skeptical about products' attributes before purchasing (Pokrywczyniski & Wolburg, 2001), emphasizing comfort and aesthetic attributes of solar-powered clothing by marketers is important. Therefore, it is worthwhile to better understand consumers' perceptions of FEA dimensions influencing their attitudes towards purchasing solar-powered clothing and wearable technology where both technology and clothing attributes coexist together.

Effects of Environmental Concerns

Hypothesis 7a proposed that environmental concerns would have positive effects on attitudes towards purchasing solar-powered clothing. This study found that environmental concerns had a significant influence on consumers' attitudes towards buying solar-powered clothing. This was consistent with previous studies that reported that consumers having high environmental concerns have a positive influence on purchasing products with pro-environmental attributes (Minton & Rose, 1997; Yan et al., 2012). The results also align with previous studies on the relationship between environmental concerns and other types of clothing with pro-environmental attributes, such as clothing made with organic fibers or recycled materials, or second-hand clothing. Supporting the statement, participants also expressed that, "[Using this product] save electricity. Have readily available energy source" (P20), while another stated, "I'm very concerned about protecting our environment and if this solar-powered clothing can contribute to save our environment I think that's the major benefit

for me" (P310). Thus, presenting clear information about the environmental benefits of the solar-powered clothing, such as how much energy is being saved, and depicting the efficiency of the products versus the price and materials of the jacket, would persuade consumers with high environmental concern to purchase the solar-powered clothing.

For hypothesis 7b, the results showed that Baby Boomers and Gen Y expressed significantly different environmental concerns. Baby Boomers expressed high environmental concern, which is supported by previous studies (Smith & Clurman, 2007; Worsley et al., 2011). This indicates that Baby Boomers have a heightened sense of obligation to make a positive contribution to the wellbeing of the planet.

Relationships Between Attitude and Purchase Intention

Hypothesis 8a proposed that attitude towards purchasing solar-powered clothing would positively influence purchase intention. The hypothesis was supported, and many empirical studies support this relationship (Ajzen & Fishbein, 1980; Chae 2009). Interestingly, for hypothesis 8b, Baby Boomers had more favorable attitudes towards purchasing solar-powered clothing. Previous studies found that price influenced consumers' attitudes towards and intention of buying (Kim & Chung, 2011), and the high cost of the solar-powered clothing may be a factor that influenced consumers' attitudes towards purchase. In this study, on average, Baby Boomers had a higher yearly income ($50,000 to $75,000) than Gen Y ($3,000 to $10,000), possibly causing Baby Boomers to have more favorable attitudes towards purchasing the solar-powered clothing compared to Gen Y consumers.

Conclusions and Implications

A very limited number of studies have examined how consumers perceive wearable technology. Overall, the phenomenon of wearable technology from a consumer perspective is not well understood, even though many researchers are developing wearable technology (Macguire, 2011; Moon & Kim, 2001). Thus, this study examined the effects of various antecedent factors that influence the acceptance of wearable technology, specifically, solar-powered clothing. Solar-powered clothing was chosen as the topic for this study, since few studies have examined consumer acceptance of smart clothing like MP3 player jackets and Music-Prism T-Shirt (Ko et al., 2008), and due to an increasing focus and development of solar-powered clothing by researchers (Cho, 2010; Schubert & Merz, 2010). Thus, this study attempted to examine various dimensions underlying the acceptance of solar-powered clothing. The findings are useful to current researchers and apparel industry members who seek to devise strategies for sales and marketing of products which inherently require both technology and clothing attributes.

Based on the TAM, the model was extended for the theoretical framework and research hypotheses. Based on the extended TAM, this study integrated seven consumer-oriented variables related to attitude and purchase intention towards solar-powered clothing; three variables from a dimension of technology acceptance (perceived usefulness, perceived ease of use, perceived performance risks), three variables from FEA dimensions of the clothing (perceived comfort, perceived compatibility, perceived aesthetic attributes), and a variable of environmental concern. Thus, the study examined the effects of technology acceptance variables, FEA variables, and environmental concerns on consumers' attitude

towards purchasing solar-powered clothing, and the differences between Gen Y and Baby Boomers.

Examining the effects of technology acceptance variables and FEA variables contributes to an understanding of consumers' acceptance of wearable technology. This study bridges the gap in understanding consumers' perceptions of and purchase intentions for solar-powered clothing by using the extended TAM. The results revealed that both technology acceptance variables and FEA variables are important factors influencing the acceptance of the clothing. Especially, perceived usefulness significantly influenced consumers' attitudes towards purchasing solar-powered clothing from a technology dimension, and perceived comfort and perceived compatibility significantly influenced attitudes towards purchasing solar-powered clothing from the FEA dimension.

This present study contributes to the growing body of research on development of wearable technology, especially the promotion of solar-powered clothing. The research confirmed the important influences of multiple dimensions on wearable technology. Further, this study validates the TAM model in explaining new technology adoption and the importance of FEA dimensions of solar-powered clothing. The two different generational cohorts, Baby Boomers and Gen Y, revealed differences in perceptions of solar-powered clothing among the generations; it is expected that consumer perceptions and attitudes will be different depending on the classified group or market. In this regard, the classification of markets relying on consumer features and corresponding commercialization strategies are necessary. For instance, identifying potential early adopters of wearable technology is needed, since the product is at the early commercialization stage. For marketers, highlighting

the usefulness through sufficient publicity about functions for a convenient lifestyle is important.

As previously discussed, both Gen Y and Baby Boomers may be a key segment of the population for solar-powered clothing. Results of this study may be useful for both fashion retailers and researchers working on solar-powered clothing. Especially, current society is concerned with the environmental crisis and thus promotes socially responsible (SR) practices by companies (Ottman, 2011). In this regard, apparel companies with SR activities may want to adopt solar-powered clothing to promote clothing with pro-environmental attributes and raise awareness of consumers. In addition, retailers can target the consumers by explicitly informing consumers about environmental attributes of the solar-powered clothing, since message explicitness, the degree of precision, and specificity provided in a communication influence consumers' attitudes and purchase intentions (Hyllegard, Yan, Ogle, & Lee, 2012). For instance, Yan, Hyllegard, and Blaesi (2012) found that participants who viewed an ad with an explicit message about the ecofriendly attributes of jeans reported more positive attitudes towards the brand than consumers who viewed an ad with an implicit message. Thus, researchers should take into account not only the technology side of the wearable technology, but also can consider FEA dimensions such as comfort, compatibility, and durability.

Considering the complexities underling wearable technology and the multiple factors involved in solar-powered clothing, researchers and designers need to take into account the various dimensions of clothing rather than focusing on either just the clothing or technology side. Thus, researchers also need to provide evidence for other important factors such as products' efficiency and durability. As more wearable technology is emerging in the society,

it is critical to consider how both dimensions of technology and clothing attributes of such innovative products can effectively coexist together to better serve consumers.

Limitations and Future Research

There are several limitations to this study. The first limitation relates to sampling; the convenience sampling method limits the generalizability of the findings. For instance, while this study did not find a significant effect of some variables (e.g., perceived aesthetic and ease of use), it might be because of the sample composition of consumers in the university, where the population is considered to be more educated. Thus, a more heterogeneous group and other age cohorts should be examined to further support the research findings.

Moreover, more than half of the respondents were previously unaware of solar-powered clothing. They responded based on the descriptions provided in the questionnaire without having had actual experience with the product. To help participants better understand the concept of solar-powered clothing, text descriptions and images of solar-powered clothing from the apparel industry were provided at the beginning of the questionnaire. However, the information page may not fully have represented all types of solar-powered clothing. To further examine wearable technology, other types of smart clothing should be examined, with both technology acceptance variables and FEA variables, and compared with the results of solar-powered clothing. Further, the current researcher developed some of the items used in the questionnaire. Although they were proven to demonstrate acceptable reliability and validity in the present study, future studies should be conducted to test the external validity of this measurement scale.

Considering the nascent field of the topic, future studies may employ qualitative research methods with in-depth interviews to identify the most important perceived attributes

considered by consumers in adopting solar-powered clothing and wearable technology in general. Other factors, such as price and psychological implications of wearing technology, may influence acceptance of solar-powered clothing. Future research should further examine physical comfort of the wearable devices and the physiological implications of wearing technology. Lastly, an experimental study may be also conducted where consumers can actually touch, feel, wear, and test the actual technology-integrated clothing.

REFERENCES

Ajzen, I. (1989). Attitude structure and behavior. *Attitude structure and function*, 241-274.Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice-Hall.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology*, *22*(5), 453-474.

Antil, J. H. (1984). Socially responsible consumers: profile and implications for public policy. *Journal of Macromarketing*, *4*(2), 18-39.

Ariyatum, B., & Holland, R. (2003). A strategic approach to new product development in smart clothing. In *Proceedings of the 6th Asian Design Conference* (Vol. 70).

Ariyatum, B., Holland, R., Harrison, D., & Kazi, T. (2005). The future design direction of smart clothing development. *Journal of the Textile Institute*, *96*(4), 199-210.

Baurley, S. (2004). Interactive and experiential design in smart textile products and applications. *Personal and Ubiquitous Computing*, *8*(3-4), 274-281.

Best Invention of 2001. (2001). Heat-generating jacket. *TIME*. Retrieved from http://content.time.com/time/specials/packages/article/0,28804,1936165_1936256_1936647,00.html

Bower, A. B., & Landreth, S. (2001). Is beauty best? Highly versus normally attractive models in advertising. *Journal of Advertising*, *30*(1), 1-12.

Brosdahl, D. J., & Carpenter, J. M. (2010). Consumer knowledge of the environmental impacts of textile and apparel production, concern for the environment, and environmentally friendly consumption behavior. *Journal of Textile and Apparel, Technology and Management*, *6*(4), 1-9.

Bruner, G. C., Hensel, P. J., & James, K. E. (2001). *Marketing scales handbook*. Chicago, IL: American Marketing Association.

Bush, A., Martin, C., & Bush, V. (2004). Sports celebrity influence on the behavior intentions of generation Y. *Journal of Advertising Research, 44*(1), 108-18.

Butler, S. M., & Francis, S. (1997). The effects of environmental attitudes on apparel purchasing behavior. *Clothing and Textiles Research Journal*, *15*(2), 76-85.

Carrigan, M., Szmigin, I., & Wright, F. (2004). Shopping for a better world? An interpretive study of the potential for ethical consumption within the older market. *The Journal of consumer Marketing, 21*(6), 401-417.

Chae, J. M. (2010). Clothing & Textiles: Consumer Acceptance Model of Smart Clothing according to Innovation. *International Journal of Human Ecology*, *10*(1), 23-33.

Chattaraman, V., & Rudd, N. A. (2006). Preferences for aesthetic attributes in clothing as a function of body image, body cathexis and body size. *Clothing and Textiles Research Journal*, *24*(1), 46-61.

Chen, L. D., Gillenson, M. L., & Sherrell, D. L. (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & Management*, *39*(8), 705-719.

Childers, T. L., Carr, C. L., Peck, J., & Carson, S. (2002). Hedonic and utilitarian motivations for online retail shopping behavior. *Journal of retailing*, *77*(4), 511-535.

Cho, G. (2010). *Smart clothing: technology and applications*. Boca Raton, Florida: CRC Press.

Cho, K. (2006). Redesigning hospital gowns to enhance end users' satisfaction. *Family and Consumer Sciences Research Journal*, *34*(4), 332-349.

Chuttur, M. (2009). Overview of the technology acceptance model: Origins, developments and future directions.

Community Banker (2000). Bet on baby boomers. Community Banker, available at: www.allbusiness.com/periodicals/article/974183-1.html

Cross, B. (2013, June 21). Solar powered clothing- practical or not? *Crunchwear.* Retrieved from http://www.crunchwear.com/solar-powered-clothing/

Damhorst, M. L. (1990). In search of a common thread: classification of information communicated through dress. *Clothing and Textiles Research Journal*, *8*(2), 1-12.

Davis, F.D. (1986). *Technology acceptance model for empirically testing new end-user information system: Theory and results.* (Doctoral dissertation, Massachusetts Institute of Technology).

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, *35*(8), 982-1003.

Dickson, M. A. (2000). Personal values, beliefs, knowledge, and attitudes relating to intentions to purchase apparel from socially responsible businesses. *Clothing and Textiles Research Journal*, *18*(1), 19-30.

Dunne, L. E. (2004). *The design of wearable technology: addressing the human-device interface through functional apparel design* (Master's thesis). Retrieved from http://ecommons.cornell.edu/bitstream/1813/150/2/Lucy%20E%20Dunne-Masters%20Thesis.pdf

Dunne, L. E., Ashdown, S. P., & Smyth, B. (2005). Expanding garment functionality through embedded electronic technology. *Journal of Textile and Apparel Technology and Management*, *4*(3), 1-11.

Eckman, M., Damhorst, M. L., & Kadolph, S. J. (1990). Toward a model of the in-store purchase decision process: consumer use of criteria for evaluating women's apparel. *Clothing and Textiles Research Journal*, *8*(2), 13-22.

eMarketer (2013, March 21). How digital behavior differs among millennials, gen xers and boomers. *eMarketer Inc.* Retrieved from http://www.emarketer.com/Article/How-Digital-Behavior-Differs-Among-Millennials-Gen-Xers-Boomers/1009748

Fiore, A. M., & Damhorst, M. L. (1992). Intrinsic cues as predictors of perceived quality of apparel. *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*, *5*, 168-78.

Forsythe, S. M., & Shi, B. (2003). Consumer patronage and risk perceptions in Internet shopping. *Journal of Business Research*, *56*(11), 867-875.

Frith, H., & Gleeson, K. (2004). Clothing and embodiment: men managing body image and appearance. *Psychology of Men & Masculinity*, *5*(1), 40.

Frost, K. (1988). *Consumer's perception of fit and comfort of pants.* (Unpublished master's thesis), University of Minnesota, St. Paul.

Fujii, S. (2006). Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. *Journal of Environmental Psychology, 26*(4), 262-268.

Gepperth, J. (2012). Smart Things: Wearables & Clothing. *Smart Things, 3*, 41-48.

Grewal, D., Gotlieb, J., & Marmorstein, H. (1994). The moderating effects of message framing and source credibility on the price-perceived risk relationship. *Journal of Consumer Research*, 145-153.

Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: antecedents in a technology acceptance model. *Journal of Business Research*, *62*(5), 565-571.

Hair, J.F., Anderson, R. E., Tatham, R.L., & Black, W.C. (2010). *Multivariate Data Analysis* (7th ed.). Upper Saddle River, NJ: Prentice-Hall.

Holbrook, M. B. (1986). Aims, concepts, and methods for the representation of individual differences in esthetic responses to design features. *Journal of Consumer Research*, 337-347.

Howden M. K., & Meyer A. J. (2011). Age and Sex composition: 2010. *US Census Bureau*. Retrieved October 23, 2013 from http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf

Huck, J., Maganga, O., & Kim, Y. (1997). Protective overalls: evaluation of garment design and fit. *International Journal of Clothing Science and Technology*, *9*(1), 45-61.

Hyllegard, K. H., Yan, R. N., Ogle, J. P., & Lee, K. H. (2012). Socially responsible labeling the impact of hang tags on consumers' attitudes and patronage intentions toward an apparel brand. *Clothing and Textiles Research Journal*, *30*(1), 51-66.

IBM , Aug. 24, 2009. Generation Y- Great Britain's Worst Environmental Offender. Retrieved September 18, 2013 at http://www03.ibm.com/press/uk/en/pressrelease/28241.wss

IBM , Aug. 24, 2009. Generation Y- Great Britain's Worst Environmental Offender. Retrieved September 18, 2013 from http://www03.ibm.com/press/uk/en/pressrelease/28241.wss

Institute for the Future. (2002). *Demographics in the 21st century: Defining future markets*. Retrieved September 14, 2013, from http://www.iftf.org/docs/SR772_Demographics_in_the_21st_Century.pdf

International Telecommunication Union. ICT Facts and Figures. (2013). Retrieved from http://www.itu.int/en/ITUD/Statistics/Documents/facts/ICTFactsFigures2013.pdf

Jeon, J.H., & Cho, G. (2010). Fundamentals of and requirements for solar cells and photovoltaic textiles. In G. Cho (Eds.), *Smart clothing: technology and applications* (pp. 249-265). Boca Raton, Florida: CRC Press.

Jeong, K.S., & Yoo, S.K. (2010). Electro-textile interfaces textile-based sensors and actuators. In G. Cho (Eds.), *Smart clothing: technology and applications* (pp. 89-113). Boca Raton, Florida: CRC Press.

Just-style.com. (2008). Global market review of performance apparel- Forecasts to 2014. *Just-Style*. Retrieved September 28, 2013, from http://www.marketresearch.com/just-style-v3410/Global-Review-Performance-Apparel-Forecasts-1807512/

Kim, H. S., & Damhorst, M. L. (1998). Environmental concern and apparel consumption. *Clothing and Textiles Research Journal*, *16*(3), 126-133.

Kim, H. Y., & Chung, J. E. (2011). Consumer purchase intention for organic personal care products. *Journal of Consumer Marketing*, *28*(1), 40-47.

Kim, H. Y., Jolly, L., & Kim, Y. K. (2007). Future Forces Transforming Apparel Retailing in the United States An Environmental Scanning Approach. *Clothing and Textiles Research Journal*, *25*(4), 307-322.

Ko, E., Sung, H., & Yun, H. (2009). Comparative Analysis of Purchase Intentions Toward Smart Clothing Between Korean and US Consumers. *Clothing and Textiles Research Journal*, *27*(4), 259-273.

Kumar, A., & Lim, H. (2008). Age differences in mobile service perceptions: comparison of Generation Y and baby boomers. *Journal of Services Marketing*, *22*(7), 568-577.

Lamb, J. M., & Kallal, M. J. (1992). A conceptual framework for apparel design. *Clothing and Textiles Research Journal*, *10*(2), 42-47.

Lăzăroiu, G. (2012). Communication functions of smart clothing. *Contemporary Readings in Law and Social Justice*, (1), 162-167.

Lee, H. H., Fiore, A. M., & Kim, J. (2006). The role of the technology acceptance model in explaining effects of image interactivity technology on consumer responses. *International Journal of Retail & Distribution Management*, *34*(8), 621-644.

Lee, M. C. (2009). Factors influencing the adoption of internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic Commerce Research and Applications*, *8*(3), 130-141.

Littrell, M. A., & Miller, N. J. (2001). Marketing across cultures: Consumers' perceptions of product complexity, familiarity, and compatibility. *Journal of Global Marketing*, *15*(1), 67-86

Lu, J., Yu, C. S., Liu, C., & Yao, J. E. (2003). Technology acceptance model for wireless internet. *Internet Research*, *13*(3), 206-222.

Macguire, E. (2011, December 23). From iPod bikinis to robot journalists: 10 amazing solar-power projects. CNN. Retrieved from http://www.cnn.com/2011/12/23/tech/innovation/amazing-solar-power projects/index.html?iref=allsearch

MacKenzie, S. B., Lutz, R. J., & Belch, G. E. (1986). The role of attitude toward the ad   as a mediator of advertising effectiveness: A test of competing explanations. *Journal of marketing research*, 130-143.

Malmivaara, M (2009). The emergence of wearable computing. In J. McCann, & D. Bryson (Eds.), *Smart clothes and wearable technology* (pp.4-24). Boca Raton, FL: CRC Press.

Mather, R.R., & Wilson, K. (2006). Solar textiles: production and distribution of   electricity coming from solar radiation applications. In H.R. Mattila, (Eds.), *In Intelligent textiles and clothing* (pp. 206-216). England: CRC press.

Matorin, J. (2003). Generation 'G': Baby boomer grandparents a growing market offering glittering opportunity. *Nation's Restaurant News, 37*(33), 26.

McCann, J. (2009). End-user based design of innovative smart clothing. In J. McCann, & D. Bryson (Eds.), *Smart clothes and wearable technology* (pp.4-24). Boca Raton, FL: CRC Press.

Minton, A. P., & Rose, R. L. (1997). The effects of environmental concern on environmentally friendly consumer behavior: An exploratory study. *Journal of Business Research*, *40*(1), 37-48.

Moon, J. W., & Kim, Y. G. (2001). Extending the TAM for a World-Wide-Web context. *Information & Management*, *38*(4), 217-230.

Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology*, *53*(2), 375-403.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York: McGraw-Hill, Inc.

O'Donnell, J. (2006). Gen Y sits on top of consumer food chain; they're savvy shoppers with money and influence. USA Today, 11 October 2006, 3B.

Ottman, J. A. (1992). Industry's response to green consumerism. *Journal of Business Strategy*, *13*(4), 3-7.

Ottman, J. A. (2011). *The new rules of green marketing: Strategies, tools, and inspiration for sustainable branding*. Berrett-Koehler Publishers.

Pallant, J. (2001). *SPSS survival manual: A step by step guide to data analysis using SPSS for Windows (Version 10)*. Buckingham: Open University Press.

Paul, P. (2003), Targeting boomers. *American Demographics*, March, pp. 24-6.

Park, J., & Stoel, L. (2005). Effect of brand familiarity, experience and information on online apparel purchase. *International Journal of Retail & Distribution Management*, *33*(2), 148-160.

Park, Y., & Chen, J. V. (2007). Acceptance and adoption of the innovative use of smartphone. *Industrial Management & Data Systems*, *107*(9), 1349-1365.

Parment, A. (2013). Generation Y vs. Baby Boomers: Shopping behavior, buyer involvement and implications for retailing. *Journal of Retailing and Consumer Services*.

Petroulas, E., Brown, D., & Sundin, H. (2010). Generational characteristics and their impact on preference for management control systems. *Australian Accounting Review*, *20*(3), 221-240.

Pokrywczynski, J., & Wolburg, J. (2001). A psychographic analysis of Generation Y college students. *Journal of Advertising Research*, *41*(5), 33-50.

Rantanen, J., Alfthan, N., Impio, J., Karinsalo, T., Malmivaara, M., Matala, R.,& Vanhala, J. (2000, October). Smart clothing for the arctic environment. In *Wearable Computers, The Fourth International Symposium on* (pp. 15-23). IEEE.

Renn, K.A., & Arnold, K.D. (2003).Reconceptualizing research on college peer group culture. *The Journal of Higher Education, 74*(2), 93-110.

Rogers, E. M. (1995; 2003). *Diffusion of Innovations*. New York: The Free Press.

Schiffman, L. G., & Kanuk, L.L. (2000). *Consumer behavior* (7th ed.) Englewood Cliffs, NJ: Prentice Hall.

Schubert, M. B., & Werner, J. H. (2006). Flexible solar cells for clothing. *Materials Today*, *9*(6), 42-50.

Schubert, M. B., & Merz, R. (2009). Flexible solar cells and modules. *Philosophical Magazine*, *89*(28-30), 2623-2644.

Schubert, M. B., & Werner, J. H. (2006). Flexible solar cells for clothing. *Materials today*, *9*(6), 42-50.

Shanley, L. A., Slaten, B. L., & Shanley, P. S. (1993). Military protective clothing: Implications for clothing and textiles curriculum and research. *Clothing and Textiles Research Journal*, *11*(3), 55-59.

Shim, S. (1995). Environmentalism and consumers' clothing disposal patterns: an exploratory study. *Clothing and Textiles Research Journal*, *13*(1), 38-48.

Shim, S., & Kotsiopulos, A. (1994). Technology innovativeness and adopter categories of apparel/gift retailers: from the diffusion of innovations perspective. *Clothing and Textiles Research Journal*, *12*(2), 46-57.

Shimp, T. A., & Bearden, W. O. (1982). Warranty and other extrinsic cue effects on consumers' risk perceptions. *Journal of Consumer research*, 38-46.

Sjöberg, L. (2000). Factors in risk perception. *Risk analysis*, *20*(1), 1-12.

Smith Walker, J. & Clurman, A. (2007). *Generation Ageless: How baby boomers are changing the way we live today…and they're just getting started.* New York:

HarperCollins Publishers.

Solomon, M. R. (2007). *Consumer Behavior (7th ed.)*. Upper Saddle River, NJ: Pearson Education, Inc.

Sonderegger, A. (2013, September). Smart garments--the issue of usability and aesthetics. In *Proceedings of the 2013 ACM conference on Pervasive and ubiquitous computing adjunct publication* (pp. 385-392). ACM.

Sontag, M. S. (1985). Comfort dimensions of actual and ideal insulative clothing for older women. *Clothing and Textiles Research Journal*, *4*(1), 9-17.

Stokes, B., & Black, C. (2012). Application of the Functional, Expressive and Aesthetic Consumer Needs Model: assessing the clothing needs of adolescent girls with disabilities. *International Journal of Fashion Design, Technology and Education*, *5*(3), 179-186.

Suh, M., Carroll, K. E., & Cassill, N. L. (2010). Critical Review on Smart Clothing Product Development. *Journal of Textile and Apparel, Technology and Management*, *6*(4).

Sung, H., & Slocum, A. (2004). Golfers' intention to adopt UV specialized clothing as innovation based on Rogers theory. *Journal of the Korean Society of Clothing and Textiles*, *28*(12), 1554-1561.

Thomas, J. R., & Nelson, J. K. (1996). *Research Method in Physical Activity* (3rd ed.). Champaign, IL: Human Kinetics.

Treacy, M. (2012). Solar cell fibers could be woven into photovoltaic fabrics. Retrieved from http://www.treehugger.com/solar-technology/silicon-based-fibers-could-make-fabric-solar-cells.html

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management science*, *46*(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Vijayasarathy, L. R. (2004). Predicting consumer intentions to use on-line shopping: the case for an augmented technology acceptance model. *Information & Management*, *41*(6), 747-762.

Voigt, K. (2007, January 9). Smart fashion strive for long-distance interaction. *CNN*. Retrieved from http://edition.cnn.com/2007/TECH/ptech/01/08/wearable.digital/

Wang, X. C., & Liu, Z. (2010). Development of comfort solar clothing. *Advanced Materials Research*, *113*, 698-701.

World Commission on Environment and Development (1987). *Report of the world commission on environment and development: Our common future*. Retrieved from http://www.un-documents.net/wced-ocf.htm

Worsley, T., Wang, W.C. & Hunter, W. (2011). Baby boomers' reasons for choosing specific food shops. *International Journal of Retail & Distribution Management, 39*(11), 867-882.

Yan, R. N., Hyllegard, K. H., & Blaesi, L. F. (2012). Marketing eco-fashion: The influence of brand name and message explicitness. *Journal of Marketing Communications*, *18*(2), 151-168.

Yang, K., & Jolly, L. D. (2008). Age cohort analysis in adoption of mobile data services: gen Xers versus baby boomers. *Journal of Consumer Marketing*, *25*(5), 272-280.

Zou, D., Wang, D., Chu, Z., Lv, Z., & Fan, X. (2010). Fiber-shaped flexible solar cells. *Coordination Chemistry Reviews*, *254*(9), 1169-1178.

APPENDIX A: IRB HUMAN SUBJECT REVIEW

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 1/28/2014

To: Chanmi Hwang   CC: Dr. Eulanda Sanders
         31 MacKay Hall   31 MacKay
                                                     Te-Lin Chung
                                                     31 MacKay Hall

From: Office for Responsible Research

Title: Acceptance of Solar Powered Clothing: Comparative Analysis between Gen Y and Baby Boomers

IRB ID: 14-022

Study Review Date: 1/28/2014

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

- (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures with adults or observation of public behavior where
    - Information obtained is recorded in such a manner that human subjects cannot be identified directly or through identifiers linked to the subjects; or
    - Any disclosure of the human subjects' responses outside the research could not reasonably place the subject at risk of criminal or civil liability or be damaging to their financial standing, employability, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**

- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

  Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

  Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. **Only the IRB or designees may make the determination of exemption,** even if you conduct a study in the future that is exactly like this study.

Please be aware that **approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **An IRB determination of exemption in no way implies or guarantees that**

permission from these other entities will be granted.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

IRB ID: 14-022

INSTITUTIONAL REVIEW BOARD (IRB)

Exempt Study Review Form

RECEIVED

JAN 17 2014

By IRB

Title of Project: Acceptance of solar powered clothing: Comparative analysis between Gen Y and Baby Boomers

Principal Investigator (PI): Chanmi Hwang		Degrees: Bachelor of Science
University ID: 768135368	Phone: 419-410-9410	Email Address: chanmih@iastate.edu
Correspondence Address: 31 MacKay Hall		
Department: Apparel, Events, & Hospitality Management		College/Center/Institute: CHS/Iowa State University

PI Level: ☐ Tenured, Tenure-Eligible, & NTER Faculty ☐ Adjunct/Affiliate Faculty ☐ Collaborator Faculty ☐ Emeritus Faculty
☐ Visiting Faculty/Scientist ☐ Senior Lecturer/Clinician ☐ Lecturer/Clinician, w/Ph.D. or DVM ☐ P&S Employee, P37 & above
☐ Extension to Families/Youth Specialist ☐ Field Specialist III ☐ Postdoctoral Associate ☒ Graduate/Undergrad Student ☐ Other (specify:)

FOR STUDENT PROJECTS (Required when the principal investigator is a student)		
Name of Major Professor/Supervising Faculty: Eulanda A. Sanders		
University ID: 975161187	Phone: 294-7857	Email Address: sanderse@iastate.edu
Campus Address: 31 MacKay		Department: Apparel, Events, & Hospitality Management
Type of Project: (check all that apply)	☒ Thesis/Dissertation	☐ Class Project ☐ Other (specify:)

Alternate Contact Person: Telin Chung	Email Address: tdchung@iastate.edu
Correspondence Address: 31 MacKay Hall	Phone: 515-294-4022

ASSURANCE

- I certify that the information provided in this application is complete and accurate and consistent with any proposal(s) submitted to external funding agencies. Misrepresentation of the research described in this or any other IRB application may constitute non-compliance with federal regulations and/or academic misconduct.
- I agree to provide proper surveillance of this project to ensure that the rights and welfare of the human subjects are protected. I will report any problems to the IRB. See Reporting Adverse Events and Unanticipated Problems for details.
- I agree that modifications to the approved project will not take place without prior review and approval by the IRB.
- I agree that the research will not take place without the receipt of permission from any cooperating institutions when applicable.
- I agree to obtain approval from other appropriate committees as needed for this project, such as the IACUC (if the research includes animals), the IBC (if the research involves biohazards), the Radiation Safety Committee (if the research involves x-rays or other radiation producing devices or procedures), etc., and to obtain background checks for staff when necessary.
- I understand that IRB approval of this project does not grant access to any facilities, materials, or data on which this research may depend. Such access must be granted by the unit with the relevant custodial authority.
- I agree that all activities will be performed in accordance with all   ersity policies.

1/16/2014
Date

'/16/2014
y Date

(Required when the principal investigator is a student)

- I have reviewed this application and determined that departmental requirements are met, the investigator(s) has/have
, and the rese   merit.

1/16/14
Date

P

For IRB Use Only	☐ Not Research Per Federal Regulations	☐ No Human Participants	Review Date: 1/28/2014
	☑ Minima	EXEMPT Per 45 CFR 46.101(b): 2	
IRB Reviewer's Signature		1/28/2014	

Office for Responsible Research
Revised: 8/15/13

1

Exempt Study Information

Please provide *Yes* or *No* answers, except as specified. Incomplete forms will be returned without review.

Part A: Key Personnel

1. List all members and relevant qualifications of the project personnel and define their roles in the research. Key personnel include the principal investigator, co-principal investigators, supervising faculty member, and any other individuals who will have contact with the participants or the participants' data (e.g., interviewers, transcribers, coders, etc.). This information is intended to inform the committee of the training and background related to the specific procedures that each person will perform on the project. For more information, please see Human Subjects – Persons Required to Obtain IRB Training.

NAME	Interpersonal contact or communication with subjects, or access to private identifiable data?	Involved in the consent process?	Contact with human blood, specimens, or other biohazardous materials?	Other Roles in Research	Qualifications (i.e., special training, degrees, certifications, coursework, etc.)	Human Subjects Training Date
Chanmi Hwang	☒	☒	☐	Literature review, data collection and analysis	Graduate student; Human Subjects Training Certification Number: 969210	8/26/2012
Eulanda A. Sanders	☒	☒	☐	Supervising Faculty	PhD	1/14/2013
Telin Chung	☒	☒	☐	Supervising Faculty	PhD NIH Certification Number: 814801	12/05/2011
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			

	☐	☐	☐			
	☐	☐	☐			

Please complete additional pages of key personnel as necessary.

☐ Yes	☒ No	**2.**	**Does your study include children (persons under age 18) as research subjects?**
			If **Yes**, please read and respond to the following:
			ISU policy requires that background checks be completed for all researchers and key personnel who will have any contact with children involved in this research project. Details regarding this policy can be found here. **Principal Investigators and faculty supervisors are responsible** for ensuring that background checks are completed BEFORE researchers or key personnel may have any contact with children. Records documenting completion of the background checks must be kept with other research records (e.g., signed informed consent documents, approved IRB applications, etc.) and may be requested during any audits or Post-Approval Monitoring of your study.
	☐ Agreed	**2.a.**	Please check here to indicate that you have read this information and agree that you will comply with these requirements.

Part B: Funding Information and Conflicts of Interest

☐ Yes	☒ No	**1.**	**Is or will the project be externally funded?**
			If **No**, skip to question 8.
			If **Yes**, please identify the type(s) of source(s) from which the project is directly funded. ☐ Federal agency ☐ State/local government agency ☐ University or school ☐ Foundation ☐ Other non-profit institution ☐ For-profit business ☐ Other; specify: _____
☐ Yes	☐ No	**2.**	Is ISU considered to be the Lead or Prime awardee for this project?
☐ Yes	☐ No	**3.**	Are there or will there be any subcontracts issued to others for this project?
☐ Yes	☐ No	**4.**	Is or will this project be funded by a subcontract issued by another entity?

☑ Yes	☐ No	5.	If ISU is the recipient of the subcontract, does it involve any federal funding, such as federal flow-through funds?

6. If this project will be externally funded, please provide the complete name(s) of the funding source(s); please do not use acronyms. If any subcontracts will be issued to others, please describe and include a list of all entities.

☐ Attached	7.	Please attach a <u>complete and final copy</u> of the entire grant proposal or contract from which the project is or will be funded.

☐ Yes	☒ No	8.	Do or will any of the investigators or key personnel listed on this application have a conflict of interest management plan in place with the Office of the Vice President for Research & Economic Development?

Part C: General Overview

Please provide a brief summary of the purpose of your study:

The purpose of this study is to examine factors affecting consumers' attitudes and purchase intentions toward solar powered clothing. Specifically, the objectives of the study are to examine: (a) age differences in Gen Y and baby boomer consumers' attitude and purchase intention toward solar powered clothing, (b) consumers' perceived usefulness of solar powered clothing and how they influence attitude and purchase intention, (c) consumers' perceived ease of use of solar powered clothing and how they influence attitude and purchase intention, (d) consumers' perceived comfort of solar powered clothing and how they influence attitude and purchase intention, (e) consumers' perceived compatibility of solar powered clothing and how they influence attitude and purchase intention, (f) consumers' perceived aesthetic attributes of solar powered clothing and how they influence attitude and purchase intention, (g) consumers' perceived performance risk of solar powered clothing and how they influence attitude and purchase intention; and (h) how environmental concern influence attitude and purchase intention toward solar powered clothing.

This study provides important implications to both academia and industry. Due to the limited amount of research on the consumers' attitudes and purchase intentions of smart clothing, this study addresses the gap in the literature. Thus, it may provide directions for future research and a framework for technology integrated clothing. In addition, by providing insights on consumers' attitudes and purchase intentions, this study aids the future growth of development and promotion of solar powered clothing in apparel industry. It also presents important information to apparel retailers about the nature of Baby boomer and Gen Y consumers, which would help retailers devising strategies. Understanding factors affecting consumers' adoption of solar powered clothing is imperative in the light of increasing technology and sustainability movement in apparel industry.

Please provide a brief summary of your research design:

An online survey method will be used to collect data for the study. Prior to collecting data, a pretest will be conducted with 8-10 graduate students from the department of Apparel, Events, & Hospitality Management. They will receive an email asking them to voluntary participate for the pretest. After participating the web-based survey, they will be asked to assess the clarity of the questionnaire, survey length, and overall instructions for the survey. Based on the results of the pretest and feedbacks, the questionnaire will be edited.

For the data collection, a list of ISU student email addresses (both undergraduate and graduate) and ISU faculty email addresses will be bought from the ISU Registrar's Office. ISU students will receive an inviataion e-mail (Appendix A) and ISU faculty will receive an invitation e-mail (Appendix B) describing the study and containing consent elements and a link to a short web-based questionnaire (Appendix C) that will take about 10 minutes to complete. Only students fall into age range of Generation Y (age between 20-34 years old as of 2014) will be invited to participate on the study. For faculty, only people who fall into age range of Baby Boomers (age between 50- 68 years old as of 2014) will be invited to participate on the study. When students and faculty agree to participate, they will be asked questions about their perceived ease of use, perceived usefulness, perceived risks, perceived comforts, perceived aesthetics, attitudes, and purchase intentions toward solar powered clothing along with demographic information. After completing the questionnaire and clicking the 'Submit' button, the participants in this study will be invited to enter their names and email addresses for a drawing of four $15 gift cards. Participants' responses will never be linked to their names and their participation in the study will be voluntary.

* Appendices were removed — they are not included because the study is exempt. (illegible) 1/28/2014

Part D: Exemption Categories

☐ Yes	☒ No	1.	Are you conducting research on Educational Practices (e.g., instructional techniques, curriculum effectiveness, etc.)? If Yes, please answer questions 1a through 1e. If No, please proceed to question 2.
☐ Yes	☐ No	1.a.	Will the research be conducted in an established or commonly accepted educational setting, such as a classroom, school, professional development seminar, etc.?
☐ Yes	☐ No	1.b.	Will the research be conducted in any settings that would **not** generally be considered to be established or commonly accepted educational settings? If *Yes*, please specify: _____
☐ Yes	☐ No	1.c.	Will the research procedures and activities involve normal educational practices (e.g., activities that normally occur in the educational setting)? Examples include research on regular or special education instructional strategies or the effectiveness of instructional techniques, curricula, or classroom management methods.
☐ Yes	☐ No	1.d.	Will the research procedures include anything **other than** normal educational practices? If *Yes*, please specify: _____
☐ Yes	☐ No	1.e.	Will the procedures include randomization into different treatments or conditions, radically new instructional strategies, or deception of subjects? If *Yes*, please specify: _____

☒ Yes	☐ No	2.	Does your research involve use of educational tests, survey procedures, interview procedures, or observations of public behavior? If *Yes*, please answer questions 2.a. through 2.b. If *No*, please proceed to question 3.
☒ Yes	☐ No	2.a.	Will the research involve one or more of the following? (Check all that apply.)

☐ The use of educational tests (cognitive, diagnostic, aptitude, achievement)

☒ Surveying or interviewing adults
☐ Observations of public behavior* of adults
☐ Observations of public behavior* of children, when the researcher will not interact or intervene with the children

*Note: Activities occurring in the workplace and school classrooms are not generally considered to involve public behavior.

☐ Yes	☒ No	2.b.	Are all of the participants elected or appointed public officials or candidates for public office?

☐ Yes ☒ No **3.** Does the research involve the collection or study of *currently existing* data, documents, records, pathological specimens, or diagnostic specimens? If *Yes*, please answer questions 3.a. through 3.b. If *No*, please proceed to question 4.

☐ Yes	☐ No	3.a.	Are all of the data, documents, records, or specimens **publicly** available?
☐ Yes	☐ No	3.b.	Will the data you record for your study include ID codes? If *Yes*, please answer 3.b.(1) and 3.b.(2).

☐ Yes	☐ No	3.b.(1).	Does a "key" exist linking the ID codes to the identities of the individuals to whom the data pertains?
☐ Yes	☐ No	3.b.(2).	Will any persons on the research team have access to this key?

☐ Yes ☒ No **4.** Does your research involve Taste and Food Quality tests and Consumer Acceptance Studies involving food? If *Yes*, please answer questions 4.a. through 4.c. If *No*, please proceed to question 5.

☐ Yes	☐ No	4.a.	Is the food to be consumed normally considered wholesome, such as one would find in a typical grocery store?
☐ Yes	☐ No	4.b.	If the food contains additives, are the additives at or below the level normally considered to be safe by the FDA, EPA, or Food Safety and Inspection Service of USDA? Consider additives in commercially available foods found at a grocery store and/or any additives that are added to food for research purposes.
☐ Yes	☐ No	4.c.	If there are agricultural chemicals or environmental contaminants in the food, are they at or below the level found to be safe by the FDA, EPA, or Food Safety and Inspection Service of USDA?

☐ Yes ☒ No **5.** Is your study a research or demonstration project to examine
• **Federal** public benefit or service programs such as Medicaid, unemployment, social

security, etc.; or
- Procedures for obtaining benefits or service under these programs; or
- Possible changes in or alternatives to those programs or procedures; or
- Possible changes in methods or levels of payment for benefits or services under these programs?

☐ Yes ☐ No	**5.a.** If *Yes*, is the research or demonstration project pursuant to specific federal statutory authority?

Part E: Additional Information

☐ Yes ☒ No **6.** Does your research involve any procedures that do not fit into one or more of the categories in items #1–#5 listed above, such as the following? (Check all that apply.)

- ☐ Usability testing of websites, software, devices, etc.
- ☐ Collection of information from private records when identifiers are recorded
- ☐ Procedures conducted to induce stress, moods, or other psychological or physiological reactions
- ☐ Presentation of materials typically considered to be offensive, threatening, or degrading
- ☐ Video recording or photographing non-public behaviors
- ☐ Use of deception (e.g., misleading participants about the procedures or purpose of the study)
- ☐ Physical interventions, such as
  - ☐ blood draws
  - ☐ new collection of biological specimens
  - ☐ use of physical sensors (ECG, EKG, EEG, ultrasound, etc.)
  - ☐ exercise, muscular strength assessment, flexibility testing
  - ☐ body composition assessment
  - ☐ measuring of height and weight
  - ☐ x-rays
  - ☐ changes in diet or exercise
- ☐ Tests of sensory acuity (i.e., vision or hearing tests, olfactory tests, etc.)
- ☐ Consumption of food (other than as described in #4) or dietary supplements
- ☐ Clinical studies of drugs or medical devices
- ☐ Other; please specify: _____

☐ Yes ☐ No **6.a.** If *Yes*, is your research conducted in an established educational setting, **and** are the checked procedures part of normal educational practices given that setting? If *Yes*, please describe:
_____

☐ Yes ☒ No **7.** Do you intend or is it likely that your study will include any persons from the following populations? (Check all that apply.)

- ☐ Prisoners
- ☐ Cognitively impaired
- ☐ Children (persons under age 18)
- ☐ Wards of the State

☐ Persons who are institutionalized

7.a. If *Yes*, please describe how they will be involved and what procedures they will complete: ____

☐ Yes   ☒ No   8. Will any of the following identifiers be *linked to the data* at any time point during the research? (Check all that apply.)

    ☐ Names: ☐ First Name Only   ☐ Last Name Only   ☐ First and Last Name
    ☐ Phone/fax numbers
    ☐ ID codes that can be linked to the identity of the participant (e.g., student IDs, medical record numbers, account numbers, study-specific codes, etc.)
    ☐ Addresses (email or physical)
    ☐ Social security numbers
    ☐ Exact dates of birth
    ☐ IP addresses
    ☐ Photographs or video recordings
    ☐ Other; please specify: ____

☐ Yes   ☒ No   9. Is there a reasonable possibility that participants' identities could be ascertained from any combination of information in the data? If *Yes*, please describe: ____

☒ Yes   ☐ No   10. Will participants' identities be kept confidential when results of the research are disseminated?

☐ Yes   ☒ No   11. Could any of the information collected, if disclosed outside of the research, reasonably place the subjects at risk of any of the following? (Check all that apply.)

    ☐ Criminal liability
    ☐ Civil liability
    ☐ Damage to the subjects' financial standing
    ☐ Damage to the subjects' employability
    ☐ Damage to the subjects' reputation

☐ Yes   ☒ No   12. Does the research, directly or indirectly, involve or result in the collection of any information regarding any of the following? (Check all that apply.)

    ☐ Use of illicit drugs
    ☐ Criminal activity
    ☐ Child, spousal, or familiar abuse
    ☐ Mental illness
    ☐ Episodes of clinical depression
    ☐ Suicidal thoughts or suicide attempts
    ☐ Health history
    ☐ History of job losses
    ☐ Exact household income other than in general ranges
    ☐ Negative opinions about one's supervisor, workplace, teacher, or others to whom the subject is in a subordinate position
    ☐ Opinions about race, gender, sexual orientation, or any other socially sensitive or controversial topics
    ☐ Sexual preferences or behaviors
    ☐ Religious beliefs
    ☐ Any other information that is generally considered to be private or sensitive

given the setting of your research; if so, please specify: _____

After completion of Parts A, B, and C of this application, please send the completed form to:

Institutional Review Board (IRB)
Office for Responsible Research
1138 Pearson Hall
Ames, IA 50011-2200

Data collection materials (e.g., survey instruments, interview questions, recruitment and consent documents, etc.) do not need to be submitted with this application.

If you have any questions or feedback, please contact the IRB office at IRB@iastate.edu or 515-294-4566.

APPENDIX B: INVITAION LETTERS

Invitation for the Study on Solar-Powered Clothing.

Dear ISU Faculty:

You are invited to participate in a research study, Acceptance of solar-powered clothing: Comparative analysis between Gen Y and Baby Boomers, by **completing a 10-minute survey**. The study examines consumer attitudes and purchase intentions toward solar-powered clothing. This study was approved by the Institutional Review Board at Iowa State University (IRB ID: 14-022).

You can participate in this research only if you are born between the years **1946 and 1964** (age 50- 68 as of 2014).

If you agree to participate, you will be asked to complete a short survey regarding your attitude and purchase intention toward solar-powered clothing as well as some basic demographics. As an appreciation for your time, you can enter a **drawing of 3 $15 Caribou Coffee gift cards**. There are no foreseeable risks from participating in this study. Your participation is voluntarily, and you may choose to withdraw at any time. Your survey responses will be anonymous, confidential and will NOT be linked to your name and email if you decide to participate in the drawing. You may skip any question you do not feel comfortable answering.

Please feel free to ask any questions at any time. For further information about the study contact Chanmi Hwang, chanmih@iastate.edu, or Dr. Eulanda A. Sanders, sanderse@iastate.edu. If you have any questions about the rights of research subjects, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office of Research Assurances, 1138 Pearson Hall, Iowa State University, Ames, Iowa 50011.

By clicking the survey link below, you agree to participate in this research study:
https://iastate.qualtrics.com/SE/?SID=SV_7X6Wk1VxkfdEKtT

Your efforts in participating in this research project are deeply appreciated.

Sincerely,

Chanmi G. Hwang, Masters Student
Apparel, Merchandising, and Design Program
Dept. of Apparel, Events, and Hospitality Management
MacKay Hall 31
Iowa State University
Ames, Iowa, 50011
Email: chanmih@iastate.edu

Invitation for the Study on Solar-Powered Clothing.

Dear ISU Student:

You are invited to participate in a research study, Acceptance of solar-powered clothing: Comparative analysis between Gen Y and Baby Boomers, by **completing a 10-minute survey**. The study examines consumer attitudes and purchase intentions toward solar-powered clothing. This study was approved by the Institutional Review Board at Iowa State University (IRB ID: 14-022)

You can participate in this research only if you are born between the years **1980 and 1994** (age 20-34 as of 2014).

If you agree to participate, you will be asked to complete a short survey regarding your attitude and purchase intention toward solar-powered clothing as well as some basic demographics. As an appreciation for your time, you can enter **a drawing of 3 $15 Caribou Coffee gift cards.** There are no foreseeable risks from participating in this study. Your participation is voluntarily, and you may choose to withdraw at any time. Your survey responses will be anonymous, confidential and will NOT be linked to your name and email if you decide to participate in the drawing. You may skip any question you do not feel comfortable answering.

Please feel free to ask any questions at any time. For further information about the study contact Chanmi Hwang, chanmih@iastate.edu, or Dr. Eulanda A. Sanders, sanderse@iastate.edu. If you have any questions about the rights of research subjects, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office of Research Assurances, 1138 Pearson Hall, Iowa State University, Ames, Iowa 50011.

By clicking the survey link below, you agree to participate in this research study:
https://iastate.qualtrics.com/SE/?SID=SV_7X6Wk1VxkfdEKtT

Your efforts in participating in this research project are deeply appreciated.

Sincerely,

Chanmi G. Hwang, Masters Student
Apparel, Merchandising, and Design Program
Dept. of Apparel, Events, and Hospitality Management
MacKay Hall 31
Iowa State University
Ames, Iowa, 50011
Email: chanmih@iastate.edu

APPENDIX C: SURVEY QUESTIONNAIRE

Solar-powered clothing are innovative, technology-integrated products that uses solar cell as an alternative energy source to generate electricity to power small portable devices. Please review the following information page about solar-powered clothing carefully before answering survey question.

Image Sources:
(kolon.com)
(scottevest.com)
(zegna.com)
(blog.naver.com/PostView.nhn?blogId=mistyluv78&logNo=130 135449956)

If you need to refer to this information page again, a link [click to review image1] will be available at the top of each page throughout the survey. The information page will open in a new window for you to view it.

Ready to go to the next page.

1   Yes

2 No

This section is to understand **your opinions about wearing/using solar-powered clothing.**

Please indicate your degree of agreement or disagreement with the statements shown below.							
	Strongly Disagree			**Neutral**			**Strongly Agree**
The use of solar-powered clothing is clear and understandable.	1	2	3	4	5	6	7
Using solar-powered clothing would not require a lot of mental effort.	1	2	3	4	5	6	7
Overall, I find solar-powered clothing easy to use.	1	2	3	4	5	6	7
Wearing solar-powered clothing would improve the quality of my life.	1	2	3	4	5	6	7
Wearing solar-powered clothing would increase my productivity.	1	2	3	4	5	6	7
Overall, I find solar-powered clothing useful.	1	2	3	4	5	6	7

Please indicate your degree of agreement or disagreement with the statements shown below.							
	Strongly Disagree			**Neutral**			**Strongly Agree**
This product would coordinate well with the other clothing I own.	1	2	3	4	5	6	7
This product would be more compatible with my current needs than clothing I already have.	1	2	3	4	5	6	7
This product would be appropriate for my lifestyle.	1	2	3	4	5	6	7

Please indicate your response by clicking the number that best describes your opinion.

Wearing this product would be _____.

Uncomfortable	1	2	3	4	5	6	7	Comfortable
Rigid	1	2	3	4	5	6	7	Flexible
Difficult to move in	1	2	3	4	5	6	7	Easy to move in
Heavyweight	1	2	3	4	5	6	7	Lightweight

Please indicate your response by clicking the number that best describes your opinion.

How confident are you that the product/ clothing will perform as described?

Not confident at all	1	2	3	4	5	6	7	Very confident

How certain are you that the product/ clothing will work satisfactorily?

Uncertain	1	2	3	4	5	6	7	Certain

Do you feel that the product/ clothing will perform the functions that were described in the information page?

Do not feel sure	1	2	3	4	5	6	7	Do feel sure

This section is to understand your **opinions about design features of solar-powered** clothing. Please review the following image that shows various design features of solar-powered clothing.

Image sources:
(scottevest.com), (zegna.com), (silvrlining.com).

Please indicate your degree of agreement or disagreement with the statements shown below.

	Strongly Disagree			Neutral			Strongly Agree
The appearance of the solar panels is aesthetically appealing to me.	1	2	3	4	5	6	7
The designs of the clothing are aesthetically appealing to me.	1	2	3	4	5	6	7
The overall style of solar-powered clothing is appealing to me	1	2	3	4	5	6	7

This section is to understand your **thoughts concerning environmental issue.**

Please indicate your degree of agreement or disagreement with the statements shown below.

	Strongly Disagree			Neutral			Strongly Agree
I think environmental problems are very important.	1	2	3	4	5	6	7
I think environmental problems cannot be ignored.	1	2	3	4	5	6	7
I think we should care about environmental problems.	1	2	3	4	5	6	7

This section is to understand your **opinions about purchasing solar-powered clothing.**

Please indicate your response by clicking the number that best describes your opinion.

Purchasing solar-powered clothing is _____.

Bad	1	2	3	4	5	6	7	Good
Unfavorable	1	2	3	4	5	6	7	Favorable
Foolish	1	2	3	4	5	6	7	Wise

Please indicate your degree of agreement or disagreement with the statements shown below.

	Strongly Disagree			Neutral			Strongly Agree
I intend to try this type of product.	1	2	3	4	5	6	7
It is likely that I will buy this product when it becomes available.	1	2	3	4	5	6	7
I would purchase this product.	1	2	3	4	5	6	7

Open-ended questions:

Q. What are your major concerns about adopting solar-powered clothing?

Q. What would be the major benefits for you about adopting solar-powered clothing?

The following questions will help us gain a better understanding of you as a participant in this study. Your information will remain completely confidential.

1. What is your gender?
a) Female
b) Male

2. What year were you born? _____

3. What ethnic group(s) do you consider yourself to be a member of? Please check all that apply.

a) White/European American   d) African American/Black
b) Native Hawaiian and Other Pacific Islander   e) Asian
c) American Indian/Alaska Native   f) Hispanic American or Latino
g) Other? (please specify)_____

4. What is the level of your education currently?
a) High school graduate, diploma or the equivalent
b) Associate degree
c) Bachelor's degree
d) Maters degree
e) Doctoral degree

5. Which college are you currently affiliated with? Check all that applies
a) College of Agriculture and Life Sciences   e) The Graduate College
b) College of Business   f) College of Human Sciences
c) College of Design   g) College of Liberal Arts and Sciences
d) College of Engineering   h) College of Veterinary Medicine
I) other, please specify _____

6. What is your yearly personal income?
a) Less than $3,000
b) $3,000 to $10,000
c) $10,000 to $25,000
d) $25,000 to $50,000
e) $50,000 to $75,000
f) $75,000 to $100,000
g) More than $100,000
h) Choose not to answer

7. Have you heard of solar-powered clothing before?
a) Yes
b) No

If you would like to be considered for three $15 gift cards drawing, please enter your name and email address.

(This information will be kept separate from survey results to ensure your anonymity.)

If you wish to skip the drawing entry, leave the boxes blank and click the "Submit" button below
First Name:
Last Name:
Email Address:

Your contribution to this research is greatly appreciated.
THANK YOU FOR YOUR PARTICIPATION!