TRUST IN INTERNET OF THINGS TECHNOLOGY:

WEARABLE FITNESS DEVICES

by

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ABSTRACT

This study focused on the role of trust in the Internet of Things (IoT) technology and how the relationships between different trust attitudes affect consumers. Specifically, this research explored trust and trust-related behaviors in the context of wearable fitness devices. Previous research has shown the importance of trust in technology adoption but other trust-related behaviors such as trusting beliefs, trusting intentions, and manufacturer trusting perceptions were not studied in depth. Therefore, this study has developed several hypotheses concerning the relationships between these trust attitudes toward wearable fitness devices. All the hypotheses were confirmed. The study concluded that general trust, trusting beliefs, trusting intentions, and manufacturing trusting perceptions were correlated and influenced one another in the case of wearable fitness devices. The study also revealed interesting insights into the difference between Apple Watch owners and Fitbit owners. In general, there were stronger correlations between these trust attitudes for Apple Watch owners. Future studies can adopt a comparison between different fitness tracker brands to learn more about consumers' behaviors while studying wearable fitness devices. Overall, this study brings new insights into understanding consumers' trust attitudes and helps manufacturers design marketing strategies and develop products that focus on the consumer's interests and requirements.

INTRODUCTION

The Internet of Things (IoT) has been around since the late 20th century but it is not until recently that more applications entered the market, for example, smart home, smart city, connected car, smart grid, and wearables to name a few. Among these applications, wearable fitness device is more popular with consumers because of its affordability and mobility. Wearable fitness devices can be worn by consumers to track information related to health and fitness. IoT wearable fitness devices contain small motion sensors to collect and sync data with other connected devices such as smartphones, laptops, cameras, etc. Data gathered from the wearable devices is transmitted to the cloud via the Internet. According to IDTechEx Research, there will be exponential growth in the adoption of IoT wearable devices in the upcoming years (Clerck, 2019). The growth will be most significant from 2020 to 2023, with an average annual rate of 23%. Specifically, wearable fitness devices as a subset of IoT wearables are expected to increase from 41% of total wearables shipments in 2016 to 52.1% in 2020 (Clerck, 2019).

The rapid diffusion of IoT technology promises a future of the Internet. IoT can create an ecosystem of connected devices with higher speed, higher ease of use, and real-time information. There have been many studies and theories used to explain the adoption and diffusion of IoT technology in recent years. Among theories presented, the technology acceptance model (TAM) is one prominent information systems theory that proposes how users accept and adopt the technology. The TAM has been continuously studied and upgraded but its original version focuses on the user's attitude, one's general impression of the technology, which in turn influences one's behavior. Specifically, two main components are used to explain and predict users' intention to adopt in the TAM including perceived ease of use and perceived usefulness (Davis et al., 1989). In later studies, numerous external variables are introduced to explain

further the notion of technology adoption and diffusion. However, one variable that was not emphasized enough in recent research is trust. Understanding the role of trust is important to comprehend how users come to accept and adopt new technologies. Especially in today's context and in the case of IoT, trust is even more important. IoT environment has been widely known as an ecosystem of connected things. Everything connects and the devices all collect and share users' data. The new infrastructure not only creates many opportunities and applications, but it also creates many privacy and security issues. According to Help Net Security (2018), 64% of people use their connected devices daily to check important personal information regarding health, home, and news. Nearly 40% of users say that access to important information is the primary use of their connected devices. Therefore, breach of personal data and invasion of privacy from these connected devices can cause anxiety and distrust among users, resulting in lower intention to use IoT connected devices in the future. To improve IoT technology adoption, trust needs to be studied thoroughly.

This paper is primarily concerned with trust as a variable in the TAM that predicts how users accept and use the IoT technology, specifically wearable fitness devices. Specifically, the study examines the correlation between consumers' trust and intention to adopt IoT wearable fitness devices. Nowadays, trust is an important factor in the buying decision process for technology gadgets as security risks and breach of personal data have been posing threats to our society. One incident regarding this issue is the case of Amazon Alexa, a cloud-based virtual assistant capable of controlling smart home devices and interacting with humans. The virtual assistant was charged with overhearing the family's conversations then sent them to a business associate (Weise, 2018). In 2018, one Portland family's conversation was recorded by Amazon Echo and sent to a contact of the father (Weise, 2018). These incidents sparked the concerns of many

Amazon Echo's users as well as owners of other virtual assistants such as Siri, Google Home, etc. While voice service is one of the appliances that IoT wearable fitness devices might possess, security threats can come in many forms when using these devices. All the threats challenge users' trust and confidence in adopting new technology. Especially, in the early stage of introduction, these inherent risks can even cause the rejection from users to these devices, if the trust is not established initially. This research will provide a better understanding of IoT wearable fitness devices and the relationship between trust and the intention to adopt this new technology. The results obtained will assist further research in IoT and Technology Acceptance Model and provide the background for improving wearable fitness device adoption.

The remainder of this paper includes a literature review on the Technology Acceptance Model, the role of trust in the TAM, and trust in IoT wearable fitness followed by the research hypotheses and methodology. There is a survey involved in this study and the detailed questionnaires are included in the references. The survey is conducted at Texas Christian University to gather information from different groups of participants. Participants in this survey are restricted to students, faculty, and staff members to conclude trust in IoT wearable fitness and its effects on people's intention to adopt this technology. This paper concludes with the survey data analysis, conclusions, limitations, and implications for future research.

LITERATURE REVIEW

The Internet of Things (IoT) and Wearable Fitness Devices

The term "Internet of Things" was first brought to life by Kevin Ashton in 1999 during his work at Procter&Gamble (Ashton, 2009). IoT can be used to describe a system of devices, machines, and objects connected to the Internet, which communicate with one another without the interference of humans. The IoT paradigm has gained significant attention in recent years because of all the potential applications and the unlimited power that the technology can bring. An all connected world or an ecosystem of connected devices, machines, and humans are no longer a concept; it has become a reality. People believe that IoT can bring substantial changes to the way we live, work, and play right now. IoT is one of the essential components that build up the digital transformation to traditional industries. By 2020, nearly 50 billion IoT devices will be connected and with this massive deployment, IoT will be able to make significant impacts in bettering the world's economy and raising people's standards of living (Evans, 2011).

Some common applications of IoT systems can be seen in smart homes, healthcare, transportation, manufacturing, and energy management. Especially, within the consumer applications, smart home appliances have gained more popularity with the examples of smart speakers, smart lights, robot vacuum, smart locks, video doorbells, smart HVAC (Heating, Ventilation, and Air Conditioning) system to name a few. These home appliances can be controlled by applications on residents' mobile devices from far away with the aid of wireless sensors and networks.

Another subset of the consumer sector that also has recently gained a lot of popularity and will be discussed in detail in this paper is the wearable fitness device. Wearable fitness devices can be

defined as small hardware worn as accessories to human bodies. These devices are equipped with sensors that track and monitor fitness metrics such as distance walked, number of steps, heart rate, calories consumed, hours of sleep, etc. Users can check real-time feedback from the trackers to understand their health conditions and become more active in their daily lives. One popular example of a wearable fitness tracker is Fitbit. Fitbit is an American company headquartered in San Francisco, producing consumer wearable devices that track data of an individual's health. Fitbit also offers a website and mobile app for iOS, Android, and Windows phones to sync data from the tracker to the user's phone. There is also a social component in the mobile apps that encourages users to challenge themselves and compare their fitness metrics with friends and family via the app's community page. Another notable example in this IoT category is the Apple Watch, also studied in this research. Apple Watch belongs to the smartwatch category but its fitness tracker component still falls under the wearable fitness category. Apple Watch is designed, developed, and marketed by Apple Inc., which includes fitness tracking and healthcare-oriented capabilities supported by iOS and other Apple's applications. According to S&P Global, smartwatches have been the primary growth driver in the wearable technology market: "the integration of fitness and wellness capabilities into new smartwatch models is attracting new buyers who previously would have purchased a lower-priced fitness tracker product" (Paxton, 2019). One primary distinction between Apple Watch and Fitbit is the required pairing between Apple Watch and iPhone, Apple's smartphone, while Fitbit can be paired with any other devices which give users of this brand more freedom to choose a smartphone.

The nature of these two products relies heavily on wireless connections to other devices such as mobile phones via Bluetooth or WiFi to make the most use out of these devices. Initially, to set

up wearable fitness devices, one has to create an account with Fitbit/Apple Watch and agree to data collection, transfer, and privacy rules. In June 2011, Fitbit was criticized for the default setting that enabled the activity-sharing function to be available for public viewing. One's physical activities could be shared automatically and publicly without his/her awareness of the default setting on the Fitbit tracker. Data collected from these trackers/smartwatches is stored in the mobile app and shared with developers and manufacturers. Hence, the system provides feedback and recommendations based on the user's goals and real-time data. This is where privacy and security concerns arise. First, there is the threat of breaching of user information, especially when wearable fitness devices store sensitive personal data such as personally identifiable data, fitness data, payments data (in the case of Apple Watch), and even locations of the user (GPS-enabled devices). The information can be used against the user of the device. Second, since these devices connect to a network, sharing information with other devices and manufacturers, they are vulnerable to all cyber threats. Most of the communications between devices are wireless, making eavesdropping and hacking rather simple.

Improving wearable IoT technology adoption through a study of Technology Acceptance Model (TAM)

Inherent risks and challenges in the IoT environment are inevitable but there are still ways to improve the adoption of this technology if user's behaviors and motivations are understood thoroughly. Understanding the way people perceive IoT and the variables that affect users' final decision to adopt the technology can improve the IoT adoption rate and make new technologies more prevalent in the future. Among all the theories that cover the topic of technology adoption,

Technology Acceptance Model (TAM) has proven to be one of the most notable theories that explain the nature of user's technology adoption (Davis et al., 1989). TAM by Davis, Bagozzi, and Warshaw is a powerful extension of Fishbein and Ajzen's theory of reasoned action (TRA) in 1967 (Venkatesh & Davis 2000). TRA is a theory in social psychology that aims to explain the connection between human attitudes and behaviors. It is mainly used to predict how a person will react to a situation based on his/her pre-existing attitudes and behavioral intentions. TAM puts more focus on the intention to adopt new technology based on the previous work in TRA. TAM expands the theory to include perceived usefulness, perceived ease of use, and external variables, which are particularly applicable for the field of information technology. Perceived ease of use refers to "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived usefulness is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis 1989).

While perceived usefulness describes the expected performance of new technology, perceived ease of use indicates the level of effort one has to put into the new technology to use it. Other factors that also affect the TAM are external variables such as gender, culture, education, social status, etc.

Often, the external variables are not the major points in research regarding the TAM. However, there have been updates to the original TAM model, resulting in TAM2 and TAM3. TAM2 was tested using four longitudinal field studies, concluding that social influence and cognitive instrumental processes can significantly influence user acceptance (Venkatesh & Davis 2000). With the second update, Venkatesh and Davis examined social influence and cognitive instrumental processes concerning perceived ease of use and perceived usefulness instead of

studying them as independent variables. It was not until TAM3 that trust was mentioned as a considerable factor and studied more in-depth. TAM3 has been proposed in the context of e-commerce with additional research on the effects of trust and perceived risk on the system use (Venkatesh & Bala 2008). This latest TAM theory update has brought attention to trust, the variable that was neglected previously, but relevant not only in the context of e-commerce but also in the content of other IT environments. As discussed, the IoT environment possesses a lot of inherent risks and challenges which can steer people away from adopting the technology, and one possible way to tackle these issues is to reinforce trust among users.

Role of trust in the adoption of IoT

Not surprisingly, trust was not a factor in the original model and it only has become relevant in today's world of information systems when data sharing and privacy issues also became prevalent. Specifically, in this study, the notion of trust refers to the belief, confidence, and reliance that one has in the IoT system (Kini & Choobineh, 1998). For example, if the user trusts his/her IoT wearable fitness device, he/she will believe in the information being presented by the device, act upon it, and feel certain that the device will do no harm but only act in the interest of its owner. There will be three types of trusting behavior discussed in this paper: trusting belief, trusting intention, and trusting perception (Sharma & Biros, 2019). Each type will be defined clearly in the research hypotheses section.

According to i-scoop (2018), trust has hit an all-time low, and distrust was poised to hit a high level. As a sector, technology enjoys the highest level of trust with 76% of survey participants said that they trusted in technology. But warning signs are clear that trust can also be lost rapidly. According to the World Economic Forum, with the pace of technological changes, innovation,

digital transformation, and automation, people are raising concerns about the future of technology.

Notable examples of consumer trust and technology integrity come from the success of the peer-to-peer (P2P) business model. In a sharing economy, transactions are made possible with heavy support of technology. The definition of trust is expanded to include trust in technology in addition to interpersonal trust between individuals involved in a transaction. Trust in a sharing economy is no longer just the trust between buyers and sellers but also the trust in the vehicles or instruments that made that transaction feasible. It is the trust in technology that helps deliver the contract between two parties. Technological trust is the belief that technology is supportive of one's goals in situations where the user cannot have complete knowledge (Lee and See, 2004). Alternatively, it is the extent a user is willing to act on recommendations of a system (Madsen and Gregor, 2000). With consumers owning more and more IoT devices and especially a market size of 212 billion U.S. dollars by the end of 2019, the adoption rate for this technology is increasing rapidly and substantially.

Trust in IoT wearable fitness devices

The most common implementations of IoT wearable are fitness devices including smartwatches and activity trackers. Wearable fitness devices are worn all the time to best monitor a user's physical activity. These devices utilize a sensor to gather information regarding user's blood pressure, heart rate, temperature, walking distance, etc. Trust behaviors in IoT wearable fitness devices can be seen as actions to make one vulnerable to the device and organization associated with it (Mayer et al. 1995). These actions include sharing personal data, monitoring health data, following the device's recommendations. Before using wearables, the device asks for the user's

data to better monitor his/her health and suggest suitable recommendations based on gender, age, and personal goals. A wearable can be connected to the user's phone or laptop to store and share real-time information. Some devices even go further with recommendations to adjust a user's diet, exercises, and sleeping habits.

Nowadays, obesity and lack of physical activity pose a severe health concern for Americans. According to the American Diabetes Association, nearly two-thirds of adult Americans are overweight or obese (Marks, 2004). Wearable fitness devices seem to be a great solution to these threats, but consumers are abandoning this technology soon after purchase. The reason behind this usage pattern is not the main purpose of this study but the decision to adopt these wearable fitness devices in the first place. Some literature suggests that trust motivates a user's behavioral intention to adopt and continue using IoT fitness technology. Technology trust or distrust is developed through direct experience and use and is influenced by the design of the technology (Hoff & Bashir, 2014). Specific design considerations for wearable fitness devices include the degree that a device safeguards privacy and health data (Ziefle, Röcker, & Holzinger, 2011), how valid or accurate the system is (Merritt, 2011; Meyers et al., 2015) as well as how consistent or reliable it is (Madsen & Gregor, 2000; Merritt, 2011). A study found that reliability, validity, and system capability were strongly correlated with each other but not so strongly correlated to be collapsed into the same factor (Rupp et al., 2016). In other research, trust and motivation along with usability and wearability were all core themes that directly affect user's experience of wearable fitness technology (Rupp et al., 2018). This study focuses on the role of trust with an emphasis on IoT wearable fitness devices. It examines the effect of trust on participants' perceptions of Apple Watch, Fitbit, or other wearable fitness devices.

RESEARCH METHODS

Research model

The survey used in this research will study the correlation between four concepts: General trust, trusting beliefs, trusting intentions, and manufacturer trusting perceptions. The researcher applies the research model presented in Figure 1 below.

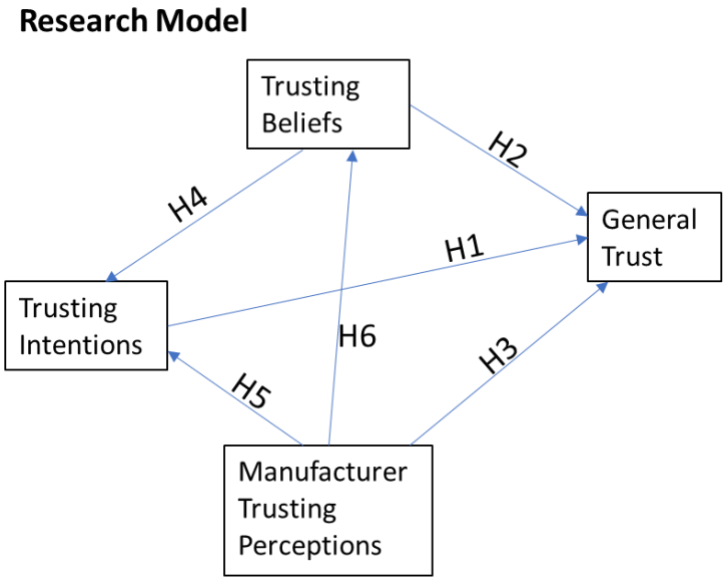

Figure 1. Research Model

There are numerous IoT wearable brands and products in the market, but this study focuses on Fitbit and Apple Watch as these two provide more ample survey opportunities. Multiple hypotheses below test the relationship between four concepts. Each hypothesis includes two domain hypotheses to test the difference between Apple Watch owners and Fitbit owners.

Research hypotheses

The study examines Apple Watch as a wearable fitness device by covering only the fitness components in the questionnaires. Other applications such as messaging, calling, map/GPS, etc. are not discussed in this study and the survey restricts all four concepts mentioned above in Apple Watch to only health and fitness. Similarly, general trust, trusting belief, trusting intention, and manufacturer trusting perception in Fitbit examined in this study only cover the fitness trackers.

H1: Higher Trusting Intentions will lead to the higher General Trust for wearable fitness devices

- **H1A: Higher Trusting Intentions will lead to the higher General Trust for Apple Watch owners**
- **H1B: Higher Trusting Intentions will lead to the higher General Trust for Fitbit owners**

General trust refers to the confidence and reliance that the user has when using wearable fitness devices. Mayer et al. (1995) defined trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectations that the other party will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party."

Trusting intentions refer to the willingness to depend, or intention to depend, on the wearable devices (Sharma & Biros, 2019). McKnight, et al., (2002) defined two sub-constructs of trusting intentions: willingness to depend, and the subjective probability of depending. An example of willingness to depend can be seen in a user who regularly checks his/her steps on an activity

tracker and intentionally walks further to achieve the goal suggested by the device. A user who has a subjective probability of depending on the device will share his/her information with the provider of these devices when asked. For example, before using a smartwatch, the user will share his/her age, gender, height, weight, etc. within the device. This study is going to explore if there is a difference between Apple Watch and Fitbit.

H2: Higher Trusting Beliefs will lead to the higher General Trust for wearable fitness devices

- **H2A: Higher Trusting Beliefs will lead to the higher General Trust for Apple Watch owners**
- **H2B: Higher Trusting Beliefs will lead to the higher General Trust for Fitbit owners**

Trusting beliefs refer to the confidence that the user places on wearable devices to deliver reliable information and results (Sharma & Biros, 2019). The user believes that these devices possess necessary attributes to be able to give accurate recommendations and therefore bring value to users. In other words, if the user has trusting beliefs in a wearable fitness device, he/she is confident that the device is reliable and competent in handling his/her interactions with it. In the case of IoT wearable devices, a user who has high trusting beliefs will display expectations that the devices will report accurate health data such as heartbeat, steps walked, sleep quality, etc and give accurate recommendations such as increase or decrease certain physical activities. Trusting belief is the very first behavior that the user might experience when introduced to a new wearable device. This study is going to explore if there is a difference between Apple Watch and Fitbit.

H3: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for wearable fitness devices

- **H3A: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for Apple Watch owners**
- **H3B: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for Fitbit owners**

Manufacturer trusting perceptions refer to the brand image or brand loyalty that user has regarding the manufacturers of wearable fitness devices (Rupp et al., 2018). Different from trusting intentions or trusting beliefs, which are directly related to the wearable devices, trusting perceptions concern the bigger entities behind these products. Trust builds brand loyalty and brand loyalty creates prejudice. Consumers sometimes purchase a wearable device because of the brand but not necessary because of the device itself. When manufacturers consistently produce high-quality products and great customer satisfaction over time, they create brand loyalty and value for their brand image. These brands can also transfer these trusting perceptions to wearable fitness devices they produce. This study is going to explore if there is a difference between Apple Watch and Fitbit.

H4: Higher Trusting Beliefs will lead to higher Trusting Intentions for wearable fitness devices

- **H4A: Higher Trusting Beliefs will lead to the higher General Trust for Apple Watch owners**
- **H4B: Higher Trusting Beliefs will lead to the higher General Trust for Fitbit owners**

People with high trusting beliefs are confident that the device is reliable and competent in handling their interactions with it. This confidence in the device's accuracy and reliability can potentially lead to a higher willingness to depend on the device. This hypothesis is used to test the correlation between trusting beliefs and trusting intentions. This study is also going to explore if there is a difference between Apple Watch and Fitbit owners in this aspect.

H5: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Intentions for wearable fitness devices

- **H5A: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for Apple Watch owners**
- **H5B: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for Fitbit owners**

Manufacturer trusting perceptions can be found among people who are loyal to certain brands and make their buying decisions based on the brands/manufacturers rather than the product itself. An impeccable reputation that a manufacturer possesses can potentially lead to higher confidence and intention to depend on the product. In this study, the correlation between manufacturer trusting perceptions and trusting intentions will be explored. The difference between Apple and the Fitbit brand name will also be studied.

H6: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Beliefs for wearable fitness devices

- **H6A: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Beliefs for Apple Watch owners**

- **H6B: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Beliefs for Fitbit owners**

Brand reputation can potentially influence the user's confidence in the device. In the case of a wearable fitness device, the user who is loyal to certain health/fitness brand might be more confident using the products of that brand and relying on the recommendations that the device suggests. The reputation that manufacturers of any wearable fitness device have regarding information privacy and security might play an important role in user confidence in sharing their data. In this study, the correlation between manufacturer trusting perceptions and trusting beliefs will be explored. The difference between Apple and Fitbit will also be studied.

Methodology

The study surveyed college students and faculty through an online Qualtrics survey platform at Texas Christian University (TCU). The survey assessed the various dimensions of user trust of IoT wearable fitness devices. Participants were restricted to the TCU population and they received the survey via emails. The email template included the purpose of the research, participant involvement, research expectations, benefits/risks (if any), data privacy, confidentiality, and contacts of the investigators. In the survey, there was a mandatory consent form to make sure that involvement in this research was voluntary. The estimated time to complete the survey was 5 minutes.

The survey was composed of four sections. In the first section, general questions regarding wearable fitness device ownership were asked. This section was useful to segment the pool of participants between wearable fitness device owners and non-owners. The second part of the

survey included general trust questions. In the third part, participants were asked to rate their agreement with six statements, which were associated with three concepts presented in this study: trusting belief, trusting intention, and manufacturer perception. The last section of the survey included demographic questions to further segment the data and compare the respondents.

The general trust questions were constructed using questionnaires from previous research on the trust-building process in an IoT based wearable platform (Sharma & Biros, 2019) and the impact of technological trust on the intention to use wearable fitness devices (Rupp et al., 2016). The questions for determining general trust in the primary wearable fitness device started with "I believe…" and include statements such as "my primary wearable fitness device would act in my best interest," "…can always be trusted," "… is competent and effective in handling all my daily interactions" (Sharma & Biros, 2019).

The trusting intentions questions were constructed using questionnaires from the Wearable Technology Trust scale (Rupp, 2016). Specifically, the survey asked participants to rate their agreement with the following statement from 1 (not at all) to 7 (very much): "My primary wearable fitness device brings me closer to my health/fitness goals." This statement was used to test the user's willingness to depend on the device to achieve his/her fitness goals, which is one of two components of trusting intentions. Also, participants were asked to rate their agreement with the statement: "I follow my primary wearable fitness device's instructions to achieve my health/fitness goals." This statement was modified from the Wearable Technology Motivation scale (Rupp, 2018) to test the user's willingness to act upon the device's recommendations, which is another component of trusting intentions. The original statement used in previous

research was “Using this device, I can be successful creating physical activity and health goals.” By changing from the indirect object “can be successful creating” to direct object “follow…instructions,” the statement emphasizes the user’s trusting intentions.

Trusting belief questions were constructed using questionnaires from both the Wearable Technology Trust scale and the Wearable Technology Motivation scale (Rupp, 2016). Specifically, the survey asked participants to rate their agreement with the following statements from 1 (not at all) to 7 (very much) for statements such as: “My primary wearable fitness device is consistent over time” and “the health information being displayed on my primary wearable fitness device is correct.” These questions intend to test the user’s confidence in the device’s reliability and competence, which are the components of trusting beliefs.

The manufacturer trusting perceptions were constructed using questionnaires from the Wearable Technology Motivation scale and Wearable Technology Trust scale (Rupp, 2016).
The classifying trusting questions were adopted from the Wearable Technology Trust scale and Wearable Technology Motivation scale (Rupp et al., 2016). Specifically, the survey asked participants to rate their agreement with the following statement from 1 (not at all) to 7 (very much): “Using my primary wearable fitness device, I feel comfortable sharing my data and physical activity milestones with others.” This statement was used to test the user’s willingness to share personal information with the manufacturers to receive feedback and recommendations. This statement is used to test if the user feels safe and confident sharing with the manufacturer of the device, identifying his/her manufacturer trusting perceptions. Another statement, “using my

primary wearable fitness device, I receive suggestions tailored to my skill level," is used to test if user trust in the recommendations suggested by the brand manufacturer.

In the classifying trusting questions, respondents were required to rate their agreement with six statements related to their trusting behaviors. The survey used a scale of seven, from 1 (not at all) to 7 (very much) to determine the respondent's degree of agreement. This survey added questions to clarify trusting behaviors that did not exist in the previous research such as "I follow my primary wearable fitness device's instructions to achieve my health/fitness goals," and "my primary wearable fitness device brings me closer to my health/fitness goals" for the third hypothesis about brand perceptions. These questions were based on the Wearable Technology Motivation scale (Rupp, 2018) to test the user's brand perceptions. The original statement used in previous research was "Using this device, I can be successful creating physical activity and health goals." By changing the subject of the sentence from the user to the "primary wearable device," the statement focuses on the device as the main subject and asks for the user's perception about the manufacturer that the device is associated with. Since there is a direct relationship between the device and its manufacturer, the perception that the user has about the device also reflects what the user thinks of its manufacturer.

General trust, trusting intentions, trusting beliefs, and manufacturer trusting perceptions were chosen to be the main subjects of this research because these concepts were not investigated enough in previous studies. Trust has been studied as one of the variables in the technology acceptance model but different trust-related behaviors were not examined in depth. Therefore, this study focused on the four trusting attitudes listed above to understand the relationships

between them and how these relationships add to the understanding of trust in IoT. Table 1 below summarized the hypotheses in the study and Table 2 below presents the specific questions used in the research to explore the hypotheses formed.

Table 1: The hypotheses description

Dimension Hypotheses	Domain Hypotheses	Description of Survey Questions
H1: Higher Trusting Intentions will lead to the higher General Trust for wearable fitness devices	H1A: Higher Trusting Intentions will lead to the higher General Trust among Apple Watch owners	To study the effect of trusting intentions on user general trust. It measures the effect of one's willingness or intention to depend on the device towards his/her trust. Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
	H1B: Higher Trusting Intentions will lead to the higher General Trust among Fitbit owners	
H2: Higher Trusting Beliefs will lead to the higher General Trust for wearable fitness devices	H2A: Higher Trusting Beliefs will lead to the higher General Trust among Apple Watch owners	To study the effect of trusting beliefs on user general trust. It measures the effect of information accuracy and reliability on user trust. Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
	H2B: Higher Trusting Beliefs will lead to the higher General Trust among Fitbit owners	
H3: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for wearable fitness devices	H3A: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust among Apple Watch owners	To study the effect of manufacturer trusting perception on user general trust. It measures the effect of brand image/loyalty on user trust. Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
	H3B: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust among Fitbit owners	
H4: Higher Trusting Beliefs will lead to higher Trusting Intentions for wearable fitness devices	H4A: Higher Trusting Beliefs will lead to the higher Trusting Intentions among Apple Watch owners	To study the effect of trusting beliefs on user trusting intention. It measures the effect of information accuracy and reliability on user willingness to depend on the device.
	H4B: Higher Trusting Beliefs will lead to the	

	higher Trusting Intentions among Fitbit owners	Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
H5: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Intentions for wearable fitness devices	H5A: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Intentions among Apple Watch owners	To study the effect of manufacturing trusting perception on user trusting intention. It measures the effect of brand image on user willingness to depend on the device. Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
	H5B: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Intentions among Fitbit owners	
H6: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Beliefs for wearable fitness devices	H6A: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Beliefs among Apple Watch owners	To study the effect of manufacturer trusting perception on user trusting belief. It measures the effect of brand image on user confidence in information accuracy and reliability of the device. Domain hypotheses are used to explore the difference between Apple and Fitbit owners.
	H6B: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Beliefs among Fitbit owners	

Table 2: The survey questions

Research concepts	**Survey Questions**
General Trust	2.1 In general, my primary wearable fitness device is competent and effective in handling all my daily interactions with it 2.2 I believe that my primary wearable fitness devices would act in my best interest 2.3 I believe that my primary wearable fitness devices can always be trusted
Manufacturer Trusting Perceptions	3.1 Using my primary wearable fitness device, I receive suggestions tailored to my skill level 3.2 Using my primary wearable fitness device, I feel comfortable sharing my personal data and physical activity milestones with others
Trusting Intentions	3.3 I follow my primary wearable fitness device's instructions to achieve my health/fitness goals

	3.4 My primary wearable fitness device brings me closer to my health/fitness goals
Trusting Beliefs	3.5 My primary wearable fitness device is consistent over time 3.6 The health information being displayed on my primary wearable fitness device is correct

DATA ANALYSIS AND RESULTS

The researcher cleaned the acquired data for analysis by removing any unfinished survey responses, any missing values from the dataset, and test responses. Removing these responses resulted in a sample size of 217. The pool of participants from TCU came from different backgrounds, genders, classifications, and areas of concentration within the university. The following section summarizes the analysis and findings from the survey.

Demographic Data

The survey included six questions related to demographics, gathering information regarding respondents' gender, age, education level, and ethnicity/ethnic origin (one question each) and two questions regarding their college affiliation and role at TCU.

Table 3: Demographic data

Gender	Female	Male						
	39.63%	60.37%						
Age	18-22	23-30	31-40	41-50	51-60	Over 60		
	86.64%	7.37%	0.46%	1.38%	3.23%	0.92%		
Ethnicity/ Ethnic Origin	White	Asian/PI	Black/AA	Hispanic/ Latino	Other			
	76.5%	14.75%	0.92%	7.37%	0.46%			
Education Level	High-school	1-year college	2-year college	3-year college	4-year college	Bachelor	Master	Doctoral
	7.37%	17.97%	32.36%	17.05%	13.36%	6.45%	0.92%	4.61%
Role at TCU	Faculty	Student	Staff	Other				
	5.07%	93.09%	0.46%	1.38%				

As the data in Table 3 indicates, the majority of respondents were white (76.5%) and 18-22 years of age (86.64%). Other ethnic and age groups were under-represented. Most of the respondents were students (93.09%) and have completed one to four years of college (80.74%).

The survey included five questions regarding wearable fitness technology ownership. These questions were used to separate between owner and non-owner of wearable fitness device and further segment the owner group into different categories such as: device owned, reliance on the device, and recommendation to purchase. Table 4 below illustrates the data on wearable fitness technology ownership as percentages out of the 217 respondents.

Table 4: Wearable fitness technology ownership

Ownership	Owner		Non-owner				
	39.63%		60.37%				
	Apple	Fitbit	Other				
	64.95%	17.44%	17.61%				
Reliance	Constantly	Several times/day	Daily	Several times/week	Weekly	Occasionally	Never
	32.56%	32.56%	18.6%	6.98%	1.16%	5.81%	2.33%
Recommend Ownership	Yes	No					
	95.35%	4.65%					
Intend to purchase Non-owner	Yes	No					
	38.17%	61.83%					

Examining the data in Table 4, one can acknowledge the majority of survey respondents did not own wearable fitness devices (60.37%), thus reducing the sample size for hypotheses testing to 86. Among device owners, the majority were using Apple Watch (roughly 65%) while only 17.44% used Fitbit. Out of all device owners, reliance on the wearable fitness device seemed high when about 65% of respondents reported checking their devices constantly or several times a day. Current device owners were asked if they would recommend purchasing a wearable

fitness device and most of them answered: “Yes” (95.35%). The pattern was opposite for non-owners when asked if they intended to purchase a wearable fitness device in the future. Roughly 62% answered with a “No” and only 38% said “Yes.” To add to the discussion of wearable fitness devices, the researcher further analyzed the behaviors within the device owner group and tested the difference between Apple and Fitbit owners’ trusting behaviors.

Scale Reliability

The first step in data analysis was the assessment of scale reliability for the four concepts in question (general trust, trusting intentions, trusting beliefs, and the manufacturer perceptions) using Cronbach’s alpha test. The second step was to use statistical analysis to test the research hypotheses. Cronbach’s alpha test is a common measure of internal consistency, which indicates the degree a survey respondent would respond to the same questions the same way (AlHogail, 2018). There are different reports and opinions about the acceptable values of alpha, ranging from 0.7 to 0.95 (Tavakol et al., 2011) In general, the survey questionnaires were considered consistent for most concepts except for the manufacturer's perceptions, which had an alpha value of 0.49. The alpha value for trusting beliefs was the highest with 0.8, followed by trusting intentions with 0.74 and manufacturer trusting perceptions with 0.49. Table 5 below demonstrates the Cronbach’s alpha for all four concepts.

Table 5: Scale reliability

	Cronbach’s Alpha
Trusting Beliefs Scale	0.80
Trusting Intentions Scale	0.74
Manufacturer Trusting Perceptions Scale	0.49
General Trust Scale	0.69

Hypothesis-related statistical analysis

Each dimension of trusting behaviors was assessed based on a scale of 1-7. Respondents were asked to rate their agreement with several statements from 1 (not at all) to 7 (very much). Then, the average of these responses was calculated. General trust was measured by averaging responses to questions 2.1-2.3 (see Table 2: The survey questions in the prior section) for each respondent then averaging again for a total sample size of 86 respondents to find the overall mean. Trusting intentions were measured by the same methodology with questions 3.3 and 3.4. Trusting beliefs were measured by the same methodology with questions 3.5 and 3.6. The manufacturer's trusting perceptions were measured by the same methodology with questions 3.1 and 3.2. Table 6 below summarizes the results of the statistical analysis of the survey data.

Table 6: All device owners –descriptive statistics

	Mean	St. Deviation	Median	% of Favorable Responses (Score of 5 or greater)
Trusting Beliefs	5.29	1.22	5.5	73.84%
Trusting Intentions	4.6	1.48	4.5	57.56%
Manufacturer Trusting Perceptions	4.55	1.54	4.5	57.56%
General Trust	5.25	1.04	5.33	71.32%

The mean and median values of all four trusting behaviors were above 4, indicating a positive attitude toward the wearable fitness devices. Trusting beliefs had the highest mean value followed by general trust, trusting intentions, and then the manufacturer's perceptions. The results might suggest that out of all trusting behaviors, users of wearable fitness devices expressed their trusting beliefs or their confidence in the device’s reliability and accuracy the highest. Moreover, the high mean value (5.25) and the lowest standard deviation value (1.04) of general trust also suggested that users’ general confidence and reliance on the device was relatively high and consistent. General statistics reported a favorable response percentage,

described as the proportion of responses with a score of five or higher in each device type dimension. This percentage was analyzed to understand the frequency distribution of positive answers, adding a more comprehensive interpretation to mean value.

The researcher further segmented the survey data into two groups, Apple Watch owners and Fitbit owners, to examine the difference in these device type dimension. The overall mean for each device type was restricted to the corresponding sample size of Apple Watch and Fitbit owners. Table 7 summarizes the results of the statistical analysis of Apple Watch owners only.

Table 7: Apple Watch owners –descriptive statistics

	Mean	**St. Deviation**	**Median**	**% of Favorable Responses (Score of 5 or greater)**
Trusting Beliefs	5.09	1.22	5.25	70.69%
Trusting Intentions	4.6	1.48	4.5	54.31%
Manufacturer Trusting Perceptions	4.7	1.57	5	61.21%
General Trust	5.06	1.02	5	68.97%

The results of Apple Watch owners followed a similar pattern to those of the entire dataset. Trusting beliefs received the highest mean value (5.09) followed by the general trust (5.06), the manufacturer's perceptions (4.7), and then trusting intentions (4.6). In the case of Apple Watch, the manufacturer's perceptions received more favorable responses than trusting intentions, compared to the results of the large dataset. Table 8 summarizes the results of the statistical analysis of Fitbit owners only.

Table 8: Fitbit owners –descriptive statistics

	Mean	**St. Deviation**	**Median**	**% of Favorable Responses (Score of 5 or greater)**
Trusting Beliefs	5.76	1.24	6	79.41%
Trusting Intentions	4.85	1.55	5	67.65%
Manufacturer Trusting Perceptions	4.32	1.55	4	50%
General Trust	5.41	0.91	5.33	52.94%

In the case of Fitbit, trusting beliefs received the highest mean value followed by general trust, trusting intentions, and then the manufacturer's perceptions. However, with a 95% confidence interval, the range was significantly higher (0.43, 0.59, and 0.74), indicating that the mean is not as representative as those in the previous sample sizes. The percentage of favorable responses was higher for trusting intentions than general trust's (67.65% and 52.94% respectively) yet the mean for trusting intentions was still lower than that of general trust (4.85 and 5.41 respectively). Interestingly, trusting beliefs for Fitbit owners was significantly higher with a mean value of 5.76 and a median value of 6, showing that Fitbit users had great confidence in the device reliability and information accuracy.

However, by looking at descriptive statistics, conclusions could not be drawn for the relationships between four trusting attitudes. Therefore, the researcher ran the Pearson correlation test at the .05 level to examine hypotheses relating to the trust attitudes of all wearable fitness device owners, Apple Watch owners, and Fitbit owners.

H1: Higher Trusting Intentions will lead to the higher General Trust for wearable fitness devices

To address the first hypothesis, the researcher analyzed the two questions related to trusting intentions (3.3-3.4) and three questions related to general trust (2.1-2.3). Trusting intentions were measured by averaging responses to question 3.3 and 3.4 for each respondent, then averaging the average responses of all respondents. General trust was measured by averaging responses to question 2.1, 2.2, and 2.3 for each respondent, then averaging the average responses of all respondents. The hypothesis was tested by running a Pearson Correlation between trusting

intentions and general trust data and seeing if it is significant at the .05 level. The finding indicates a moderate positive correlation between the two variables with a value of 0.5687.

H1A: Higher Trusting Intentions will lead to the higher General Trust for Apple Watch owners

To test the validity of hypothesis 1A, the researcher analyzed the responses of Apple Watch owner for two questions related to trusting intentions (3.3-3.4) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between trusting intentions and general trust data. The finding indicates a moderate positive correlation between the two variables with a value of 0.6397.

H1B: Higher Trusting Intentions will lead to the higher General Trust for Fitbit owners

To test the validity of hypothesis 1B, the researcher analyzed the responses of Fitbit owner for two questions related to trusting intentions (3.3-3.4) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between trusting intentions and general trust data. The finding indicates a high positive correlation between the two variables with a value of 0.7852.

H2: Higher Trusting Beliefs will lead to the higher General Trust for wearable fitness devices

To address the second hypothesis, the researcher analyzed the two questions related to trusting beliefs (3.5-3.6) and three questions related to general trust (2.1-2.3). Trusting beliefs were measured by averaging responses to question 3.5 and 3.6 for each respondent, then averaging the

average responses of all respondents. The hypothesis was tested by running a Pearson Correlation between trusting beliefs and general trust data and seeing if it is significant at the .05 level. The finding indicates a moderate positive correlation between the two variables with a value of 0.6360.

H2A: Higher Trusting Beliefs will lead to the higher General Trust for Apple Watch owners

To test the validity of hypothesis 2A, the researcher analyzed the responses of Apple Watch owner for two questions related to trusting beliefs (3.5-3.6) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between trusting beliefs and general trust data. The finding indicates a moderate positive correlation between the two variables with a value of 0.6371.

H2B: Higher Trusting Beliefs will lead to the higher General Trust for Fitbit owners

To test the validity of hypothesis 2B, the researcher analyzed the responses of Fitbit owner for two questions related to trusting beliefs (3.5-3.6) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between trusting beliefs and general trust data. The finding indicates a moderate positive correlation between the two variables with a value of 0.5812.

H3: Higher level of Manufacturer Trusting Perceptions will lead to higher General Trust for wearable fitness devices

To address the third hypothesis, the researcher analyzed the two questions related to manufacturer trusting perceptions (3.1-3.2) and three questions related to general trust (2.1-2.3). Manufacturer trusting perceptions were measured by averaging responses to question 3.1 and 3.2 for each respondent, then averaging the average responses of all respondents. The hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and general trust data and seeing if it is significant at the .05 level. The finding indicates a moderate positive correlation between the two variables with a value of 0.5741.

H3A: Higher level of Manufacturer Trusting Perceptions will lead to higher General Trust for Apple Watch owners

To test the validity of hypothesis 3A, the researcher analyzed the responses of Apple Watch owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and general trust data. The finding indicates a moderate positive correlation between the two variables with a value of 0.6906.

H3B: Higher level of Manufacturer Trusting Perceptions will lead to the higher General Trust for Fitbit owners

To test the validity of hypothesis 3B, the researcher analyzed the responses of Fitbit owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and three questions related to general trust (2.1-2.3). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and general trust data. The finding indicates a moderate positive correlation between the two variables with a value of 0.6404.

H4: Higher Trusting Beliefs will lead to higher Trusting Intentions for wearable fitness devices

To address the fourth hypothesis, the researcher analyzed the two questions related to trusting beliefs (3.5-3.6) and two questions related to trusting intentions (3.3-3.4). The hypothesis was tested by running a Pearson Correlation between trusting beliefs and trusting intentions data and seeing if it is significant at the .05 level. The finding indicates a moderate positive correlation between the two variables with a value of 0.5421.

H4A: Higher Trusting Beliefs will lead to the higher Trusting Intentions for Apple Watch owners

To test the validity of hypothesis 4A, the researcher analyzed the responses of Apple Watch owner for two questions related to trusting beliefs (3.5-3.6) and two questions related to trusting intentions (3.3-3.4). Then the hypothesis was tested by running a Pearson Correlation between trusting beliefs and trusting intentions. The finding indicates a moderate positive correlation between the two variables with a value of 0.6089.

H4B: Higher Trusting Beliefs will lead to higher Trusting Intentions for Fitbit owners

To test the validity of hypothesis 4B, the researcher analyzed the responses of Fitbit owner for two questions related to trusting beliefs (3.5-3.6) and two questions related to trusting intentions (3.3-3.4). Then the hypothesis was tested by running a Pearson Correlation between trusting beliefs and trusting intentions. The finding indicates a low positive correlation between the two variables with a value of 0.4875.

H5: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Intentions for wearable fitness devices

To address the fifth hypothesis, the researcher analyzed the two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting intentions (3.3-3.4). The hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting intentions data and seeing if it is significant at the .05 level. The finding indicates a high positive correlation between the two variables with a value of 0.7433.

H5A: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Intentions for Apple Watch owners

To test the validity of hypothesis 5A, the researcher analyzed the responses of Apple Watch owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting intentions (3.3-3.4). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting intentions. The finding indicates a high positive correlation between the two variables with a value of 0.7408.

H5B: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Intentions for Fitbit owners

To test the validity of hypothesis 5B, the researcher analyzed the responses of Fitbit owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting intentions (3.3-3.4). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting intentions. The finding indicates a high positive correlation between the two variables with a value of 0.7345.

H6: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Beliefs for wearable fitness devices

To address the fifth hypothesis, the researcher analyzed the two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting beliefs (3.5-3.6). The hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting beliefs data and seeing if it is significant at the .05 level. The finding indicates a moderate positive correlation between the two variables with a value of 0.5740.

H6A: Higher level of Manufacturer Trusting Perceptions will lead to higher Trusting Beliefs for Apple Watch owners

To test the validity of hypothesis 6A, the researcher analyzed the responses of Apple Watch owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting beliefs (3.5-3.6). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting beliefs. The finding indicates a moderate positive correlation between the two variables with a value of 0.6659.

H6B: Higher level of Manufacturer Trusting Perceptions will lead to the higher Trusting Beliefs for Fitbit owners

To test the validity of hypothesis 6B, the researcher analyzed the responses of Fitbit owner for two questions related to manufacturer trusting perceptions (3.1-3.2) and two questions related to trusting beliefs (3.5-3.6). Then the hypothesis was tested by running a Pearson Correlation between manufacturer trusting perceptions and trusting beliefs. The finding indicates a low

positive correlation between the two variables with a value of 0.4987. The interpretation of Pearson's Correlation Coefficient can be seen in Table 9 below.

Table 9: Degree of correlation

Size of Correlation	Interpretation
Near ± 1	Perfect correlation
Between ± 0.50 and ± 1	High degree of correlation
Between ± 0.30 and ± 0.49	Moderate degree of correlation
Below + .29	Low degree of correlation
0	No correlation

Table 10 below summarizes the correlations for six main hypothesis testing relating to the trust attitudes of all wearable fitness device owners at the .05 level of significance. All the coefficient values were above 0.5, indicating a high degree of correlation. Especially, the data indicates that trusting perceptions and trusting intentions had a strong positive correlation with a value of 0.743. Based on this analysis, all main hypotheses are confirmed.

Table 10: All the device owners –Correlation Coefficients – main hypotheses

	Trusting beliefs	Trusting intentions	Trusting perceptions	General trust
Trusting beliefs	1	0.542	0.574	0.636
Trusting intentions		1	0.743	0.569
Trusting perceptions			1	0.574
General trust				1

Table 11 below summarizes the correlations for six hypothesis testing relating to the trust attitudes of Apple Watch owners at the .05 level of significance. All the coefficient values were above 0.6, indicating a high degree of correlation. Furthermore, the data indicates that

trusting perceptions and trusting intentions had a very strong positive correlation with a value of 0.741. Based on this analysis, hypotheses 1A, 2A, 3A, 4A, 5A, and 6A are confirmed.

Table 11: Apple Watch Owners Only – Correlation Coefficients – all A hypotheses

	Trusting beliefs	**Trusting intentions**	**Trusting perceptions**	**General trust**
Trusting beliefs	1	0.609	0.666	0.637
Trusting intentions		1	0.741	0.640
Trusting perceptions			1	0.691
General trust				1

Table 12 below summarizes the correlations for six hypothesis testing in the case of Fitbit owners at the .05 level of significance. General trust and trusting intentions had a high coefficient value of 0.785. The correlation between trusting intentions and general trust was also strong, with a coefficient value of 0.734. Even though the correlations between trusting intentions and trusting beliefs (0.487), trusting perceptions, and trusting beliefs (0.499) were moderate, hypothesis 4B and 6B are still confirmed. Since all the correlations were in a moderate degree or higher, all hypotheses B are confirmed.

Table 12: Fitbit Owners Only - Correlation Coefficients – all B hypotheses

	Trusting beliefs	**Trusting intentions**	**Trusting perceptions**	**General trust**
Trusting beliefs	1	0.487	0.499	0.581
Trusting intentions		1	0.734	0.785
Trusting perceptions			1	0.640
General trust				1

DISCUSSION

This study aimed to explore the role of trust in IoT wearables and how to improve the usage of wearable fitness devices through understanding user trust. At the onset of this work, the researcher had proposed six main hypotheses relating to the trust attitudes of all wearable fitness device owners. Four trust attitudes discussed in this study were general trust, trusting beliefs, trusting intentions, and manufacturer trusting perceptions. The results of the data analysis gathered through the survey supported all six hypotheses (H1-6). Statistical analysis revealed that general trust has a strong correlation with trusting beliefs, trusting intentions, and manufacturer trusting perceptions at the .05 level of significance. This study also found that all trusting behaviors correlated with one another.

Out of all hypotheses, Hypothesis 5, higher level of manufacturer trusting perceptions will lead to higher trusting intentions for wearable fitness devices, was supported with the highest correlation coefficient value of 0.743. It was evident that brand loyalty played an important role in the user's willingness to depend on the device. Recent incidents of wearables' data breaches have raised concerns over the manufacturer's ability to safeguard user's health data and personal information. Therefore, when deciding on whether to share information with the device provider, the brand name will be the factors that consumers consider.

Moreover, this study showed that trusting beliefs had the highest mean among all four concepts (5.29 out of 7), suggesting that most owners of wearable fitness devices had favorable views of the products' reliability and information validity. Device owners also expressed high general trust toward wearable fitness devices with a mean value of 5.25, indicating a high degree of

confidence and reliance on wearable fitness devices. Indeed, the survey general questions confirmed a high degree of confidence when more than 95% of current device owners would recommend purchasing these products. Users also experienced high reliance on wearable fitness devices with more than 65% of wearable fitness device owners either checked the devices constantly or several times a day. This study reinforces the current trend in the wearable market, which shows the growing interests and confidence of consumers in wearable fitness devices.

Hypotheses 1A-6A focusing on the trust attitudes of Apple Watch owners were all confirmed. Statistical analysis revealed that in the case of Apple Watch, general trust has a strong correlation with trusting beliefs, trusting intentions, and manufacturer trusting perceptions. It was found that all trusting behaviors correlated with one another. Moreover, all the correlation coefficient values of Apple Watch owners (all above 0.6) were higher than those of the entire dataset. This sample also indicated a strong correlation between trusting perceptions and trusting intentions as the entire dataset suggested. Apple has long been known as a prestigious brand name in the tech industry and indeed this manufacturer brand name did affect user intention and willingness to depend on its devices.

Hypotheses 1B-6B focusing on the trust attitudes of Fitbit owners were all confirmed. However, the results from statistical analysis varied. While hypotheses 1B and 5B were supported with high coefficient values (0.785 and 0.734 respectively), hypotheses 4B and 6B were supported with just moderate values (0.487 and 0.499 respectively). Based on this analysis, Fitbit owners showed a strong willingness/intention to depend on the device if there were established brand loyalty and confidence on the devices. Then again, the device reliability and accuracy only had a

moderate influence on the user's willingness to depend on the device.

When comparing the mean of each trust attitude between Apple Watch and Fitbit owners, the study found that Fitbit owners had higher ratings for all four except for manufacturer trusting perception (Apple was 4.7 and Fitbit was 4.32). This was an interesting observation between the two manufacturers which were long considered rivals in the wearable market. Even though Fitbit specialized in producing wearable fitness devices for a long time and Apple entered the market later, Apple has been gaining more popularity. This study revealed insights into a user's trusting attitudes towards the two noteworthy brands.

LIMITATIONS

This study has several noteworthy limitations that need to be addressed. First, the survey sample lacked a diversity of respondents. The majority of respondents were white (76.5%), 18-22 years of age (86.64%). Most of the respondents were students (93.09%) and attended the same university. Although the researcher did not use this demographic information in testing or use as variables in the research, a more diverse and broader presentation of all groups would increase the accuracy of the results and conclusions.

Another limitation of this study would be a small sample size. Out of 217 respondents, only 86 owned wearable fitness devices, significantly reducing the number of available data points for hypothesis testing. The majority of these device owners used Apple Watch (roughly 65%) while Fitbit and other brands were owned by roughly 17% of respondents, each. This study focuses on only Apple Watch and Fitbit, which potentially overlooked many valuable insights from other

brands' owners.

Moreover, considering that Apple Watch essentially belongs to the smartwatch category and Fitbit belongs to a fitness tracker category of wearable devices, the comparison of the fitness components between the two devices might not seem straightforward to some survey respondents. Owners of Apple Watch might find it more difficult to assess their devices solely based on their health/fitness attributes. Therefore, the respondents' judgments could be biased or confused by other functions of the Apple Watch.

Lastly, in this study the researcher has focused solely on general trust, trusting beliefs, trusting intentions, and manufacturer trusting perceptions and the relationships between them, while other variables that can affect the user's trust and confidence in wearable fitness devices such as perceived value, easiness of use, or social influence (Davis et al., 1989) were not studied. For future studies, it may be useful to take a more complex view of trust while studying wearable fitness devices.

IMPLICATIONS

This study results in several implications for wearable fitness device consumers and manufacturers alike. First, it is crucial that consumers understand their trusting attitudes and how their trust relates to the adoption of new technology. Consumers often make a buying decision without thinking about the factors that affect their choices. By understanding one's trusting behaviors, he/she can rationalize his/her buying decision and purchase the product for its real value. Moreover, consumers are the main actors in technology diffusion. No matter how brilliant

the technology, if no one uses it, it will soon disappear. People may have heard of Fitbit but not all of them heard of Pebble, a smartwatch brand that was later acquired by Fitbit. The idea was great but the market for it was small and the adoption rate was so low that it soon killed the product. Consumers were not familiar with smartwatches when Pebble was introduced, as they are today, and therefore were resistant to adopt the new technology at that time. This fact led to the failure of Pebble. Since trust plays an important role in consumers' adoption intention, consumers must understand their trusting behaviors so that they can make rational adoption intentions.

More importantly, this study provides a pathway for manufacturers to successfully impact consumers' behaviors, not only in their marketing strategies but also in the earlier stages of the product development life cycle. In the product design phase, manufacturers need to take into consideration the impact of consumers' trust and critically tailor product features that address consumers' trust. A recent example of this application is the introduction of the Apple-Hermes Watch. Apple and Hermes are both well-known in their respective industry categories: technology and fashion. In introducing this "high-end" version of the Apple Watch, Apple has successfully increased its manufacturer trusting perceptions, which refer to the brand image or brand loyalty that user has regarding the manufacturers of wearable fitness devices (Rupp et al., 2018). This kind of trusting perception concerns the bigger entities behind these products. This is not merely a smartwatch, but the epitome of consumers' trust in the values of Apple and Hermes. Since the innovative collaboration between Apple and Hermes, other tech companies have attempted to use fashion to sell wearables, namely FitBit's partnership with Vera Wang and Tory Burch, or Google's partnership with Kate Spade, Michael Kors, and Emporio Armani. Similarly,

since manufacturers have used fashion to elevate consumers' trust in wearable fitness devices, they can attract new users by gaining consumers' trust through collaborations with fashion companies.

Lastly, this study also has implications for public health organizations around the world. Understanding the role of trusting behaviors can improve the adoption of this technology in healthcare. With the increasing adoption of wearable fitness devices, people are now more conscious about their health conditions, thus maintaining a healthier lifestyle and preventing diseases in the early stage. Wearable fitness devices can prevent obesity in preadolescents and adolescents by measuring, promoting, motivating, and recording physical activity (Turner et al., 2015) By understanding consumers' trusting behaviors, public health organizations can help promote the usage of wearable fitness devices and utilize the data shared by users to monitor their health conditions. When using wearable fitness devices, all user's health data and physical activities are monitored and can be shared with user consent. The more people use wearable fitness devices; the more health data will be collected. This will benefit public health organizations in collecting data and creating better health policies.

CONCLUSION

This study contributes to the study of wearable fitness devices in two ways. First, it provides a literature review to understand the role of trust in improving technology adoption. Second, it offers additional insights into the relationships between general trust, trusting beliefs, trusting intentions, and manufacturer trusting perceptions. With the rapid growth in demand and advancement in design, wearable fitness device market is promising and has the potential to

change the landscape of healthcare and other industries significantly. However, the world of IoT technology has always been filled with abundant uncertainties and threats. Trust has played an important role in improving and motivating technology adoption. Therefore, understanding the consumers' trusting attitudes can influence the motivation and adoption of this technology. Future studies may consider specific domains of wearable IoT products such as fitness trackers, smartwatches, glucose meters, and restrict the research subject within one category. Additionally, the extent of this study only focused on one community. Further research should extend the boundaries of examination to include various communities so that the results would be more comprehensive and generalizable.

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APPENDIX A
Consent Statement (In the Qualtrics Survey)

This research project is being conducted by Mai Bui (Undergraduate Honors Student; Business Information Systems; Texas Christian University; Study Investigator) and Beata M. Jones, Ph.D (Honors Faculty Fellow and Professor of Business Information Systems; Neeley School of Business; Texas Christian University; Principal Investigator) You are invited to participate in this research project concerning the trust in wearable fitness devices.

Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. Should you decide not to participate in this study, or if you withdraw from participating at any time, you will not be penalized.

This procedure involves filling out a short online survey that will take no more than 10 minutes to complete. Your responses will be confidential, and we do not collect identifying information such as your name or IP address. Beyond some fundamental demographic questions, the survey asks questions about your opinion on using wearable fitness device. Specifically, it will ask you questions about your trust in using a wearable device to track your health/fitness goals.

We will keep all information confidential. All data will be stored in a password protected electronic format. The results of this study will be used for scholarly and research purposes.

If you have any questions about the research study, please contact:
1. Mai Bui by phone at 214-763-2363 or via email at mai.bui@tcu.edu
2. Beata M. Jones by phone at 817-257-6948 or via email at b.jones@tcu.edu

Please select your age. If you are under 18, exit the survey now.
- o I am over 18 years of age.
- o I am under 18 years of age.

By agreeing to participate in this study, you agree to the following:
- You are free to withdraw from the study at any time without penalty.
- You have read and understood all the above material.

- o Yes, I agree and consent to participate

- o No, I disagree and do not consent to participate

Survey

Background Information: *Wearable IoT (Internet of Things) devices such as smartwatches and fitness trackers are defined as small electronic devices that can be worn as accessories and exchange data through the Internet with developer/manufacturer or other connected devices. These wearable devices help users complete simple to complex tasks such as checking the time, tracking exercises, making the calls, or even manipulating home appliances. Users normally connect these wearable devices to the Internet or other devices including their phones, tablets, laptops, or home appliances to make the best use of them. This connectivity allows the sharing of user's information with developer/manufacturer and other devices via the Internet and provides user with feedback to act upon.*

Section 1: General questions

Instructions*: Read the following questions fully and answer truthfully after reading the background information above.*

1.1 Do you currently own any wearable fitness devices that send and receive data via the Internet? Select all that apply.

a. Fitbit
b. Apple Watch
c. If other, please specify
d. No, I do not

If Yes, …

1.2 What is your primary wearable fitness device?

b. Fitbit
c. Apple Watch
e. If other, please specify

1.3 How often do you check your wearable fitness devices?

a. Constantly
b. Several times a day
c. Daily
d. Several times a week
e. Weekly
f. Occasionally
g. Never

1.4 Would you recommend purchasing a wearable fitness device?

a. Yes
b. No

If No, …

1.5 Do you intend to purchase one in the future?

a. Yes

b. No

Section 2: General trust questions

Instructions*: Read the following questions fully and answer truthfully. Please rate your agreement with the following statements from 1 (not at all) to 7 (very much)*

If Yes, …

2.1 In general, my primary wearable fitness device is competent and effective in handling all my daily interactions with it
2.2 I believe that my primary wearable fitness devices would act in my best interest
2.3 I believe that my primary wearable fitness devices can always be trusted

If No to 1.1 and Yes to 1.5, …

2.4 I believe that the wearable fitness device is competent and effective in handling all my daily interactions with it
2.5 I believe that wearable fitness devices would act in my best interest
2.6 I believe that primary wearable fitness devices can always be trusted

Section 3: Classifying trusting behaviors

Instructions*: Read the following questions fully and answer truthfully. Please rate your agreement with the following statements from 1 (not at all) to 7 (very much)*

If Yes, ...
3.1 Using my primary wearable fitness device, I receive suggestions tailored to my skill level
3.2 Using my primary wearable fitness device, I feel comfortable sharing my personal data and physical activity milestones with others
3.3 I follow my primary wearable fitness device's instructions to achieve my health/fitness goals
3.4 My primary wearable fitness device brings me closer to my health/fitness goals
3.5 My primary wearable fitness device is consistent over time
3.6 The health information being displayed on my primary wearable fitness device is correct

Section 4: Demographic questions

Instructions*: Read the following questions fully and answer truthfully. Select the one option that you most identify with.*

4.1 What gender do you identify with?
a. Male
b. Female
c. Other
d. Prefer not to say
4.2 How old are you?

a. 18 – 22
b. 23 – 30
c. 31 – 40
d. 41 – 50
e. 51 – 60
f. Over 60

4.3 Please specify your ethnic origin/ethnicity:

a. White
b. Hispanic or Latino
c. Black or African American
d. Native American or American Indian
e. Asian / Pacific Islander
f. Other

4.4 What is your highest earned education level?

a. High-school diploma
b. One year of college
c. Two years of college
d. Three years of college
e. Four years of college
f. Bachelor Degree
g. Master Degree
h. Doctoral Degree

4.5 What is your role at Texas Christian University?

a. Student
b. Faculty
c. Staff
d. Other
e. None

4.6 What college at Texas Christian University are you affiliated with?

a. Addran College of Liberal Arts
b. Bob Schieffer College of Communication
c. College of Education
d. College of Fine Arts
e. College of Science & Engineering
f. Harris College of Nursing & Health Sciences
g. Neeley School of Business
h. School of Interdisciplinary Studies
i. TCU & UNTHSC School of Medicine
j. Other
k. N/A

Thank you for completing the survey!