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A quantitative study on the intention to use internet of things services

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Abstract

The Internet of Things (IoT) has become an integral part of our lives. It provides great convenience to consumers in their work and home lives and in the services they receive, such as health and tourism. However, as with other technological innovations, consumers have privacy and security concerns about IoT services. This study investigated how perceived usefulness and privacy risk affected consumers' attitudes toward IoT services. The study also examined how their attitudes toward IoT services affected their intention to use them. The research hypotheses were tested with the structural equation model. The results showed that perceived usefulness positively affected consumers' attitudes, affecting their intention to use IoT services. On the other hand, perceived privacy risk did not significantly affect their attitudes toward IoT services.

Keywords: Internet of Things, Perceived Usefulness, Intention to Use

JEL Codes: M11, M31, O36

1. Introduction

The implementation of digital transformation through Industry 4.0 is currently undergoing and will gradually undergo further development. Traditional production resources are able to be transformed into smart objects that are enriched with the capabilities of identification, sensing, and networking thanks to new technologies such as Industry 4.0, the Internet of Things (IoT), cyber-physical systems, cloud computing, and big data, amongst others (Guo et al., 2021: 1). IoT is a new technology paradigm that envisions a global network of interconnected machines and devices (Lins et al., 2018: 8). IoT is a comprehensive plan for connecting and communicating amongst a wide variety of devices and things over a network (Guo et al., 2020: 387). Industries show great interest in IoT because they see it as the technology of the future (Lins et al., 2018: 8). It is projected that IoT will have a substantial impact on all aspects of our life in the future (Guo et al., 2020: 387). IoT is a revolutionary technology that is based on information and communication technology and offers new possibilities and solutions (Guo et al., 2020: 388).

Consumers increasingly use technology, causing their expectations, habits, and tendencies to change. In this context, smart objects, which communicate with one another online, make consumers' lifestyles technology-based and eliminate physical boundaries. Moreover, through their interaction with smart objects, consumers can remotely control other technological equipment (Tiryaki & Önder, 2022: 183). However, it is essential to consider how ready consumers are to adopt and use such a system before installing it. Although tech-based systems accelerate processes, it raises questions like "How useful do consumers consider systems?" "What kind of attitudes do they have toward systems?" and "Do their attitudes toward systems affect their intention to use them?" Therefore, this study sought answers to those questions within the scope of IoT services.

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2. Internet of Things (IoT)

Industry 4.0, first introduced in 2011 at the Hannover Fair, is bringing IoT into everyday life. By 2013, it had been publicly proclaimed as a German strategic plan to play a pivotal role in the transformation of manufacturing. The term "Industry 4.0" refers to the latest developments in factory automation through the implementation of various technologies (Xu et al., 2018: 2941). This evokes a new industrial revolution triggered by the convergence between the physical and digital domains. IoT-enabled manufacturing is a new concept that allows production resources to sense, interconnect, and interact with others to execute production logics in an automated and adaptive way (Guo et al., 2021: 2). The term IoT describes a global network of individually addressable physical devices that are linked together and exchange data using established protocol (Vaidya et al., 2018: 235). The key characteristics of IoT are connectivity, heterogeneity, and dynamic change. It has connectivity because objects are connected through the communication infrastructure. As a result of objects' ability to communicate with and interact with other devices and service platforms through different networks, this environment can be described as heterogeneous. In the end, it's dynamic in nature because to the fluctuating quantity of items (Bertin et al., 2013: 259).

IoT has been around for almost 20 years, but it just became mainstream around 1999. The term IoT was coined by Kevin Ashton (Haddud et al., 2017: 1055). Using a wide range of electrical, wireless, and optical network technologies, it connects millions of privately owned, publicly accessible, academic, and commercial networks on a local to global scale. These networks range from private to public to business to governmental (Shehabat & Al-Hussein, 2018: 574). It's a brand new paradigm that's gaining traction quickly in the realm of wireless communications right now. The core concept is that autonomous vehicles and other devices [RFID tags, sensors, actuators, mobile phones, etc.] that can communicate with one another using their own individual addressing schemes work together and with their neighbors to accomplish a shared objective (Osisanwo et al., 2015: 61). Automation technologies are gradually evolving, and manual systems are being transformed into automated systems. Moreover, the Internet is an integral part of our lives, and IoT is the latest and evolving Internet technology changing how things are viewed (Govindraj et al., 2017: 1059). The Internet of Things differs from conventional Internet applications because real-world physical objects are embedded with living and non-living sensors to enable object traceability (Shehabat & Al-Hussein, 2018: 574). IoT is regarded as the next logical progression, providing a wide range of services in manufacturing, smart grids, security, healthcare, automobile engineering, education, and consumer electronics. The majority of these systems already have a Web, but they primarily use Web-independent protocols (Want et al., 2015: 28).

The proliferation of IoT has resulted in a large number of interconnected devices. Typically, these objects range from small sensors to complex controllers and household appliances and offer monitoring and control services to perform and automate everyday tasks (Serror et al., 2020: 2985). From a personal user perspective, IoT will have its most pronounced effects on both work and domestic spheres (Atzori et al., 2010: 2788). IoT has many applications, ranging from healthcare to home sciences and energy management to security and digital enterprises (Bertin et al., 2013: 231). A wide variety of industries, including health, smart retail, customer service, environmental monitoring, smart homes, and the industrial Internet, are already making use of services provided by IoT (Kassab et al., 2020: 116).

2.1. The Advantages of the Internet of Things

The main advantage of IoT services is that they can potentially change users' daily processes (Dlamini & Johnston, 2016: 432). RFID technology, identification and tracking systems, wired and wireless sensor and actuator networks, cutting-edge communication protocols, and distributed intelligence for smart things are just some of the technologies and communication solutions that IoT includes (Brous et al., 2020: 3). Data sharing is available on almost every device today. The communication environment is shifting from wired to wireless technologies such as Wi-Fi and Bluetooth. The wireless environment eliminates the need for cables. The majority of modern physical gadgets are wireless. Performance and interoperability with other devices will both increase thanks to wireless networks (Gupta & Gupta, 2016: 2). As a result, IoT may achieve real-time monitoring of nearly every link in the supply chain, from commodity design to raw material procurement, production, transportation, warehousing, distribution, and sale of semi-finished products (Kaur & Singh, 2016: 331). Another advantage of IoT services is that they reduce data collection costs because they allow devices, machines, or objects to work together and share resources. IoT technologies will allow us to use previously unavailable data because they can interact with people and real-time data for decision-making. This way, businesses will have a competitive advantage (Dlamini & Johnston 2016: 432). In addition, IoT technology generates large amounts of information and data, such as customer profiles or customer behavior, which inform businesses about their customers' activities. This allows them to collect large amounts of information and data that help them develop marketing strategies. This knowledge helps them learn customers' preferences and develop products they are most likely to buy (Dlamini & Johnston, 2016: 432).

IoT services provide benefits, such as automated payments, inventory management, store layout optimization, customer tracking, and product location identification. In addition, IoT services provide benefits in home appliances such as energy consumption management, interaction with devices, emergency detection, home security, and quickly locating items (Haddud et al., 2017: 1058). Therefore, IoT makes people's lives easier. Consequently, IOT services are also crucial in developing smart home infrastructure. A smart home relies on wireless networks, such as Bluetooth, Wi-Fi, Bluetooth 4.0, and others, to link its many devices. They are controlled via smartphones, tablets, or computers. For example, smart thermostats, air conditioners, lights, and other home equipment may all be managed from a user's smartphone or tablet with the help of a home automation system. Adjustments can be made in real time, allowing the user to do things like adjust the temperature or the lighting in a room (Korneeva et al., 2021: 2). For example, you can use your smartphone to remotely turn on your air conditioner or schedule this task into your daily routine (Miranda et al., 2015: 40).

IoT is also used in robot technology. Therefore, humans can use robots to overcome physical obstacles. Artificial intelligence (AI) allows robots to sense dynamic changes and act accordingly. Using other devices and network technologies, robots can better serve consumers (Gupta & Gupta, 2016: 2). IoT technology will also provide significant benefits in healthcare. Healthcare professionals can use IoT devices to monitor patients' general health and nutritional status. Rehabilitation processes can also be efficiently supported by IoT technologies (Nizetic et al., 2020: 5). Chronic diseases are on the rise. Therefore, more and more patients require urgent medical attention, which has always put pressure on healthcare services. Recent advancements in healthcare, particularly IoT and convergent technologies, have the potential to make healthcare better and to support healthcare professionals in the delivery of healthcare solutions in the most effective and time-saving manner possible. This is because these technologies have the ability to streamline the delivery of healthcare solutions. (Al-rawashdeh et al., 2022: 2).

IoT services also provide significant benefits for the tourism sector. For example, wearable technology can recognize a loyal customer and provide offers tailored to her tastes and preferences. A mobile key can notify her when her room is available and allow her to enter her room without her needing a key (Infante-Moro et al., 2021: 1). Hotels can use recognition technology to monitor visitors' locations and perform smart systems and activities (e.g., delivering customized messages). For example, hotel Symbol in Hong Kong has started testing smart guest bedrooms that provide a customizable room feel and voice-activated devices tailored to guests (Rajesh et al., 2022: 4). In addition, a smartphone application can provide the hotel management with a comprehensive summary of the overall emotional state of the hotel and indicate the necessity of taking action to improve the hotel's standards (Pelet et al., 2021: 4038).

Smart systems that provide people with real-time information based on the current traffic situation significantly impact human life (Brous et al., 2020: 3). Thus, Internet of Things services play a significant role in the development of smart cities. Traffic bottlenecks, power outages, water shortages, security breaches, and other infrastructure issues can all be spotted in real time with the help of IoT technology, which are monitored by trained professionals. (Nizetic et al., 2020: 3). IoT technologies can also provide drivers with better navigation and safety (Kaur & Singh, 2016: 331).

2.2. Security and Privacy Risks of the Internet of Things

Although IoT has many benefits, it also has certain drawbacks, such as security and privacy concerns.

Security issues caused by IoT technologies are one of the biggest challenges for businesses. As IoT technologies proliferate, more cyber-attacks occur (Dlamini & Johnston, 2016: 432). When sensors have finished collecting data, the next step is to send that data across a communication network. Connecting sensors to networks can be done using 3G/4G, Bluetooth, Wi-Fi, and other protocols. There is a significant challenge involved in connecting a large number of devices. There is a cap on the number of connected devices that can be serviced by a single base station. Wireless networks also lead to privacy and security issues (Gupta & Gupta, 2016: 2). IoT technologies are small and mobile devices with many constraints. Therefore, installing a dynamic security patch can be very difficult as the operating system or protocol stack may not support updated codes and libraries. In addition, more and more devices are connected to the Internet, raising issues such as scalability in security (Sayana & Joshi, 2016: 3). Privacy and security risks are essential for both businesses and consumers. Due to the growth of IoT, billions of new sensors and devices are being added to the Internet, creating a vast amount of information about people, with or without their consent, including their shopping records, financial transactions, photos, voice recordings, chats, health conditions, etc. This excessive amount of information makes privacy problematic (Öztürk & Zeybek, 2021: 4). For example, smart home applications use different sensors to remotely control rooms and collect data from private areas (e.g., bedrooms). Therefore, IoT applications lead to security risks that pose major challenges for consumers (AlHogail, 2018: 2).

3. Literature Review and Research Hypotheses

The term "perceived usefulness" relates to whether or not a new technology assists in the resolution of issues (Chuang et al., 2020: 254).

IoT is a modern, disruptive approach connecting devices and people anytime and anywhere. IoT technologies generate high economic returns, boost operational processes' efficiency, and improve end users' personal and professional lives (Arfi et al., 2021).

In order to understand what makes people comfortable with IoT technologies in the home, Park et al. (2017) conducted extensive research into this topic. They concluded that users' perspectives on IoT technologies were governed by their perceptions of their utility. The technology acceptance model (TAM) is used by researchers as an explanation for whether or not people would embrace new forms of information technology. Using TAM, Gao and Bai (2014) studied 368 Chinese consumers' opinions on a product's usefulness, ease of use, and trustworthiness. Consumers' intent to use and opinions about IoT devices are influenced by how they are perceived to be beneficial. TAM was utilized by Zhu et al. (2012) in their investigation of the external factors that influence Taiwanese players' acceptance of online gaming. The researchers reported that perceived usefulness positively affected players' attitudes toward online games. Tirkayi and Önder (2022) found that perceived ease of use significantly affected consumers' attitudes toward using smart wearables. Teo et al. (2008) state that perceived usefulness and ease of use are important determinants of attitudes. Narakorn and Seesupan (2019) found that perceived usefulness positively affected Thai consumers' (n=272) attitudes toward IoT services. Mital et al. (2018) also reported similar results.

In this context, the following is the first hypothesis.

H1: Consumers who believe in the usefulness of IoT services are more likely to have positive attitudes toward those services.

A person's impression of the probable outcomes of an activity as a result of the degree of ambiguity associated with that behavior is what is meant by the term "perceived risk." When faced with potential losses, it is important to make judgments that minimize those losses to the greatest extent possible. Therefore, the higher the perceived risk a consumer has, the more likely it is that he/she will have negative behavioral intentions (Arfi et al., 2021). Perceived privacy risk is one's beliefs about the possible breach of private information when using IoT services. Users have the right to be worried that

IoT providers may collect personally identifiable information without providing prior warning or may make unlawful secondary uses of personally identifiable information for the sake of financial benefit. It's possible that worries of this sort will have a negative impact on how valuable IoT services are seen to b (Hsu & Lin, 2018).

People who worry more about their privacy are less likely to embrace IoT devices, as reported by Hsu and Lin (2016). The results of this study demonstrate that users' intentions to disclose personal information are influenced by privacy concerns. As a result, consumers who worry about privacy breaches are less likely to be positive about utilizing IoT services.

According to AlHogail (2018), security is a primary concern for customers adopting a new product or service. In other words, consumers with security concerns trust a product or service less and have difficulty adopting it. Therefore, a lack of security is a major issue that prevents customers from adopting IoT services (AlHogail, 2018). Health information is personal. If consumers think that a third party may access their information data while using IoT health products and services, they may refuse to use them (Karahoca et al., 2017). Therefore, they will be less likely to adopt IoT health technologies. Dong et al. (2017) determined that perceived privacy risk had a negative impact on smart home users' (n= 337) behavioral intentions to use IoT. Princi and Krämer (2020) found that personal data breaches made consumers less likely to use IoT health technologies. Jayashankar et al. (2018) also determined that American farmers with high perceived risk were less likely to adopt IoT technologies.

In this context, the following is the second hypothesis.

H2: Consumers with high perceived privacy risks are more likely to have negative attitudes toward IoT technologies.

Attitude is a feeling or opinion about something or someone or behavior caused by something or someone (Alraja et al., 2019). Attitude toward technology use is defined as one's general emotional response toward using a system (Romero-Rodríguez, et al., 2020). Intention to continue using is the degree to which users believe they will use IoT services again. Consumers use IoT services as long as they find them useful (Hsu & Lin, 2016).

Kim et al. (2017) argue that perceived usefulness, ease of use, and enjoyment determine consumers' attitudes toward using a technology, shaping their intentions. Yoon (2016) found that perceived usefulness, interactivity, and ease of use affected users' attitudes and intentions to use mobile library apps. Chang et al. (2012) reported that Taiwanese university students' (n=158) attitudes toward mobile learning positively affected their intention to continue using mobile technologies to learn English. Romero-Rodríguez et al. (2020) determined that university professors' performance expectations, enabling conditions, and attitudes toward using the technology made them more enthusiastic about using IoT technologies. Park et al. (2017) found that consumers' attitudes toward IoT technologies in a smart home environment significantly affected their intention to use technologies. Hsu and Lin (2016) collected data from 508 respondents through an online survey in Taiwan. They reported that consumers' attitudes toward using IoT services positively affected their intention to use them. Narakorn and Seesupan (2019) found that Thai consumers' (=272) attitudes toward IoT services positively affect their intention to continue using them. Tirkayi and Önder (2022) also reported that consumers' attitudes toward using smart wearables positively affected their intention to use them.

In this context, the following is the third hypothesis.

H3: Consumers with positive attitudes toward IoT services are more likely to use them.

4. Methods and Findings

This study investigated (1) whether perceived usefulness and perceived privacy risk affected consumers' attitudes toward IoT services and (2) whether their attitudes toward IoT services affected their intention to use them. Figure 1 shows the research model.

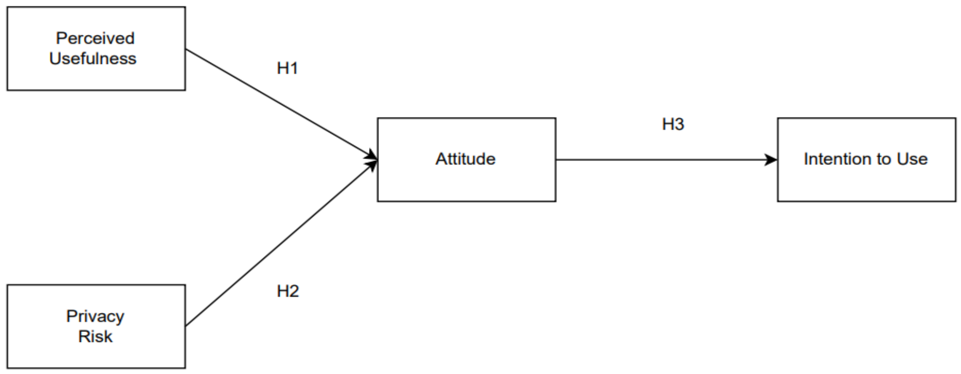

Figure 1. Research model

The sample consisted of 141 participants from different cities in Türkiye. Data were collected online between October 2022 and November 2022. Convenience and snowball sampling were utilized in the process of participant recruitment.

Permission for the research was obtained from Kastamonu University Research and Publication Ethics Committee with the decision dated 3/10/2022 and numbered 10/12.

The perceived usefulness and use intention scales were based on Hsu and Lin (2018) and Narakorn and Seesupan (2019). The perceived privacy risk scale was derived from Hsu and Lin (2018). Finally, the attitude scale was derived from Narakorn and Seesupan (2019).

Data were collected using a survey consisting of two parts. The first part was a personal information form on demographic characteristics. The second part consisted of the Perceived Usefulness Scale, the Perceived Privacy Risk Scale, and the Use Intention Scale. The scales consisted of items rated on a five-point Likert-type scale (1=Strongly disagree to 5=Strongly agree). Scale questions are given in Appendix 1.

Table 1 shows all participants' demographic characteristics.

Table 1. Demographic characteristics

	Frequency	**Percent**
Woman	65	46,1
Man	76	53,9
Age	**Frequency**	**Percent**
18-25	36	25,5
26-35	39	27,7
36-45	44	31,2
46-55	18	12,8
56 +	4	2,8
Education	**Frequency**	**Percent**
Middle School	13	9,2
Associate Degrees	38	27,0
Bachelor's Degrees.	44	31,2
Master	32	22,7
PhD	14	9,9
Occupation	**Frequency**	**Percent**
Public Sector	41	29,1
Private Sector	41	29,1
Self-employed	8	5,7
Shopkeepers / Company Owners	15	10,6
Retired	2	1,4
Housewives	13	9,2
Student	21	14,9

Income	**Frequency**	**Percent**
5000 -	18	12,8
5000-15000	49	34,8
15000-25000	49	34,8
25000-35000	15	10,6
35000 +	10	7,1

Men made up seventy-six percent of the total participants. Age range ranging from 36 to 45 years was represented by 44 individuals. There were 39 individuals who were between the ages of 26 and 35. 36 of the participants were in the age range of 18 to 25 years old. Between the ages of 46 and 55, there were eighteen participants. Over the age of 55, there were four participants. The participants' highest level of education was a bachelor's degree. The participants' highest level of education was an associate's degree. Master's degrees were held by thirty-two of the participants. Fourteen individuals held Ph.D. degrees. Thirteen of the participants had completed their middle school education. The private sector was represented by forty-one of the participants. The public sector was represented by forty-one of the participants. Students made up twenty-one of the participants. Fifteen participants were shopkeepers or company owners. Thirteen participants were housewives. Eight participants were self-employed. Two participants were retired. Forty-nine participants had an income of 15000 to 25000. Forty-nine participants had an income of 5000 to 15000. Eighteen participants had an income below 5000. Fifteen participants had an income of 25000 to 35000. Ten participants had an income above 35000.

Exploratory factor analysis (EFA), confirmatory factor analysis (CFA), reliability analysis, and normality tests were used to establish the validity and reliability of the scales.

Table 2. EFA results

Perceived Usefulness	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
PU1	,914	-1,161	2,051	3,91	,882
PU2.	,929	-,820	,733	3,86	,923
PU3	,920	-,861	1,341	3,89	,863
PU4	,906	-,811	1,386	3,87	,847
PU5	,906	-1,027	1,176	3,89	,969
PU6	,857	-,734	1,201	3,87	,852
PU7	,904	-,978	1,268	3,88	,922
KMO: , 933 Approx. Chi-Square: 1105,938 df:21 sig.:,000 Total Variance Explained: % 81,994					
Perceived Privacy Risk	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
PR1	,884	,179	-,424	2,63	1,045
PR2	,885	,158	-,012	2,70	,939
PR3	,927	,065	-,345	2,78	1,001
PR4	,869	,209	-,273	2,86	1,025
KMO: , 834 Approx. Chi-Square: 392,376 df:6 sig.:,000 Total Variance Explained: % 79,477					
Attitude	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
AT1	,848	-,732	1,326	3,77	,787
AT2	,901	-1,099	1,977	3,74	,840
AT3	,917	-,941	1,813	3,72	,831
AT4	,896	-,938	1,825	3,70	,826
AT5	,873	-,734	1,197	3,71	,866
KMO: ,860 Approx. Chi-Square576,721 df:10 sig.:,000 Total Variance Explained: % 78,714					
Use Intention	**Factor Loidings**	**Skewness**	**Kurtosis**	**Mean**	**Std. Deviation**
IU1	,877	-,581	,536	3,77	,857
IU2	,868	-,569	,785	3,71	,858
IU3	,881	-,301	,162	3,40	,902
IU4	,881	-,224	,089	3,48	,930
KMO: ,772 Approx. Chi-Square: 365,312 df:6 sig.:,000 Total Variance Explained: % 76,862					

The EFA results showed that the items had factor loadings greater than 0.50. The perceived usefulness scale had factor loadings of 0.857 to 0.929. The perceived privacy risk scale had factor loadings of 0.869 to 0.927. The attitude scale had factor loadings of 0.848 to 0.917. The use intention scale had factor loadings of 0.868 to 0.881. All scales had KMO (Kaiser-Meyer-Olkin) values greater than 0.70, for which Bartlett's test of sphericity was significant. These results showed that the sample was large enough for factor analysis. All scales explained over 50% of the total variance. They had kurtosis and skewness values of -2 to + 2, indicating normal distribution (Field, 2017).

Table 3 shows the CFA goodness of fit results.

Table 3. Goodness of fit results.

Variable	χ^2	df	χ^2/df	GFI	CFI	NFI	TLI	SRMR
Criterion			≤*5*	≥*.85*	≥*.90*	≥*.90*	≥*.90*	≤*08*
Perceived Usefulness	46,531	41	3,324	0,911	0,971	0,959	0,956	0,0230
Perceived Privacy Risk	5,724	2	2,862	0,98	0,991	0,986	0,972	0,0184
Attitude	4,886	4	1,221	0,986	0,998	0,992	0,996	0,0157
Use Intention	4,123	1	4,123	0,986	0,991	0,989	0,949	0,0120

Because there were fewer than 250 people in the sample, the SRMR value was calculated and examined. The findings of the CFA indicated that the requirements for the scales' goodness of fit were satisfactory (Boateng et al., 2018).

Reliability was assessed after the EFA and CFA.

Table 4 shows the Average Variance Extracted (AVE) and composite reliability (CR) values.

Table 4. Reliability results

Variable	AVE	CR	Cronbach' Alpha
Perceived Usefulness	0,76	0,96	0,963
Privacy Risk	0,72	0,91	0,913
Attitude	0,74	0,93	0,932
Use Intention	0,80	0,93	0,899

The reliability of the scales was demonstrated by the fact that their respective alpha coefficients were higher than 0.70. In addition, the scales had AVE values that were greater than 0.50 and CR values that were greater than 0.70, which demonstrated that the scales were both valid and dependable (Kautish & Sharma, 2019).

With the intention of putting the hypotheses to the test, a structural equation model was constructed. Figure 2 shows the model.

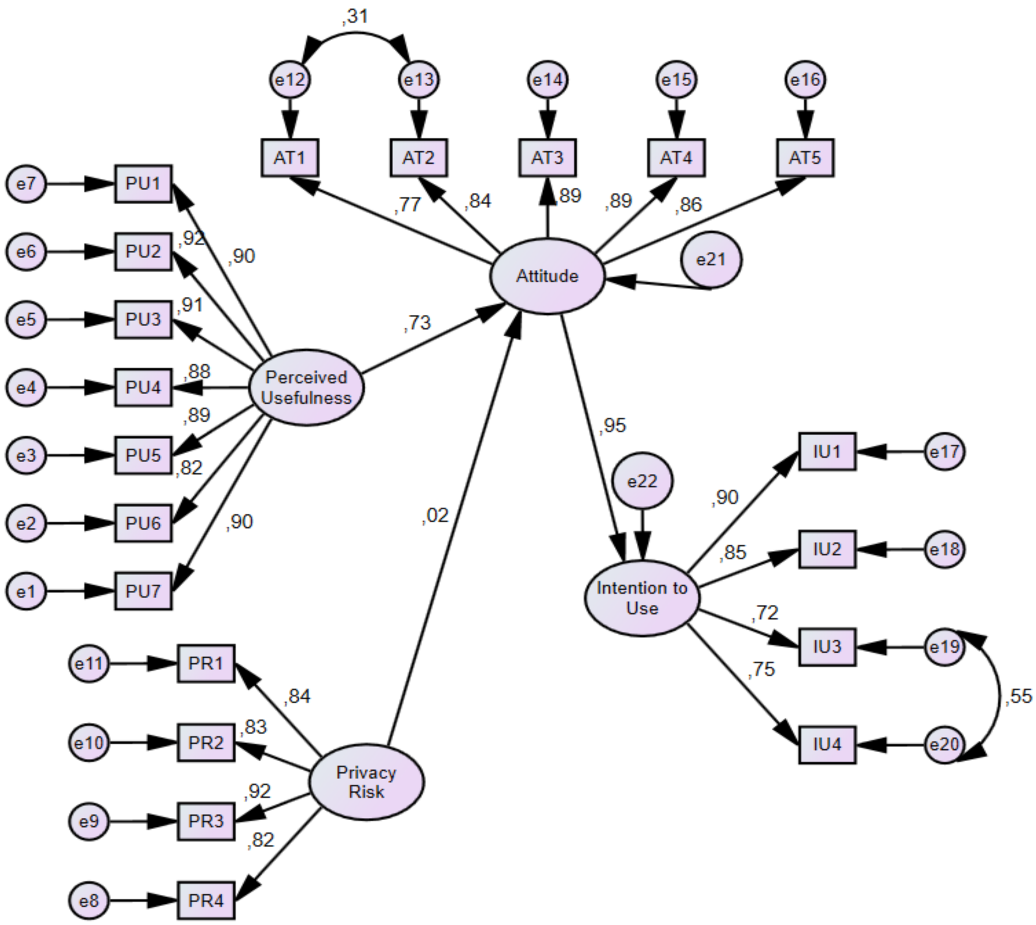

Figure 2. Structural equation model

Table 5 shows the goodness of fit values for the structural equation model.

Table 5. Goodness of fit values for the structural equation model

Variable	χ^2	df	χ^2/df	GFI	CFI	NFI	TLI	SRMR
Criterion			*≤5*	*≥.85*	*≥.90*	*≥.90*	*≥.90*	*≤.08*
Model	257,274	165	1,559	0,856	0,964	0,917	0,955	0,0696

According to the findings, the structural equation model had values of goodness of fit that were within acceptable ranges.

Table 6. Structural equation model analysis results

Analysis Path			B	β	S.E.	C.R.	p
Attitude	<---	Perceived usefulness	0.54	0.732	0.064	8.453	***
Attitude	<---	Perceived privacy risk	0.017	0.024	0.047	0.365	0.715
Intention to use	<---	Attitude	1.21	0.95	0.108	11.208	***

Perceived usefulness positively affected attitude. Attitude significantly affected usage intention. Perceived privacy risk did not significantly affect attitude. The results confirmed H1 and H3.

5. Conclusion

This study investigated the impact of perceived usefulness and privacy risks on consumers’ attitudes toward IoT services and the impact of their attitudes on their intentions to use those services. The results showed that perceived usefulness positively affected consumers' attitudes toward IoT services, which is consistent with the literature (Narakorn & Seesupan, 2019; Xiao & Goulias, 2022). These results indicate that consumers who consider IoT services useful are more likely to have positive attitudes toward those services. The results showed that perceived privacy risk did not significantly affect attitude. Some researchers argue that perceived risk significantly negatively affects attitudes (Meidute-Kavaliauskiene et al., 2021), while others claim that it does not significantly affect attitudes (Çelik & Aydın, 2021). The sample consisted of participants who have experienced IoT services and have a high level of education. Therefore, researchers should compare those who have experienced IoT services and those who have not. They should also investigate the effect of education on perceived usefulness and attitudes toward IoT services. Our results indicate that consumers with IoT experiences do not perceive too much risk, which does not affect their attitudes. The results also showed that participants' attitudes affected their intentions, which is consistent with the literature (Narakorn & Seesupan, 2019; Tiryaki & Önder, 2022). This result indicated that consumers with positive attitudes toward IoT services were more likely to use those services. IoT technologies offer enormous opportunities for many new applications that promise to improve our quality of life (Xia et al., 2012: 1101). The more consumers believe they can adopt and adapt an IoT product or service, the more they integrate it into their lives (Tsourela & Nerantzaki, 2020). Technology experts and analysts propose a wide variety of smart home devices as the most useful for managing and coordinating one's dwelling. For example, smart TVs, voice assistants, smart lights, motion detectors, surveillance cameras, smart thermostats, and smart blinds are the most popular smart home applications (Korneeva et al., 2021: 4). Consumers are able to make better use of the resources that are accessible to them thanks to sensors that are installed in kitchens. These sensors detect the date of expiration of various products and beverages. An AI-integrated sensor can offer meal options by detecting the available ingredients in the refrigerator (Rajesh et al., 2022: 4). However, new technological applications are costly. In addition to high costs, the expansion of the worldwide market for smart homes may be stymied by a number of technical challenges, including but not limited to interconnection and charging standards (Korneeva et al., 2021: 5). Therefore, it is of utmost importance for manufacturers to design products in such a way as to reduce costs and even achieve high energy savings. In addition, protecting privacy should be a key priority for successfully adapting and developing IoT systems. We must protect privacy by design. IoT customers should have the necessary features to control their information and choose who can access it (Öztürk & Zeybek, 2021: 7). In practice, corporations are obligated to advise customers of the intended use of their data before gathering it (Hsu & Lin, 2016).

This study had two limitations. First, the sample was not heterogeneous because we recruited consumers who had already used IoT services before. Second, most of our participants were well-educated people.

Researchers should also investigate the effect of innovativeness on use intentions and attitudes. For example, they should analyze whether the risk perceptions of users with low and high levels of innovativeness differ. In addition, energy savings are of paramount importance. Therefore, researchers should also investigate whether consumers' attitudes towards IoT services vary according to their energy-saving sensitivity.

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Appendix 1: Scale items

Perceived Usefulness
PU1: Using IoT services will improve my work/life performance. (Hsu & Lin, 2018)
PU2: Using IoT services will increase my work/life effectiveness. (Hsu & Lin, 2018)
PU3: Using IoT services will improve the quality of my life and work. (Narakorn & Seesupan, 2019)
PU4: Using IoT services will improve my lifestyle and work efficiency. (Narakorn & Seesupan, 2019)
PU5: Using IoT services will help me finish many tasks related to my life and work quickly. (Narakorn & Seesupan, 2019)
PU6: Using IoT services will help me get useful information for work and life. (Narakorn & Seesupan, 2019)
PU7: Using IoT services will be beneficial for life and work. (Narakorn & Seesupan, 2019)
Perceived Privacy Risk
PR1: Using IoT services will have a significant privacy risk. (Hsu & Lin, 2018)
PR2: There is much uncertainty around using IoT services. (Hsu & Lin, 2018)
PR3: My decision to use IoT services will expose me to privacy risks. (Hsu & Lin, 2018)
PR4: Using IoT services will result in a breach of privacy. (Hsu & Lin, 2018)
Attitude
AT1: It will be fun to use IoT services. (Narakorn & Seesupan, 2019)
AT2: I think it is a good idea to use IoT services. (Narakorn & Seesupan, 2019)
AT3: I think using IoT services will make me feel good. (Narakorn & Seesupan, 2019)
AT4: Using IoT services will make me happy. (Narakorn & Seesupan, 2019)
AT5: In general, I have a positive attitude toward IoT services. (Narakorn & Seesupan, 2019)
Use Intention
IU1: I plan to use IoT services in the future. (Hsu & Lin, 2018)
IU2: I plan to recommend my friends to use IoT services. (Hsu & Lin, 2018)
IU3: I plan to use IoT instead of other channels. (Narakorn & Seesupan, 2019)
IU4: I will always use IoT services if possible. (Narakorn & Seesupan, 2019)

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Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara ve bilimsel atıf gösterme ilkelerine riayet edildiğini yazarlar beyan eder. Aksi bir durumun tespiti halinde Business, Economics and Management Research Journal'ın hiçbir sorumluluğu olmayıp, tüm sorumluluk makale yazarlarına aittir. Yazarlar etik kurul izni gerektiren çalışmalarda, izinle ilgili bilgileri yöntem bölümünde ve ayrıca burada belirtmişlerdir.

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