Why would I adopt a smart speaker?

Consumers' intention to adopt smart speakers in smart home environment

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Abstract

As the rapid development of Internet of Things technology is becoming a promising industry, an increasing number of fields are implementing this concept into traditional products, systems and services. In the construction field, many companies have already used IoT in home automation. However, only few studies are focusing on exploring the consumer behaviour and user experience of IoT technology in smart home environment.

This research chose a very popular category of smart home devices, IoT-based smart speakers. In order to examine the key factors that influence the intention to adopt smart speakers in particular under the context of smart home environment, a new extended model developed from Technology Acceptance Model (TAM) was proposed and analysed. Three individual user characteristics, three product characteristics, one social context factor and one economic factor were integrated in the model.

By using a survey questionnaire, the relationship between the independent variables (perceived usefulness, perceived ease of use, attitude, perceived cost, social influence, IoT skills, trust, self-innovativeness, enjoyment, reliability, and security) and the dependent variable (intention to adopt) was examined. Data from 305 respondents were included to test the proposed model. The results showed that intention to adopt was directly influenced by attitude, social influence and trust. Attitude was greatly affected by perceived usefulness, trust, enjoyment, and the level of self-innovativeness. A noteworthy finding was that trust was a significant factor that can predict perceived ease of use, attitude, and intention to adopt. A strong support was also indicated for the effects of security, enjoyment, IoT skill, trust, self-innovativeness and social influence.

Compared with the original TAM, the extended model provides more explanation on the predictors for consumers' intention to adopt smart speakers in smart home environment. The present study serves as an initial step for future research to discover the adoption process of smart speakers and it will give the business some insights to optimize their products and marketing campaigns.

Keywords: Internet of Things, smart speaker, intention to adopt, technology acceptance model (TAM), consumer behaviour.

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1 Introduction

Internet of Things (IoT), by providing interconnection among objects regardless of time and space, makes it possible for people to utilize the internet in day-to-day lives in countless ways (Want, Schilit, & Jensen, 2015). There is an increasing amount of areas which use IoT technology, for instance, healthcare, retail industry, smart house, and so forth (Ding, 2013). It is considered by many people that IoT is "the next generation of information and communication technology" (Uckelmann, Harrison, & Michahelles, 2011; Zorzi et al., 2010), and a comprehensive part of the future internet, as the European Commission stated (Clark,2008).

Smart home is a home automation system which connects sensors, monitors, interfaces and devices with the Internet of Things (loT) to get an overall control of the domestic environment (Cook, 2012). It has been emphasized in the Strategic Energy Technology Plan of EU, to "create technologies and services for smart homes that provide smart solutions" is one of the 10 priority action areas. The networked appliances and devices using in smart home environment include, not only restrict to, lighting, heating system, electricity, doors, windows, refrigerators, and other kinds of household appliances (Robles & Kim, 2010). The figure of such online capable devices increased 31% from 2016 to 8.4 billion in 2017. Experts estimate that the IoT will consist of about 30 billion objects by 2020. It is also estimated that the global market value of IoT will reach $7.1 trillion by 2020. It's the future.

Despite smart home presents a bright future, it still needs a huge amount of research in its development and advancement. While there are many competing vendors of smart home all around the world, there are very few worldwide accepted industry standards and the smart home space is heavily fragmented. Moreover, smart home faces a lot of risks, such as security and privacy issues.

Since smart home technologies are all depending on the internet, there is a big chance that your smart home can be hacked by other people. It's horrible to imagine the risk that someone is taking control of your own house. It's a serious issue and has been shown that security needs to be considered in depth when Internet of Things devices are being developed.

What's more, privacy issue is another major concern of home automation system. Many IoT devices are programmed to continuously collect personal data to enhance their functionality and facilitate efficient use of resources. Users exercise less control over the manner of data collection in IoT as devices often have automatic settings with no user interface to configure privacy preferences. Privacy issue also involves the use of collected personal data. IoT companies know the value of personal data and will likely exploit the data beyond the expectation of consumers through aggregation, repurposing, and sharing with third parties. In most cases, however, the sharing is done without the informed consent of consumers.

Several smart home devices have already come into use and made their way into thousands of households throughout the globe, among which smart speakers are becoming increasingly popular in recent years. Based on the IoT technology, artificial intelligence and automatic speech recognition, smart speakers can answer any questions, control your smart home devices, help managing your personal information and schedules, and so much more. Amazon Echo is probably the first and most recognizable name in this area. It is a central

hub for other smart home devices and appliances functioning through its artificial intelligence assistant, Alexa. However, Amazon Echo is no longer alone in the smart speaker industry. Google entered this area with Google Home and it now has the Home Mini and the Home Max. Apple also got into the artificial intelligence smart speaker area with its HomePod. There are clear signs that the market is starting to move from the early adopter phase to hitting the mass market (Strategy Analytics, 2017).

In March of this year, several Amazon Echo owners have shared similar stories about the devices on social media, with reports of multiple Alexa voice assistant turning themselves on and laughing for no reason in the middle of the night. Amazon said in a statement that the outbursts are due to its smart speakers hearing accidental orders. Amazon claimed "In rare circumstances, Alexa can mistakenly hear the phrase 'Alexa, laugh'". Amazon did not say why the speaker would laugh when no one is talking (Glowatz, 2018). This case may serve as a major consideration that prevent the public from adopting the new technology. Moreover, smart speakers are typically more expensive than their non-connected counterparts, so consumers would definitely feel the hit in their wallets at first.

Despite the broad application of IoT in smart home environment, few studies have focused on the user experience of Internet of Things or home automation and the factors that can predict the acceptance of IoT in smart home environment (Park, Cho, Han, & Kwon, 2017), not to mention consumer behaviour for a specific category, smart speakers. Moreover, given the rapid growth of IoT technology and smart home applications, it is crucial for both professionals and practitioners to understand the adoption process of potential consumers. Research on the factors influencing the adoption of smart speakers may give us a more detailed knowledge about this digital trend from a theoretical perspective. And in practice, it will guide the potential customers what need to be considered before accepting smart speakers or even home automation system; to the manufacturers what to be improved in their products; to marketers how to plan marketing strategies to best promote products.

To conclude, the review of the literature revealed that it could not sufficiently explain consumers' intention to adopt IoT technology and smart speakers in smart home environment. That is the gap which this research addresses. This study aims at building a model with regards to consumers' acceptance of smart speakers for this trending technology to reach commercialisation. This model is based on the Technology Acceptance Model brought up by Davis in 1989, but the new model will be incorporated and extended considering the Internet of Things Technology in the context of smart home environment. Integrated version of the model will be presented to predict consumers' intention to adopt smart speakers from the perspectives of product itself, individual characteristics, financial concerns and social influence. Based on the literature reviewed, the main research question is:

RQ: What are the factors that influence perspective users' intention to adopt smart speakers in smart home environment?

The following factors are examined in this study: perceived usefulness, perceived ease of use, attitude, familiarity with technology, IoT skills, trust, social influence, perceived cost, security, enjoyment and reliability. The relationships between the independent variables and the dependent variable have been examined by the means of a survey.

2 Theoretical Framework

2.1 Internet of Things (IoT) in smart home environment

Before deeply studying the related issues about smart speakers, the basic knowledge about Internet of Things and smart home technology need to be briefly explained first.

Internet of Things (IoT) is a procedure and technology that connects objects with the Internet, using sensors and components included in each object (Fubbi, Buyya, Marusic & Palaniswami, 2013). Due to the attributes that IoT can be used in home networks, many IoT corporates have developed smart home platform, "one of the most promising IoT sectors (Valtchev, D. & Frankov, I., 2002)". Using IoT to provide novel technology and solutions is the mainstream of home automation environment (Park, Kim, Kim & Sang, 2017). Based on this technology, household devices are linked between Internet and mobile applications with wireless network. Such smart home devices and appliances include, but not restrict to, security camera, smart speakers, light system, smart thermostat, smart home hub, smart smoke detector, etc.

The International Data Corporation did an estimation in 2015, concluding that the total amount spent on the Internet of Things throughout the world will increase to around $1.3 trillion in the upcoming four years, among which Asia Pacific will top the list, holding over 40% of the entire amount (IDC, 2015). Among those IoT devices and appliances, smart homes services accounted for $25.38 billion approximately around the world in 2015, and is predicted to have 17.2% annual growth rate in the following five years (Markets and Markets, 2016).

For this study, smart home devices can be defined as a general term representing all solutions which use IoT technology to monitor, control and manage systems connecting all electronic appliances (Kim, Park, & Choi, 2017). Smart speakers, as a kind of relatively new smart home devices, are designed not only to play music, but to control home automation devices using human voice. After giving permission to smart speakers to get access to your personal information and your smart home devices, consumers can use them to switch on the lamp before getting out of bed, turn on the coffee maker on the way to the kitchen, or dim the lights from the couch to watch a movie—all without lifting a finger. Ask the intelligent assistants to turn on the TV, turn up the volume, change the channel, or play your favourite movie. Echo, for example, can control your Amazon Fire TV and select devices from Sony, Dish, and Logitech. Control multiple devices at scheduled times or with a single voice command, like locking the doors and turning off the lights when you go to bed. They work with lights, locks, switches, thermostats, and more from WeMo, Philips Hue, SmartThings, Insteon, Nest, ecobee, and Wink and so forth. Together with Apple Music and Siri, Apple Homepod creates an entirely new way for consumers with everyday tasks from getting the latest weather to sending messages and controlling smart home accessories, Siri makes it easy to multitask with just consumers' voice.

Some research has probed potential customers' concerns about home automation devices by combining several methods such as workshops, focus groups or technology labs (Balta-Ozkan et al., 2013a, 2014). In the meantime, these studies have also discovered the possible barriers of adopting smart home devices including "cost, privacy, security, reliability, and the interoperability of different technologies".

2.2 Technology Acceptance Model (TAM)

Although Internet of Things has already had its development in recent decade, the practical use in normal people's life is still limited. Since the user base of smart speakers is relatively small, the study of the intention to adopt serves as a necessary base for later studies of consumer behaviour.

When a new technology or system is introduced in the increasingly competitive market, one practical and effective way to estimate its success is to study the acceptance or adoption pattern (Gagnon et al., 2003). There are several theoretical models for exploring the acceptance process, one of the most diffusely used model is Technology Acceptance Model (Davis, 1989). It is brought up by Davis in 1989, which is a predominant extension of the theory of reasoned action. It is proved to be more empirical in supporting IT related area than the theory of planned behaviour (Ajzen, 1985). There are four constructs accounting for the original TAM, namely the intention to use, perceived usefulness, perceived ease of use and attitude.

For the exploration of information oriented technology or smart systems, TAM has been implemented as a valuable theoretical model (Park, Kim, Kim & Sang, 2017). Previous studies have confirmed and validated the TAM as a key model for novel technologies, especially for information-related devices and systems (Park et al., 2014). In professional area, there are several research applying TAM model. For instance, it is used by Chen et al (2009) to illustrate consumers' intention to use smart phones and is added self-efficacy factor in the original model. Kim (2008), Kang et al (2011), Lee et al (2012) and Pan et al (2013) used TAM model to investigate the acceptance and adoption of smartphones among different target groups. TAM has also a wide range of applications in other areas, such as the adoption of e-health (Dunnebeil et al., 2012) and e-learning (Lee et al., 2012), internet banking (Alajam & Nor, 2013), online shopping (MccloKcy, 2003).

A large number of empirical research has found that intention to use is an appropriate variable in that it is a proper predictor of later usage and consumer behaviour (Lee, Park, Chung & Blakeney, 2012). In this study, intention to use can be considered as the intention to adopt IoT technology in smart home environment.

According to Davis (1989), the intention to use a new technology is decided by the attitude toward the technology and perceived usefulness, whereas attitude can be influenced by the perceived usefulness and perceived ease of use.

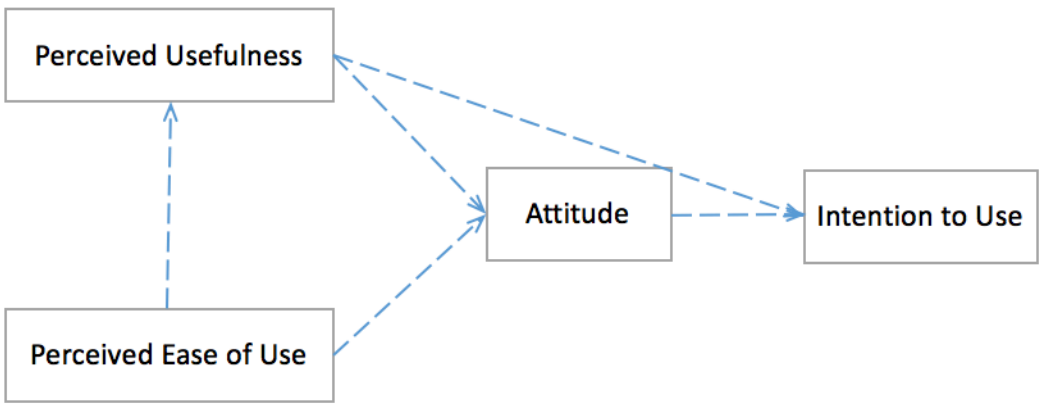

Figure 1. The original TAM

2.2.1 Attitude toward IoT

Attitude is an evaluative judgment or beliefs and feelings consumers find a particular object (Kardes, Cronley &Cline, 2011). In the context of smart speakers in smart home environment, attitude can be considered as the expected feelings of potential consumers towards the new products and the degree to which consumers expect the performance of a certain device to be satisfying. Prior research has found that determinants such as perceived usefulness, perceived ease of use influence behavioural intention through attitude. Bhattacherjee (2000) and Kim et al (2011) suggested an important relationship between attitude and intention. The results in Park et al. (2017)'s research suggested that consumers' attitude toward IoT technology is the most essential factor of their intention to use.

2.2.2 Perceived usefulness

Perceived usefulness has been described as the extent to which a person believes that using a specific system or service would improve performance (Davis, 1989). It has been treated as one of the most important factors of IT acceptance. The Innovation Diffusion Theory (IDT) underscores that consumers will choose to use innovations only if the innovations can offer a unique advantage over the existing solutions (Rogers, 1995). Applying this in the TAM, the unique advantage can be seen as the perceived usefulness. Therefore, in this case, perceived usefulness is consumers' feeling about enhanced performance when they are using smart speakers. Consumers perceived usefulness is found to have a positive influence in people's intention to use smartphones (Park & Chen, 2007) and long-term evolution (LTE) services (Park & Kim, 2013).

2.2.3 Perceived ease of use

Perceived ease of use has been defined as the extent to which consumers believe that using a specific technology would be free from effort. In other words, consumers need to feel the new devices in their homes are easy to use. It is a similar construct as the complexity of the innovation diffusion theory (IDT) and the effort expectancy of the unified theory of acceptance and usage of technology (UTAUT) (Venkatesh et al., 2003). As for smart home consumers to adopt smart speakers, it is essential for them to feel that smart speakers are easy to use and control. Prior research has suggested that perceived ease of use is a crucial factor for intentions to use the technologies (Davis, 1989; Lee et al., 2012). Kim et al. (2015) suggested that customer satisfaction for smart home system is considerably lower than other technologies, one of the reasons is the difficulty of operating IoT devices. According to TAM, perceived ease of use also influences perceived usefulness. (Venkatesh et al., 2003).

Based on the original TAM in the prior research, the following hypotheses regarding the intention to adopt smart home technology can be proposed:

H1: Attitude toward smart speakers has a positive influence on the intention to adopt.

H2: Perceived usefulness of smart speakers has a positive influence on attitude.

H3: Perceived usefulness of smart speakers has a positive influence on the intention to adopt the technology.

H4: Perceived ease of use of smart speakers has a positive influence on attitude toward the technology.

H5: Perceived ease of use of smart speakers has a positive influence on the perceived usefulness of the technology.

Following TAM, these three variables serve as an important part in predicting consumers' intention to use a new technology. For this research, TAM acts as a solid theoretical basis and has been adapted to the context of smart speakers in smart home environment. It is validated by Gao and Bai (2014) that two elements in the original TAM, i.e., perceived usefulness and perceived ease of use account for user intentions to use IoT technology, along with other factors such as social influence, perceived enjoyment and so forth. According to Venkatesh et al. (2012), apart from TAM, other factors, for example the opinions from other people, also affect a person's acceptance toward IoT devices. What's more, albeit very willing to adopt, consumers are not capable to do so if they don't have necessary skills (Ajzen, 2011). Therefore, certain extensions to TAM are reasonable to account for the adoption intention of smart speakers since the original model may not be sufficient under the smart home environment. This research will extend the original TAM in four perspectives-user characteristics, product characteristics, social characteristics and economic characteristics.

2.3 User Characteristics

2.3.1 Self-innovativeness

Self-innovativeness describes as a person's willingness to seek and try out a new technology and the extent to which a person is relatively earlier in adopting new technology than other people (Sánchez-Franco et al., 2011). Since smart speakers represent an innovation, previous studies about innovation may be effectively applied to this area. If consumers are more willing to embrace innovative technology in general, they may be more willing and more confident to use smart speakers- as a new technology device. As Sánchez-Franco et al. (2011) suggested personal innovativeness has a stable effect on situations related to information technology. As Woszczynski et al. (2002) argued that people who has a high score on personal innovativeness tend to be the first to adopt a new product. Agarwal and Prasad (1998) have also taken self-innovativeness as an important personal trait for examining the acceptance of IT innovations particularly.

A study conducted by Sang (2014) suggested that self-innovativeness has a significant influence on smartphone adoption, which indicated a person who "perceives him/herself as being innovative is more possible to buy a smartphone". Early adopters, one of the first people or organizations to make use of a new technology, who is more likely to be attracted by the novelty of smart home devices, are of vital importance for differentiated marketing and sales strategies (Wilson, Hargreaves, & Hauxwell-Baldwin, 2017). By testing new technologies and communicating their pros and cons to the more risk-averse majority, early adopters will influence market growth in a great scale (Rogers, 2003).

H6: Self-innovativeness has a positive influence on attitude toward smart speakers.

H7: Self-innovativeness has a positive influence on the adoption of smart speakers.

2.3.2 Trust

The concept of trust can vary from different areas of studies, but can be loosely defined as "a state involving confident positive expectations about another's motives with respect to oneself in situations entailing risk" (Siau & Shen, 2003). In the context of IoT, trust can be

considered as the extent to which consumers believe the smart speakers will keep their data safe and will have a positive impact for their life.

When people are facing with uncertainty, trust is a vital determinant of what people expect from the situation, both in social interaction and in business interaction (Awad & Ragowsky, 2008). Trust is a pivotal factor in stimulating purchases over the Internet (Quelch & Klein, 1996), especially at the early stage of buying behaviour. Awad and Ragowsky (2008) suggested that increasing level of trust are connected with the increasing level of use. Due to the high involvement of IT in IoT technology, consumers are inclined to feel uncertain and doubted about adopting it. Trust can effectively reduce uncertainty and provide safety to some extent. Trust has been integrated into TAM in Shih's research (2004) and showed a better result of consumer's behavioural intention than other existing models.

H8: Consumers' trust with smart speakers has a positive influence on the attitude.

2.3.3 IoT skills

With the fast advancement of internet in the last decade, the skills of using the internet seem to be fundamental for those who have access to internet. To use smart home devices including smart speakers successfully, consumers also need IoT knowledge and skills to some extent. There are some suggestions such as some mentioned in the article "Six Essential Skills for Mastering the Internet of Connected Things". One of the skills is to envision connected things to take into account the capabilities and characteristics of the thing, the data flowing to and from the thing, and the applications able to access the thing (Charmonman et al., 2015).

To explain individuals' differences in internet use, digital skills have been proven to be a significant factor (Van Dijk, 2005). Van Dijk and Van Deursen (2014) developed a typology of digital skills including six parts: operational skills, formal skills, information skills, communication skills, content creation skills and strategic skills. Applying this typology into the IoT technology, Van Deursen and Mossberger (2018) suggest that some characteristics of IoT demands more in information, communication and strategic skills; however, operational and formal skills are less important. Comparing to its traditional counterparts, IoT devices collect more information from its users and generate more data with little control from the users. As a result, in this study IoT skills for using smart speakers mainly include the skills to operate the devices and manage the data the speakers gather, which are the ability to use hardware and software, to interpret the data, to understand how speakers communicate with other devices and to decide what data should be collected and used (van Deursen & Mossberger, 2018).

Having IoT skills in this content can be seen as being familiar with IoT technology. According to Dabholkar (1996), the level of familiarity with technology has an effect on using technology-oriented self-service. The more familiar consumers are with technology, the more favourable attitudes they will form. Moreover, if a person becomes familiar to a specific technology, he or she will be more readily to adopt other technologies (Dickerson & Gentry, 1983). Therefore, consumer familiarity with technology in general has a straightforward relation with consumer attitudes and behaviour toward a particular technology (Dabholkar, Bobbitt & Lee, 2003). In the interviews Ehrenhard et al. (2014) conducted about smart home service, one key factor that constrains implementation of IoT is unfamiliarity with the technology. Consumers are fear of using a new technology under the circumstances that they don't know much about it.

H9: Consumers' IoT skills affect the perceived ease of use of smart assistant positively.

H10: Consumers' IoT skills affect the intention of adopting smart assistant positively

2.4 Social Characteristics

Social Influence

Social influence is defined by Lin and Bhattacherjee (2010) as the extent to which consumers achieve respect and admiration from their peer group in social network. It can be described in this study as the degree to which consumers believe using smart speakers is popular in their social surroundings. The influence of social surroundings can come from peers, relatives, and in a larger scale, from media, even the whole society. The influence from social context should be taken into consideration when evaluating the process of decision making of technology innovation especially in the early stage of the diffusion when most consumers know little about the new product or service.

According to Deutsch and Gerard (1995), social influence in the interpersonal influence theory contains two aspects: informational influence and normative influence. In Venkatesh and Bala's (2008) model these two aspects are called subjective norm and image. Informational social influence occurs when information obtained from other people is considered as evidence about reality. Assessments, reviews and opinions from peers and mass media can influence consumer behaviour toward smart home devices. Consumers' acceptance may increase when they see other people are using these products or when others encourage them to adopt these devices. Normative social influence arises when a user complies to the expectations to obtain a reward or avoid a punishment, which is a form of self-identification and compliance. Park and Chen (2007) discovered that people's intention to buy products from worldwide luxury brands had a positive relation with an intense belief in social recognition. What's more, del Rio et al (2001) found that sometimes people purchase specific products partly because they want to express their social status. Chan and Lu (2004) also suggested that normative influence had a positive effect on the perception of IT adoption. Smart speakers are relatively the latest IT products, comparing to smartphones and tablets, etc., which might result in the users can be considered as innovators because of their early adoption (Yang et al, 2016). It is confirmed by Hsu and Lu (2004) that incorporating social influence into TAM showed significant influence on users' intention to accept technologies.

H11: Social influence influences perceived usefulness of smart speakers positively.

H12: Social influence influences the intention to adopt smart speakers positively.

2.5 Product Characteristics

2.5.1 Security

In order to provide tailored actions to best meet householders need, smart home devices need to collect information and data from users. Such information can be users' preference for food, their daily routine, energy consumption. A basic requirement for the industry is to ensure private information and data be secured safely. As a smart speaker will act as an assistant of users' daily life, it also requires permission of personal data such as calendar, contact book, email, and so forth. Moreover, considering the remote control of household appliances on mobile devices, especially security devices (such as opening the

door), effort will also be stressed to make sure these security appliances work functionally (Balta-Ozkan et al., 2013).

Security is an essential factor in using information-based systems (Daniel, 1999). Based upon the definition of security on information systems used by previous studies, security can be defined as "the protection level against the potential threats (Yousafzai et al, 2010)" when using smart home system.

Technically, the IoT technology still has some potential risks, such as system and data hacking, certain security threats due to the use of internet connection, etcetera. Especially the possibility that the security of the house or the private data may be collected and controlled by someone they don't know. Therefore, security concern is a core determinant for users to adopt the technology when it is still in its development stage. Several studies have reported that the level of perceived security is of significance in users' perception of IT related products and services (Cheng et al., 2007; Dong, 2009).

H13: The level of security of smart speakers has a positive influence on perceived usefulness of the technology.

2.5.2 Enjoyment

On the basis of the definition of enjoyment used by previous research, perceived enjoyment in this study can be defined as the degree of which using smart speakers is perceived to be playful and enjoyable (internal and emotional benefits) (Heijden, 2003). When using smart speakers can bring pleasure, users will be inherently motivated to adopt the innovation. It has been taken as a possible motivation by Davis et al. (1989) when considering the determinant of TAM. They examined both intrinsic and extrinsic factors, and then discovered notable relationship between perceived enjoyment and the two moderators of TAM.

Bruner and Kumar (2005) has found enjoyment, as a major intrinsic motivation, is able to prompt consumers to adopt an innovation. Some studies have underscored the relationship between perceived enjoyment and consumers' other perception. Kim et al. (2008) found an obvious connection between perceived usefulness and enjoyment under the context of mobile message service. Enjoyment also plays a significant role on user intention and behaviour in mobile commerce (Song et al., 2008). According to Rese et al. (2014), in the context of information technology, users' enjoyment determines perceived usability of the technology. It is also proved that perceived enjoyment is a significant determinant of perceived ease of use of information delivering system (Pobil & Park, 2013).

H14: Perceived enjoyment of smart speakers has a positive effect on perceived usefulness of the technology.

H15: Perceived enjoyment of smart speakers has a positive effect on perceived ease of use of the technology.

2.5.3 Reliability

Reliability can be understood as the extent to which the smart speakers can provide reliable services that meet consumers' expectations (Park, Kim &Ohm, 2015). "The standardization, interoperability and compatibility" of the technology and products all serve as a great barrier for reliability (Ehrenhard et al., 2014). The reliability of smart speakers is composed of two aspects. On one hand, the devices should carry out exactly the desired

action of the householder. In another word, if the system cannot understand and act accurately as it is told, even though it is flawless in technical implementation, it will still be taken as unreliable. On the other hand, the reliability lies in the likelihood that the IoT technologies will not malfunction (Balta-Ozkan et al., 2013).

It is illustrated by Lu et al. (2008) that perceived reliability from consumers is a predominant factor of Technology Acceptance Model regarding wireless mobile services.

H16: The level of reliability of smart home devices has a positive influence on perceived usefulness of the technology.

2.6 Economic Characteristics

Perceived cost

Albeit the intentions to use new technologies are prominent, financial burden is still one significant factor that hinder people from accepting it (Kim & Ammeter, 2014). Shin (2009) defined the perceived cost in information services and systems as the consideration and worry concerning the costs to purchase, maintain, and repair the necessary elements in the services and systems. Prior studies on new technologies showed clear evidence about the relationship between consumer acceptance and perceived cost. William, Bernold and Lu (2007) discovered that perceived cost played an important part in consumers' intention to adopt information oriented technologies. Market research in the IoT area has discovered the most important barrier for the majority to adopt is the price (GfK, 2016). Park et al. (2017) also found similar results showing cost as a notable predictor of intention. As the smart speakers are still in the early stage of competitive market, the economic part is also necessary in the market success.

Based on the definition included in the previous research, the perceived cost of this study can be defined as potential users' concern about the estimated costs to purchase, maintain and repair the devices and appliances in smart home system. It can consist of three parts: the cost of purchasing and installing the products; the cost of a new building system that fit for the products; and the maintenance cost. Son et al (2012) illustrate that there is a negative relation between the perceived cost and the will to adopt information systems proved by a wide range of previous research.

Thus based on negative correlation between costs and adoption that the prior research conducted, this study suggests the following hypothesis:

H17: Perceived cost of smart home devices has a negative influence on the intention of adoption.

2.7 Conceptual Model

To be able to answer the research question by testing the above-mentioned hypotheses, the following conceptual framework, an integrated technology acceptance model, has been proposed. It is based on the theory of technology acceptance model (TAM), in the meantime integrating several other potential factors in developing a comprehensive model of consumer adoption of smart speakers.

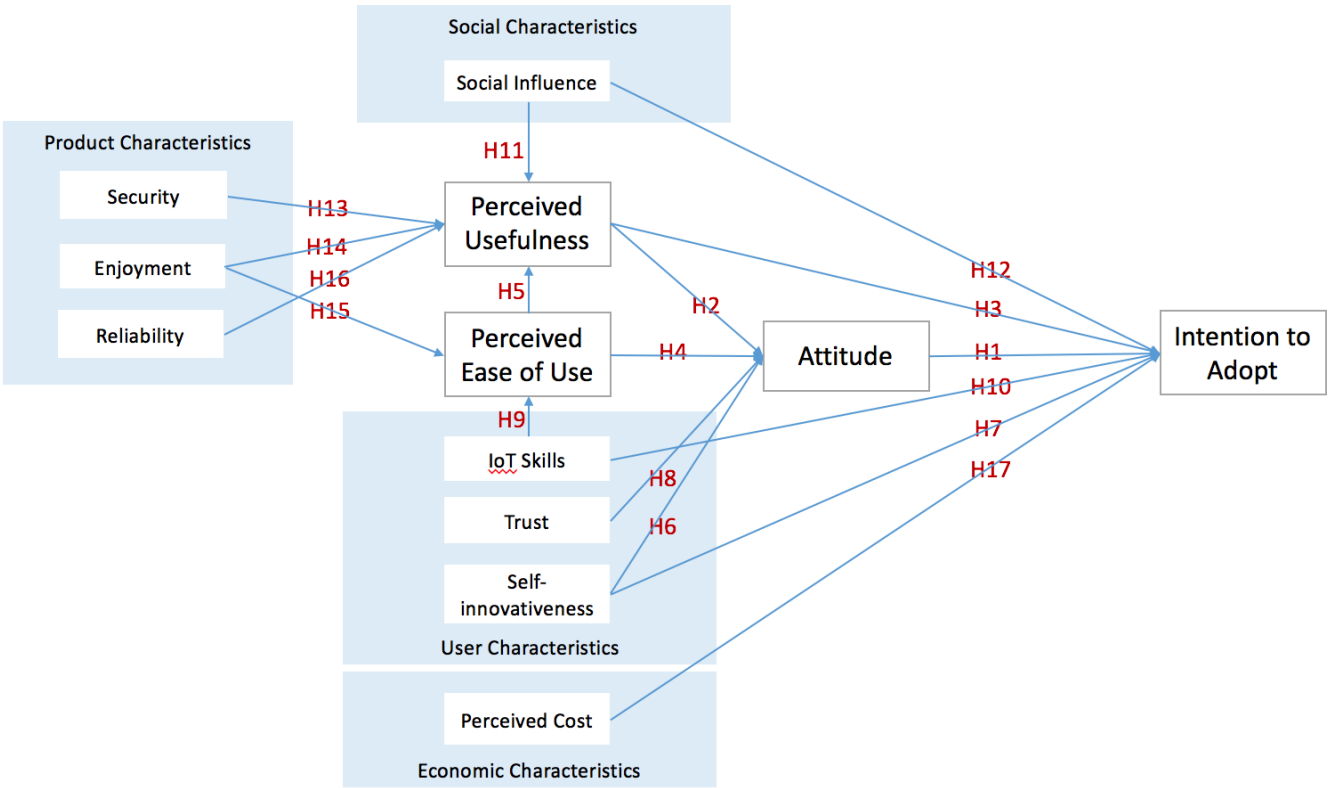

Figure 2. Conceptual model

3 Method

3.1 Research design

The research used a questionnaire survey in order to examine the proposed model. In order to prime the respondents with smart speakers, a brief introductory material was shown to the respondents before they did the survey (See Appendix 1).

The first section of the survey was composed of questions concerning demographic information about the participants (i.e., gender, age, education level, income level, living situation). User experience with smart home devices and smart speakers were also included.

The second part contained items used to measure factors from the extended model. A five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was used in constructing the survey.

The survey will be constructed in English and will be translated into Chinese in case some Chinese respondents cannot understand English very well.

3.2 Pre-test

The questionnaire was pre-tested by 5 participants before the main study to determine whether all the related information and survey items could be understood. Those respondents did not take part in the final survey. They suggested some minor changes in the wording of some items and the questionnaire's format and indicated no problems with its length or the time needed to complete it. After the pre-test, some modifications were made based on the suggestions they provided.

3.3 Data collection

The survey was conducted over 10 days in the autumn of 2018. The intended population of this study mainly focused on adults aging from 18 to 60 with no further age restrictions or nationality restrictions. The average time for all the survey questions was 10 minutes.

The sampling procedure used snowball sampling consisting of two stages. In the first stage, a group of 150 respondents were approached by direct message through personal social network. On the second stage, those who participated in the first stage were requested to forward the questionnaire to two other individuals through their social network.

In total, a convenience sample of approximately 500 people was selected, from which the response rate was around 75.4%, from which 72 responses were still in progress by the end of the collecting process. There were 305 recorded responses totally with 150 male respondents and 155 female respondents. Among all the participants, over half of them have no experience with smart speakers and almost a half have no experience with any kind of smart home devices. The youngest respondent is 18 years old and the oldest is 58 years old. 51 respondents from Europe filled the questionnaires in English. 254 respondents are from China and used the Chinese version. All the demographic information is displayed in Table 1.

Table 1. Respondents' demographic information

Measure	Items	Frequency	Percentage
Gender	Female	155	50.8%
	Male	150	49.2%
	Other	0	0%
Living situation	Live with parents	46	15.1%
	Live alone	79	25.9%
	Live with spouse	102	33.4%
	Live with house mates	69	22.6%
	Other	9	3.0%
Education	Junior school or less	5	1.6%
	High school	30	9.8%
	Bachelor degree or equivalent	210	68.9
	Master degree or equivalent	54	17.7%
	Doctor degree or equivalent	6	2.0%
Income	Less than 50k CNY/20k EUR	111	36.4%
	50k-150k CNY/20k-40k EUR	111	36.4%
	150k-250k CNY/40k-60k EUR	59	19.3
	Higher than 250k CNY/70k EUR	24	7.9%
Experience with smart home devices	Have smart home devices at home	98	32.1%
	Used smart home devices but do not have one	78	25.6%
	No experience	129	42.3%
Experience with smart speakers	Have smart speaker at home	66	21.6%
	Used smart speaker but do not have one	73	23.9%
	No experience	166	54.4%
Total		305	100%

3.4 Measures

All the constructs in the conceptual model were measured by 5-point Likert scale items, with 1 being strongly disagree and 5 being strongly agree. Some of the items were adopted from existing literature with necessary adaption and the others were self-generated specifically for the context of home automation. Besides the constructs, the survey had several items to measure the respondents' demographic characteristics, including their age, gender, income level, living situation as well as their experience with smart home devices and smart speakers. The entire questionnaire can be found in Appendix 2.

The dependent variable intention to adopt was measured using the purchase intention scale developed by Baker and Churchill (1977). The scale was characterized by three 5-point

Likert items used to measure the inclination of a consumer to buy a smart speaker (M=3.59, SD=0.86, α=0.83). Example items were: I am willing to use smart speakers in the near future; I intend to use smart speakers in the near future.

The items to measure attitude toward smart speakers were based on a set of three items (M=3.55, SD=0.77, α=0.81). Example items of this scale were: I like the idea of using smart speakers; I will be satisfied by smart speakers.

Perceived ease of use was measured combining the scale used by Nysveen et al. (2005) and Thompson et al. (2005). Thompson et al. (2005) used statements to assess how easily a person perceives that a specific product can be used or learn to be used. Nysveen et al. (2005) examined mobile services using their scale composing five-point Likert type statements that were intended to measure a person's attitude concerning the effort required to learn and use something. Perceived ease of use (M=3.71, SD=0.81, α=0.82) was measured by three items such as: The commands of operating smart speakers will be clear and understandable; Remembering use of commands of smart speakers will be difficult for me.

Perceived usefulness was measured through the usefulness of the object scale by Nysveen, Pederson and Thorbjornsen (2005) with mobile services. The scale was composed of five-point Likert-type statements intended to measure the extent to which a person views the usage of something as helping to improve one's efficiency and effectiveness (M=3.55, SD=0.79, α=0.81). Perceived usefulness was measured with three items such as: Using smart speakers will make it difficult for me to do daily tasks; Using smart speakers improves my efficiency and effectiveness of daily tasks.

The measurement of self-innovativeness was inspired by the object scale developed by Oliver and Bearden (1985). This scale is adapted to the IoT context and consisted of four items (M=3.35, SD=0.84, α=0.76). Example items were: I perceive myself as an early adopter with new technology; I consider myself knowledgeable about the new trend of technology.

The perceived cost was measured by four items adjusted from Adaval and Monroe's (2002) scale for sacrifice (M=3.19, SD=1.03, α=0.92). Two example items were: The price for smart speakers is expensive for me; Buying and operating smart speakers are a financial burden to me.

Social influence was measured by Bearden, Netemeyer and Teel's (1989) consumer susceptibility to interpersonal influence (CSII) scale. The scale measures the degree to which a person expresses the tendency to seek information about products by observing others' behaviour and asking for their opinions with four items (M=3.56, SD=0.81, α=0.84). Example scale items were: People who are important to me use smart speakers; I heard successful experience about using smart speakers from other people.

Some of the independent variables are specifically related to the IoT technology in smart home environment. Therefore, some self-generated scales were used to measure them. Security was measured with three items (M=3.12, SD=0.88, α=0.79). Example items were: I think no one else can see and use my personal information stored in smart speakers; Smart speakers will keep my personal information safely. There were four items measuring enjoyment (M=3.72, SD=0.74, α=0.76) with examples like: I think using a smart speaker is enjoyable; Using a smart speaker will give pleasure. Reliability was measured with three items (M=3.30, SD=0.77, α=0.72). For example: smart speakers can perform their functions

all the time; smart speakers can provide reliable information. IoT skill was measured by four items (M=3.27, SD=0.73, α=0.59). Example items were: I know how to use smart speakers and its applications; I know how to interpret data from smart speakers. Trust with three items (M=3.45, SD=0.77, α=0.75) such as: smart speakers are trustworthy; smart speakers act with good intentions.

Table 2. Descriptive information & reliability assessment

Variables	No. of Items	Mean	Std Deviation	Cronbach's alpha
Security	3	3.12	0.88	0.79
Enjoyment	4	3.72	0.74	0.76
Reliability	3	3.30	0.77	0.72
Internet Skills	4	3.27	0.74	0.59
Trust	3	3.45	0.77	0.75
Self-innovativeness	4	3.35	0.84	0.76
Social Influence	4	3.56	0.81	0.84
Perceived usefulness	3	3.55	0.79	0.81
Perceived ease of use	3	3.71	0.81	0.82
Perceived cost	4	3.19	1.03	0.92
Attitude toward smart speakers	3	3.55	0.77	0.81
Intention to adopt	3	3.59	0.86	0.83

Reliability was test using Cronbach's alpha. Measurement validation consisted of testing convergent validity and discriminate validity using varimax rotated component matrix in factor analysis.

Kline (2015) recommend the reliability criterion to be higher than 0.6-0.7. The results showed that values for Cronbach's alpha ranged from 0.72 to 0.92 except the value for IoT skills is just below 0.6, but considering errors in social science research it was considered to be relevant for this study.

Convergent validity can be established when composite reliability (CR) is 0.7 or higher and the average variance extracted (AVE) is 0.5 or higher. As presented in Table 4, CR values were higher than the criterion 0.7 for all constructs and the AVE values were also higher than the criterion 0.5 for all constructs, thereby establishing convergent validity (Fornell & Larcker, 1981).

The squared root of the AVE for every factor is greater than the correlation coefficient between the relevant factor and other factors indicated the discriminant validity in the measurement model as shown in Table 3.

Table 3. Validity assessment

Constructs	Items	Factor loading	CR	AVE	SQRT(AVE)
Security	SE1	0.81	0.88	0.71	0.84
	SE3	0.85			
	SE4	0.86			
Enjoyment	EN1	0.74	0.85	0.59	0.77
	EN2	0.80			
	EN3	0.77			
	EN4	0.75			
Reliability	RE1	0.80	0.85	0.64	0.80
	RE2	0.81			
	RE3	0.79			
IoT Skills	IS1	0.74	0.76	0.55	0.74
	IS2	0.62			
	IS3	0.64			
	IS4	0.67			
Trust	TR1	0.84	0.86	0.67	0.82
	TR2	0.87			
	TR3	0.74			
Self-innovativeness	SIT1	0.75	0.85	0.58	0.76
	SIT2	0.79			
	SIT3	0.72			
	SIT4	0.78			
Social Influence	SI1	0.83	0.89	0.68	0.82
	SI2	0.87			
	SI3	0.84			
	SI4	0.75			
Perceived Usefulness	PU1	0.84	0.89	0.72	0.85
	PU2	0.85			
	PU3	0.86			
Perceived Ease of Use	PEOU1	0.87	0.89	0.74	0.86
	PEOU3	0.85			
	PEOU4	0.86			
Perceived Cost	PC1	0.85	0.95	0.81	0.90
	PC2	0.92			
	PC3	0.90			
	PC4	0.92			
Attitude	AT1	0.79	0.88	0.64	0.80
	AT2	0.83			
	AT3	0.76			
	AT4	0.82			
Intention to Adopt	ITA1	0.86	0.90	0.75	0.87
	ITA2	0.89			
	ITA3	0.84			

3.5 Data analysis

The analysis of the study started after merging and importing the data into SPSS 25. The analysis consisted of different frequency and descriptive tables, and reliability analysis (Cronbach's alpha), a correlation analysis, and model testing by a regression analysis. Several descriptive results and the reliability analysis were addressed in this method section already. The results of the correlation analysis and regression analysis were stated in the following results section. By using AMOS, structural equation modelling was applied to test the hypotheses and relations presented in the conceptual model in Figure 1.

4 Results

4.1 Correlations

A Pearson correlation analysis was conducted to test for correlations of each construct. Table 4 shows an overview of the correlations. Consumers' attitude toward smart speakers is strongly correlated with their intention to adopt such devices (r=0.78) and perceived usefulness is strongly correlated with attitude (r=0.61). These are two of the main constructs of TAM and also proven by this study. There is a strong correlation between IoT skills and self-innovativeness (r=0.59) which may suggest that people who perceive themselves as innovative are very likely to possess IoT skills. The results showed that social influence is an influential variable because there are four correlations above 0.50 between social influence and other variables (trust, perceived usefulness, attitude, and intention to adopt). The same also goes with trust. There are four correlations above 0.50 including two strong correlations with perceived usefulness (r=0.62) and reliability (r=0.61).

According to the results, there are some correlations but relatively weak among demographic information. For instance, gender has a negative correlation with IoT skills(r=-0.18) and self-innovativeness (r=-0.24). Since in the questionnaire, 1 stands for male and 2 stands for female, this may suggest that male respondents would be more likely to perceive themselves as innovative and possessing IoT skills than female respondents did. In regard to perceived cost, as the income level goes higher, respondents are supposed not to take cost as a burden to them. Moreover, on the contrary of expectations, the correlations between age and IoT skills (r=-0.08) as well as self-innovativeness (r=0.08) are very weak. However, participants' experiences with smart speakers do have significant correlations with several variables, such as intention to adopt (r=-0.35), attitude (r=-0.38), self-innovativeness (r=-0.29), and IoT skills (r=-0.29). Since experience with smart speakers was measured by a three-point scale, it was not included in the conceptual model.

Correlation

	SE	EN	RE	IS	TR	SIT	SI	PU	PEOU	PC	AT	ITA	Gen	Age	Edu	Inc	EXP1	EXP2
Security	1																	
Enjoyment	.11	1																
Reliability	.49**	.23**	1															
Internet Skills	.21**	.41**	.27**	1														
Trust	.48**	.37**	.61**	.24**	1													
Self-innovativeness	.16**	.23**	.24**	.59**	.11**	1												
Social Influence	.31**	.45**	.41**	.35**	.56**	.25**	1											
Perceived usefulness	.44**	.46**	.47**	.39**	.62**	.31**	.55**	1										
Perceived ease of use	.15*	.34**	.30**	.34**	.42**	.31**	.40**	.49**	1									
Perceived cost	-.00	.27**	-.01	.40**	.02	.44**	.11	.11	.08	1								
Attitude	.26**	.62**	.37**	.50**	.49**	.43**	.53**	.61**	.45**	.30**	1							
Intention to adopt	.26**	.52**	.40*	.44**	.51**	.40*	.56**	.56**	.44**	.25**	.78*	1						
Gender	-.04	-.10	-.05	-.18**	-.07	-.24**	-.02	-.06	-.10	-.13*	-.05	-.06	1					
Age	.10	.07	.15*	-.08	.15**	.08	.18**	.07	-.03	.03	.07	.12*	-.14*	1				
Education level	-.22**	.16**	-.06	.11	-.04	.08	.01	.06	.13*	.02	.11*	.14*	-.01	.02	1			
Income level	.00	.21**	.08	.18**	.05	.22**	.14*	.07	.05	.31**	-.16**	.14*	-.22**	.34**	.12*	1		
Experience 1	.00	-.21**	-.05	-.22**	-.10	-.22**	-.14*	-.14**	-.15*	-.20**	-.26**	-.24**	.12*	-.20**	-.06	-.08	1	
Experience 2	.01	-.26**	-.06	-.29**	-.14*	-.30**	-.19**	-.21**	-.21**	-.26**	-.38**	-.35**	.07	-.14**	-.09	-.11	.68**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4. Correlations

4.2 Model testing

The conceptual model (see Figure 1) is analysed through structural equation modelling (SEM) using AMOS. First the conceptual model has been tested for goodness-of-fit statistics: X^2/df ratio, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the goodness-of-fit index (GFI), the normed fit index (NFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). After that, several paths between several variables based on modification indices were added to the conceptual model. These paths were chosen based on common knowledge and previous studies, and then tested respectively to get the best model fit. The final modified model was tested again regarding the related statistics. These statistics were shown in Table 5.

Hoe (2014) states that CFI>0.90 indicates an acceptable model fit. For TLI, Hu and Bentler (2009) suggest TLI>0.95 indicates close fit, TLI>0.90 indicates fair fit, and TLI>0.85 indicates acceptable fit. For the RMSEA statistic, Steiger (1989) suggests values between 0.00 to 0.05 indicate close fit, values between 0.05 to 0.08 indicate fair fit and values between 0.08 to 0.10 indicate acceptable fit. And for SRMR, values <0.08 indicate appropriate model fit (Hu& Bentler, 2009).

Table 5. Goodness-of-fit estimates for conceptual model and modified model

	χ^2/df	CFI	TLI	GFI	NFI	RMSEA	SRMR
Conceptual model	7.96	0.91	0.72	0.92	0.90	0.15	0.08
Modified model	1.12	0.99	0.99	0.99	0.99	0.02	0.02

The modified model can be found in Figure 2. Table 6 shows the standardized direct, indirect, and total effects (β) of all the hypotheses and some added paths.

The dependent variable intention to adopt has a $R^2$of 0.64 which means the variance of intention to adopt can be explained for 64% by social influence, trust, and attitude. Perceived usefulness, perceived ease of use, enjoyment, trust, and self-innovativeness have an explanatory power of 59% regarding attitude. In regard to perceived usefulness, social influence, security, enjoyment, reliability, trust, and perceived ease of use have an explanatory power of 55%. Moreover, IoT skills, trust, self-innovativeness, and enjoyment have an explained variance of 0.30 for perceived ease of use.

The analysis supports the paths of the technology acceptance model except for the influence of perceived usefulness on intention. Attitude is a significant predictor for intention to adopt (β=.71, p=<.001). Perceived usefulness (β=.24, p=<.001) and perceived ease of use (β=.12, p=0.012) both influence attitude significantly. The influence of perceived ease of use on perceived usefulness (β=.25, p=<.001) is also supported.

As for the extended model, social influence is a significant predictor, which has a direct influence on intention to adopt (β=.18, p=<.001) and perceived usefulness (β=.15, p=<.001). Also, the influence of enjoyment on perceived usefulness (β=.20, p=<.001) and perceived ease of use (β=.23, p=<.001) is supported. Moreover, the results showed enjoyment has a direct influence on attitude (β=.13, p=<.001). However, the direct influences of IoT skills, self-innovativeness and perceived cost on intention to adopt are rejected, which are not conforming the stated hypothesis. The prediction of trust for attitude (β=.13, p=<.001) and self-innovativeness for attitude (β=.19, p=<.001) are supported. Following the analysis,

perceived usefulness is a key variable in the extended model for adopting smart speakers, since it is significantly influenced by most of the independent variables (social influence, security, enjoyment, reliability), and has a strong influence on attitude. Another significant predictor is trust, which influences perceived ease of use (β=.33, p=<.001), attitude (β=.36, p=<.001), and intention to adopt (β=.12, p=.011).

Some paths are added based on modification indices to improve the model fit. Trust has direct influence on perceived ease of use (β=.33, p=<.001), and has affected intention to adopt both directly and indirectly (β=.24). Trust might be one determinant for perceived ease of use due to the reason that if the consumer trusts the smart speaker (how it operates, what does it provides), he or she will perceive the device as easy to use. The direct influence of self-innovativeness on perceived ease of use (β=.19, p=<.001) is added due to common sense. An innovative consumer is more likely to possess IT skills and is willing to use new devices, therefore, he or she is more likely to find a smart speaker easy to use. Enjoyment has a significant effect on attitude toward smart speakers (β=.49, p=<.001). As is known to all, if one finds something enjoyable, there will be a great chance that the attitude will change.

Table 6. Standardized direct, indirect and total effects

Hypothesis	Path	Direct effects (β)	Indirect effects (β)	Total effects (β)
H1	Attitude-->Intention to Adopt	.71	-	.71
H2	Perceived Usefulness-->Attitude	.24	-	.24
H3	Perceived Usefulness-->Intention to Adopt	.06	.22	.28
H4	Perceived Ease of Use-->Attitude	.12	.09	.21
H5	Perceived Ease of Use-->Perceived Usefulness	.25	-	.25
H6	Self-innovativeness-->Attitude	.19	-	.19
H7	Self-innovativeness-->Intention to Adopt	.06	.17	.23
H8	Trust-->Attitude	.13	-	.13
H9	IoT Skills-->Perceived Ease of Use	.26	-	.26
H10	IoT Skills-->Intention to Adopt	.00	.04	.04
H11	Social Influence-->Perceived Usefulness	.15	-	.15
H12	Social Influence-->Intention to Adopt	.18	.07	.25
H13	Security-->Perceived Usefulness	.18	-	.18
H14	Enjoyment-->Perceived Usefulness	.20	.06	.26
H15	Enjoyment-->Perceived Ease of Use	.23	-	.23
H16	Reliability-->Perceived Usefulness	.13	-	.13
H17	Perceived Cost-->Intention to Adopt	.02	-	.02
Added	Trust-->Intention to Adopt	.12	.12	.24
Added	Trust-->Perceived Ease of Use	.33	-	.33
Added	Self-innovativeness-->Perceived Ease of Use	.19	-	.19
Added	Enjoyment-->Attitude	.36	.13	.49
Added	Self-innovativeness<-->Perceived Cost	.44	-	.44
Added	Reliability<-->Social Influence	.41	-	.41
Added	Enjoyment<-->Social Influence	.45	-	.45
Added	Perceived Cost<-->IoT Skills	.40	-	.40
Added	Security<-->Trust	.48	-	.48
Added	Security<-->Reliability	.49	-	.49
Added	Reliability<-->Trust	.61	-	.61
Added	Social Influence<-->Trust	.56	-	.56

4.3 Overview of hypotheses

Table 7 shows an overview of the hypotheses which are supported (significant) and which are rejected (non-significant).

Table 7. Overview of hypotheses

Hypothesis	Path	Std Estimate	P	Results
H1	Attitude-->Intention to Adopt	.71	***	Supported
H2	Perceived Usefulness-->Attitude	.24	***	Supported
H3	Perceived Usefulness-->Intention to Adopt	.06	.187	Rejected
H4	Perceived Ease of Use-->Attitude	.12	.012	Supported
H5	Perceived Ease of Use-->Perceived Usefulness	.25	***	Supported
H6	Self-innovativeness-->Attitude	.19	***	Supported
H7	Self-innovativeness-->Intention to Adopt	.06	.188	Rejected
H8	Trust-->Attitude	.13	***	Supported
H9	IoT Skills-->Perceived Ease of Use	.26	***	Supported
H10	IoT Skills-->Intention to Adopt	.00	.983	Rejected
H11	Social Influence-->Perceived Usefulness	.15	***	Supported
H12	Social Influence-->Intention to Adopt	.18	***	Supported
H13	Security-->Perceived Usefulness	.18	***	Supported
H14	Enjoyment-->Perceived Usefulness	.20	***	Supported
H15	Enjoyment-->Perceived Ease of Use	.36	***	Supported
H16	Reliability-->Perceived Usefulness	.13	.006	Supported
H17	Perceived Cost-->Intention to Adopt	.02	.676	Rejected

Note. *** significant at p-value <.001

4.4 Final research model

Figure 2 shows the research model with the correlation coefficients, regression coefficients, and explained variances.

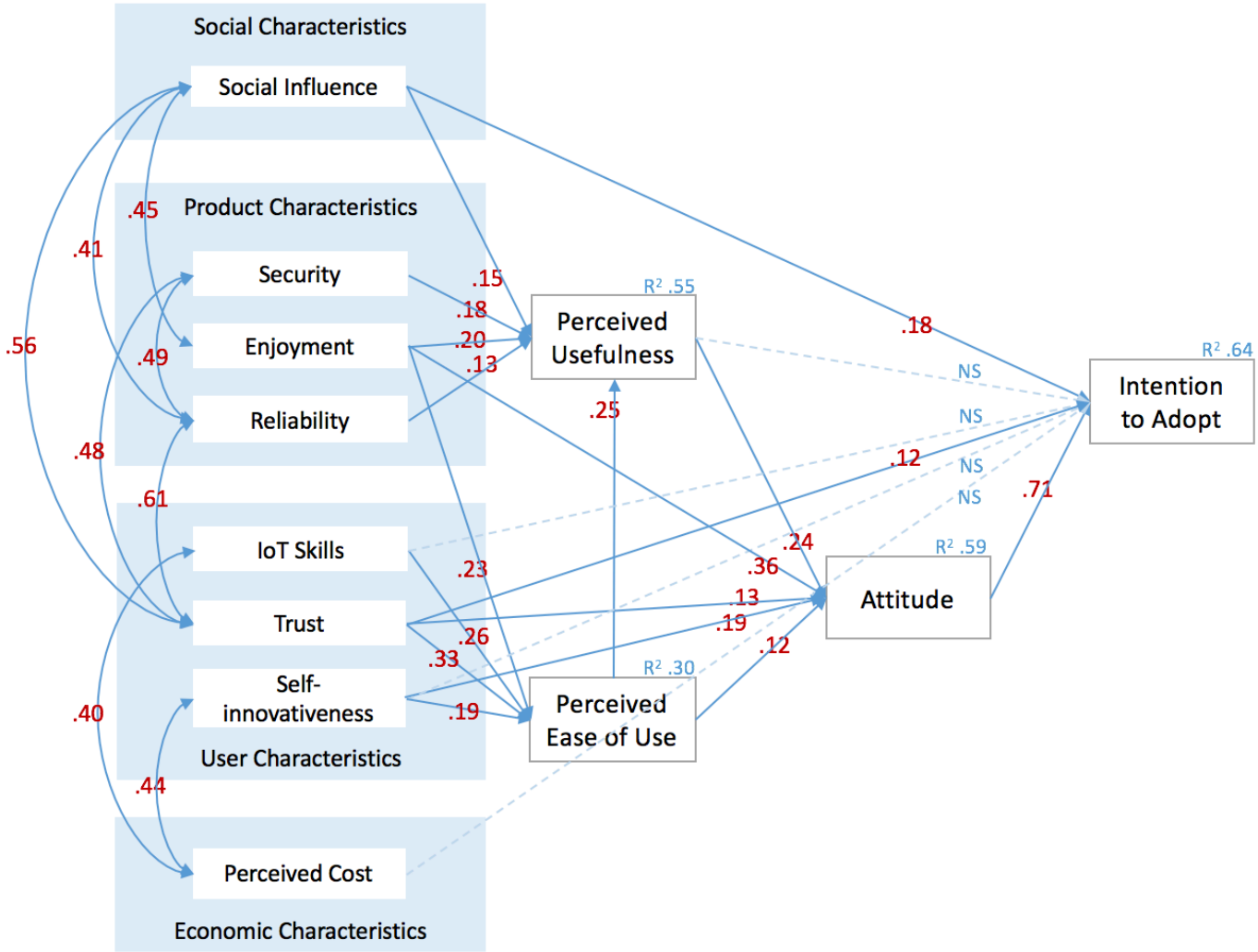

Figure 2. Final research model

5 Discussion

This study conducted analysis using an extended technology acceptance model on motivations that would prompt consumers to consider whether to adopt a smart speaker or not. An extended technology acceptance model was proposed for smart speakers integrating four aspects, namely product characteristics, social characteristics, user characteristics and economic characteristics, were added. According to the final modified model, the results showed that variables from those perspectives are predictive of intention to adopt IoT-based smart speakers in smart home environment, among which social influence, trust and consumers' attitude toward smart speakers are direct predictors. However, against TAM, perceived usefulness only affects intention to adopt indirectly through attitude. In regard to attitude, perceived usefulness and enjoyment have a great influence, followed by self-innovativeness, trust and perceived ease of use. Notably, enjoyment has a significant influence in all three mediating variables. Apart from enjoyment, trust and self-innovativeness are decisive determinants on both perceived ease of use and attitude.

Conforming with the technology acceptance model, this study showed that consumers' attitude toward smart speakers is the most influential factor for consumers' intention to adopt such devices. This significant influence is also observed by many previous studies in different areas, such as online shopping (Pookulangara et al., 2001), mobile advertising (Izquierdo-Yusta et al., 2015). Positive attitude towards smart speakers will exert positive influence on consumers' intention to adopt. The results indicate that consumers' attitude is directly determined by perceived usefulness, perceived ease of use, trust and self-innovativeness, in which perceived usefulness is a major decisive predictor of shaping consumers' attitude toward smart speakers. This supports the prior technology acceptance model research finding perceived usefulness to be a strong determinant of attitude (Davis et al., 1989). Perceived ease of use played a critical part in enhancing consumers' perceptions of usefulness and attitude toward smart speaker.

Notably, according to the results, not all the TAM assumptions are supported under the context of smart speakers in IoT environment. There is no direct influence between perceived usefulness and the intention to adopt smart speakers. Nowadays, the usefulness of a product is basically the lowest requirement. Consumers are not likely to conduct purchasing behaviour if a smart speaker cannot meet their utilitarian requirements. Another reason for why perceived usefulness influence intention to adopt directly is that smart speakers cannot meet consumers' need for what they are able to do without smart speakers. Several previous studies (Park & Chen, 2007; Park & Kim, 2013) have supported the direct positive influence of perceived usefulness on intention to use, probably due to the reason that smartphones or other devices they dig in have irreplaceable new utilitarian functions. However, smart speakers cannot provide a unique advantage over the existing solutions as Rogers supposed in 1995. People already have speakers to play music, or they can turn on the lights by themselves instead of a smart speaker. As a result, consumers' usability perception is not a direct reason that can explain their adoption behaviour.

Social influence is the second largest determinants of intention to adopt smart speakers and a main determinant of perceived usefulness. The rationale for this finding is that the respondents aging from 18 to 36, which account for 91.8% of the total amount, are considered to be easily influenced by social influence. They are more sensitive to new

trends and more easily to shifting rapidly to new trends and styles (Lu et al., 2003). Influence from peers and mass media may change their decision to use a smart speaker. The direct effect of social influence on intention to adopt is also shown by Chong et al. (2012), which based on the category of mobile commerce. Furthermore, this was also confirmed in other theories such as Theory of Planned Behaviour (TPB), and Theory of Reasoned Action (TRA), which included social aspects to behaviour.

Based on the study, unexpectedly, there is no significant relation between perceived cost and intention to adopt. One explanation for this insignificant effect may be the notion that if the benefits of a smart speaker far exceed the disadvantages, cost would not be a problem. Furthermore, as smart speakers and other smart home devices have sprung up throughout the world, brands or manufacturers are trying to lower the cost hoping to increase the competitiveness. Moreover, as the majority of respondents in this survey are aging between 22 to 35, hold college degree and above, have annual income above 20,000 Euro/50,000 CNY, we can assume that the cost of buying and operating a smart speaker is not a very heavy financial issue for them.

The finding shows that attitude is enhanced by two strong factors (perceived usefulness and enjoyment) and three moderate factors (trust, self-innovativeness, and perceived ease of use). In particular, the effects of perceived usefulness and enjoyment are more pronounced than the other three. This shows that consumers care more about how useful a smart speaker can be to build their attitude. Enjoyment is not only a determinant of attitude through perceived usefulness and perceived ease of use, but is also the most powerful direct predictor. This is also observed by precious research in the context of handheld internet devices (Bruner & Kumar, 2005) and e-learning (Lee et al., 2011). In regard to three moderate factors, several studies proved trust has a significant direct effect on attitude (Tan et al., 2010; Byoung et al., 2011). As for self-innovativeness, the more innovative a consumer considers oneself to be, the more likely he or she will obtain a positive attitude toward a new product, in this research, a IoT-based smart speaker. Individuals with higher levels of personal innovativeness tend to be more risk-taking, and keen to experience new technology.

Trust is the third determinant of intention to adopt and the most influential factor for predicting perceived ease of use. Trust can be understood as the extent to which a consumer believes that using a smart speaker is secure and has no privacy threats (Wei, et al., 2009). Pavlou (2003) has found that trust has a significant influence on perceived ease of use. This can be understood that when users have no trust issues and no worries about a product, they will not bother about controlling and operating the product. Less effort will be needed to use a worry-free product. The direct effect of trust on intention to adopt can be understood that if an individual does not trust a smart speaker at all, he/she is almost unlikely to buy one. Conforming with the previous study, trust also affects the intention to adopt smart speakers indirectly through attitude (Yoon, 2002).

Variables from the product characteristics (security, enjoyment, and reliability) influence perceived usefulness to a great extent. In comparing path coefficients of the three factors from product perspective, security emerged as a powerful predictor relative to the other factors. It could be inferred that security issues are one of main consideration that hinder consumers from accepting IoT-based smart speakers. Consumers will have purchase intentions of smart speakers if they feel that their personal information is safe. This is

consistent with the study of Chen et al. (2007) that consumers' usability perception on online service is influenced by their perception of the security level of the devices. In the short term, terminals that are used by the internet still face high security risks from hacking and other technical risks. It is a top priority that must be resolved by the manufacturers before consumers deciding to adopt such devices.

The results reveal the direct effect of enjoyment on perceived usefulness and perceived ease of use. It conforms with the findings of Kim et al. (2008) under the context of mobile message service and Pobil et al. (2013) in information delivering system. Consumers would like to have some 'fun' from their interaction with smart speakers. It is more likely for consumers to consider smart speakers as useful and easy to use if they are more enjoyable.

Social influence has been found to have affected attitude indirectly via perceived usefulness. This is in accord with previous research proving that perceived usefulness can be influenced by social influence under the context of advanced wireless Internet (Lu et al., 2005). However, even if enjoyment and social influence has notable influence on perceived usefulness, the magnitude of these two factors is still smaller than that of other factors. This means that consumers consider more from the actual functions, like security and reliability, of smart speakers as their utilitarian perceptions.

In conclusion, the results indicated that the most influential determinant for consumers' intention to adopt smart speakers is their attitude, followed by social influence and trust. Whereas, attitude is a mediating factor which is influenced largely by perceived usefulness and enjoyment, and slightly by trust, self-innovativeness and perceived ease of use. Furthermore, trust is the most significant factor in predicting both perceived usefulness and perceived ease of use. Apart from all the findings above, there are some aspects that also need to be addressed.

As for the reliability test of the variables, the value of Cronbach's alpha of IoT skill appeared to be slightly lower than 0.6. This could be the result of lack of knowledge and experience in the context of IoT. As Ehrenhart et al. (2014) found in the interview about smart home services that many people are not familiar with IoT technology. Like all the other technologies, individuals' skills tend to be low in the early stage of development. Thus respondents may have different thoughts regarding the questionnaire items of IoT skills when they are not well familiar with its technicalities. Moreover, since the research is based on the category of smart speakers, respondents may have the stereotype of traditional speakers that using speakers will not require much skills. Additionally, people may act differently about evaluating their own skills. However, of the two external factors impacting perceived ease of use, IoT skill appears as the more influential one. The more IoT skills consumers possess, the more easily they will consider smart speakers as simple to use and easy to understand.

There are some inter-correlations among external factors. Security and reliability have positive correlations with trust respectively. This means the more likely a smart speaker performs the functionalities in a right and reliable way, the more likely customers will trust the products. And if a smart speaker is able to secure its user's data safely, the user tends to trust the product. Self-innovativeness correlates with perceived cost positively. The higher level of an individual perceives oneself as innovative, the less likely one will take financial issue as an important factor.

In the light of the context of the research, gender, age and education did not have significant influence on the main variables. Obviously, this indicated that female and male participants showed no significant difference in consumer behaviour towards adoption of smart home devices such as smart speakers. This result was in harmony with several previous research in the context of other technologies (Bigne et al., 2005). However, it was unexpected that even IoT skills and self-innovativeness were not affected by age significantly. It was common that the older consumers are, the less IoT skills they master, and the less they will consider them self as innovative in advanced technology. On the contrary to the stereotypes, there was also a lack of correlation between consumers' age and their trust toward smart speakers. Older people did not show much difference in trust comparing to younger people. This could be associated with the fact that the majority of the sample in this study are aging between 22 to 35, who are not defined as 'old'.

6 Implications and limitations

6.1 Theoretical and practical implications

Both theoretical and practical implications can be provided based on the findings of this research. In theoretical perspective, this research contributes to a better understanding of IoT adoption by extending technology acceptance model with particular emphasis on smart speakers. The current model was presented integrating factors from product, social, user, and economic characteristics, which also validated the theoretical capability of the original TAM framework. From a practical perspective, the study provides related industry and practitioners with an awareness of the adoption pattern of IoT-based smart speakers in smart home environment, which is an increasingly popular category.

First, the functionality of smart speakers can be improved. The smart speaker industry must simultaneously develop and refine functionalities to improve its usefulness as a basis. As for its functionality, security of personal data has to be ensured. The truth that a great amount of personal information has leaked out makes people wary of the pitfalls the new technology has brought with. In addition, the devices and systems need to be simple to understand and be user-friendly to increase users' perception of ease-of-use. Consequently, consumers will find the products more useful and develop a more positive attitude. Apart from usability and ease of use, hedonic value of products should also be taken into consideration since enjoyment is a quite decisive factor in the model. Thus, practitioners should endeavour to consider many aspects on the design stage with consumers' requirements in mind.

Apart from improving the performance of the products, practitioners can also obtain insights about which factors should be taken into consideration when making strategies about brand promotion. For example, social influence is a main predictor of intention to adopt IoT-based smart speakers. Marketers can stimulate individuals' subjective norms through mass media. For example, by the ways of different kinds of advertising, a favourable environment can be generated which may encourage their adoption of smart speakers. Furthermore, practitioners should be aware of the importance the opinions and reviews from early adopters of smart speakers since they may generate positive or negative word-of- mouth effects. Positive reviews may be a key approach to help the majority overcome barriers to adopting smart speakers especially during the early stages. Using such testimonials as an advantage and obtaining celebrity or influencer endorsements may be an influential way of promoting consumers' adoption intention. Consumers' trust degree toward smart speakers can also be increased by marketing strategies.

Although early adopters might be familiar with smart speakers for a "long" time, to the mass majority, smart speaker still sounds new. As a result, consumers' familiarity with these technologies and their relevant goods and services is low. Many people lack the basic IoT knowledge or skills. They may not know how a smart speaker operates and how to use one. Consequently, they may consider it as a difficult thing to learn or to use, thus they may not be willing to use a product they barely know. Smart speaker brands need to run marketing campaigns to let more potential consumers know about IoT usage and skills in using it. Thus, they will consider smart speakers as an easy way to perform daily tasks or hedonic usage step by step.

Improvements from those variables will finally lead to improvements of consumers' attitude towards smart speakers, since attitude is the most crucial factors of intention to adopt. Every strategy the practitioners make should be aimed at raising positive attitude. Practitioners should also monitor consumers' attitude closely in order to attract more consumers and avoid consumer loss within the expanding and competitive market.

Practitioners can find some insight among the findings to improve the current products in the designing and manufacturing process, and also to make proper strategies regarding marketing campaigns.

6.2 Limitations and suggestions for future research

Several study limitations need to be addressed in the future research. Some suggestions for future research are also provided.

First, it is suggested by previous research that the influence of perceived usefulness, perceived ease of use, attitude, etc., on the intention to adopt can be different depending on atmospheres (Childers et al, 2001). For instance, in a hedonic usage environment and a utilitarian usage environment, consumers' intention to accept a smart speaker can be affected by these factors in a totally different way.

Second, in regard to the sample, this study did not restrict respondents' nationality since the results may be influenced by different cultural backgrounds. The age of participants is also a limitation of this study. It may be difficult to generalize the results to all age populations. Further research should broaden the scope of the sample to get more representative findings.

Although early adopters are quite familiar with smart speakers, to the mass majority, the exposure of smart speakers is still in its infancy. As a result, variables such as enjoyment, IoT skills, can be vague to the respondents, and hard to imagine even if there was an introduction before the survey started. Future studies could find better ways to ensure participants know what the survey questions are talking about, so that they could fully understand the questions to conduct more accurate responses.

Other methods can be used in this field. For instance, qualitative research can be used for future research to obtain deeper understanding from consumers' point of view toward smart home devices. Future research could add other potential factors into the proposed model to test the predictors of consumers' intention to adopt. These factors can be, but are not limit to, brand preference or loyalty, cultural backgrounds, so on and so forth. Moreover, the inter-correlations among four characteristics (user, social, product, and economic characteristics) can be investigated.

Furthermore, this study used one specific smart speaker category. The results may not be able to fit in other categories of smart home devices. Different categories of IoT products, such as exercise and health monitoring devices or home theatre system, will be needed to generalize the research model.

Overall, this study provides an integrated technology acceptance model for the intention to adopt IoT-based smart speakers from the perspective of the product, individual, social and financial characteristics. The present research acts as an initial stage of adopting smart home devices. Smart speakers and other IoT devices has the potential to create smart home environment that will revolutionize multiple industries and impact the whole society.

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8 Appendices

8.1 Appendix A: Survey Questionnaire

Introduction

Smart speaker

A smart speaker is a type of wireless speaker and voice command device with an integrated virtual assistant (artificial intelligence) that offers interactive actions and hands-free activation with the help of one "hot word" (or several "hot words"). Some smart speakers can also act as a smart device that utilizes Wi-Fi, Bluetooth and other wireless protocol standards to extend usage beyond audio playback, such as to control home automation devices. This can include, but is not be limited to, features such as compatibility across a number of services and platforms, peer-to-peer connection through mesh networking, virtual assistants, and others.

Google Home $129.00

Hands-free help from the Google Assistant: get answers, play songs, tackle your day, enjoy your entertainment and control your smart home with just your voice.

Amazon Echo $99.00

Echo connects to the Alexa Voice Service to play music from Amazon Music Unlimited or from your own collection and services when using Echo over Bluetooth. Also control compatible smart home devices, make calls or send and receive messages to other Echo Devices or the Alexa App.

Apple HomePod $349.00

Together with Apple Music and Siri, Apple HomePod creates a new way for you to discover and interact with music at home. And it can help you with everyday tasks — and control your smart home — all with just your voice. It is great at the things you want to know, and do, in your home. From getting the latest weather to sending messages and controlling your smart home accessories, Siri makes it easy to multitask with just your voice.

Hey Siri, text Sofia "I'm running late"
Send and receive texts.

Hey Siri, set a 20-minute timer
Set and control timers.

Hey Siri, turn on the kitchen lights
Control your HomeKit accessories.

Hey Siri, put on NPR news
Get headline and local news.

Hey Siri, what's my first meeting today?
Manage your Calendar events.

Demographic information

Age

Gender: Male; Female; Other

Living situation: Live with parents; Live alone; Live with spouse; Live with other house mates; Other

Education level: Junior school or less; High school or equivalent; Bachelor degree or equivalent; Master degree or equivalent; Doctor degree or above

Income level: Less than 50k CNY/20k EUR; 50k-150k CNY/20k-40k EUR; 150k-250k CNY/40k-60k EUR; Higher than 250k CNY/70k EUR

Experience with smart home devices: Have smart home devices at home; Have used smart home devices but do not have one; No experience

Experience with smart speakers: Have a smart speaker at home; Have used a smart speaker but do not have one; No experience

Survey questions

Items	Factor loading
Security (SE)	
SE1: Smart speakers will not keep my personal information safely.	0.810
SE2: I think my personal information will be used in unrelated areas.	-
SE3: I think my personal information will not be manipulated by other people.	0.854
SE4: I think no one else can see and use my personal information stored in smart speakers.	0.859
Enjoyment (EN)	
EN1: I think using a smart speaker is enjoyable.	0.741
EN2: I think I will have fun using a smart speaker.	0.798
EN3: It is not interesting to use a smart speaker.	0.765
EN4: Using a smart speaker will not give me pleasure.	0.753
Reliability (RE)	
RE1: Smart speakers can provide reliable information.	0.803
RE2: Smart speakers can perform their functions all the time.	0.814
RE3: I perceive smart speakers as reliable.	0.791
RE4: Smart speakers cannot provide what I really need.	-
IoT skills (IS)	
IS1: I know how to use smart speakers and its applications.	0.739
IS2: I don't know with whom smart speakers share data.	0.620
IS3: I don't have confidence in operating a smart speaker.	0.644
IS4: I know how to interpret data from smart speakers.	0.668
Trust (TR)	
TR1: Smart speakers are trustworthy.	0.840
TR2: I think smart speakers are honest.	0.869
TR3: Smart speakers act with good intentions.	0.744
Self-innovativeness (SIT)	

SIT1: I perceive myself as an early adopter with new technology.	0.749
SIT2: I consider myself knowledgeable about the new trend of technology.	0.793
SIT3: I will not try new technological devices before others use them.	0.724
SIT4: I don't care about new trend in technology, I just follow others.	0.776
Social influence (SI)	
SI1: People who are important to me recommend smart speakers.	0.828
SI2: People who are important to me use smart speakers.	0.868
SI3: I heard successful experience about using smart speakers from other individuals.	0.838
SI4: The mass media talks a lot about smart speakers.	0.749
Perceived usefulness (PU)	
PU1: Using smart speakers improves my efficiency and effectiveness of daily tasks.	0.840
PU2: Using smart speakers is more convenient than the traditional way.	0.853
PU3: Using smart speakers will improve my performance with daily tasks.	0.856
PU4: Using smart speakers will make it difficult for me to do daily tasks.	-
Perceived ease of use (PEOU)	
PEOU1: Learning to use smart speakers is easy for me.	0.867
PEOU2: Remembering use of commands of smart speakers will be difficult for me.	-
PEOU3: Operating smart speakers will not require a lot of mental effort.	0.854
PEOU4: The commands of operating smart speakers will be clear and understandable.	0.855
Attitude (AT)	
AT1: I like the idea of using smart speakers.	0.794
AT2: I have negative feelings toward smart speakers.	0.828
AT3: I will be satisfied by smart speakers.	0.755
AT4: I don't like working with smart speakers.	0.819
Perceived cost (PC)	
PC1: The price for smart speakers is expensive for me.	0.853
PC2: I will not buy smart speakers because of its expensive price.	0.923
PC3: I am not able to afford smart speakers easily.	0.904
PC4: Buying and operating smart speakers are a financial burden to me.	0.924
Intention to adopt (ITA)	
ITA1: I intend to use smart speakers in the near future.	0.862
ITA2: I am willing to use smart speakers in the near future.	0.892
ITA3: I will not use smart speakers in the near future.	0.843

8.2 Appendix B: Coding Scheme

Items	Scale
Security (SE)	
SE1: Smart speakers will not keep my personal information safely.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
SE2: I think my personal information will be used in unrelated areas.	-
SE3: I think my personal information will not be manipulated by other people.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SE4: I think no one else can see and use my personal information stored in smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
Enjoyment (EN)	
EN1: I think using a smart speaker is enjoyable.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
EN2: I think I will have fun using a smart speaker.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
EN3: It is not interesting to use a smart speaker.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
EN4: Using a smart speaker will not give me pleasure.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
Reliability (RE)	
RE1: Smart speakers can provide reliable information.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
RE2: Smart speakers can perform their functions all the time.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
RE3: I perceive smart speakers as reliable.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
RE4: Smart speakers cannot provide what I really need.	-
IoT skills (IS)	
IS1: I know how to use smart speakers and its applications.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
IS2: I don't know with whom smart speakers share data.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
IS3: I don't have confidence in operating a smart speaker.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
IS4: I know how to interpret data from smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
Trust (TR)	
TR1: Smart speakers are trustworthy.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
TR2: I think smart speakers are honest.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree

TR3: Smart speakers act with good intentions.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
Self-innovativeness (SIT)	
SIT1: I perceive myself as an early adopter with new technology.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SIT2: I consider myself knowledgeable about the new trend of technology.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SIT3: I will not try new technological devices before others use them.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
SIT4: I don't care about new trend in technology, I just follow others.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
Social influence (SI)	
SI1: People who are important to me recommend smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SI2: People who are important to me use smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SI3: I heard successful experience about using smart speakers from other individuals.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
SI4: The mass media talks a lot about smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
Perceived usefulness (PU)	
PU1: Using smart speakers improves my efficiency and effectiveness of daily tasks.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
PU2: Using smart speakers is more convenient than the traditional way.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
PU3: Using smart speakers will improve my performance with daily tasks.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
PU4: Using smart speakers will make it difficult for me to do daily tasks.	-
Perceived ease of use (PEOU)	
PEOU1: Learning to use smart speakers is easy for me.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
PEOU2: Remembering use of commands of smart speakers will be difficult for me.	-
PEOU3: Operating smart speakers will not require a lot of mental effort.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
PEOU4: The commands of operating smart speakers will be clear and understandable.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
Attitude (AT)	
AT1: I like the idea of using smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
AT2: I have negative feelings toward smart speakers.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
AT3: I will be satisfied by smart speakers.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree

AT4: I don't like working with smart speakers.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
Perceived cost (PC)	
PC1: The price for smart speakers is expensive for me.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
PC2: I will not buy smart speakers because of its expensive price.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
PC3: I am not able to afford smart speakers easily.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
PC4: Buying and operating smart speakers are a financial burden to me.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree
Intention to adopt (ITA)	
ITA1: I intend to use smart speakers in the near future.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
ITA2: I am willing to use smart speakers in the near future.	1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree
ITA3: I will not use smart speakers in the near future.	1=strongly agree; 2=somewhat agree; 3=neutral; 4=somewhat disagree; 5=strongly disagree