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Determinants of business organization’s adoption of complex innovative product: A case of the intelligent IoT system for hog-raising

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DETERMINANTS OF BUSINESS ORGANIZATION'S ADOPTION OF COMPLEX INNOVATIVE PRODUCT: A CASE OF THE INTELLIGENT IOT SYSTEM FOR HOG-RAISING

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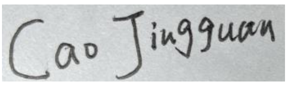
I hereby declare that this dissertation is my original work and it has been written by me in its entirety.

I have duly acknowledged all the sources of information which have been used in this dissertation.

This dissertation has also not been submitted for any degree in any university previously.



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Abstract

With the development of science and technology, various opportunities emerged for the application of complex innovative products. However, not all business organizations are willing to adopt complex innovative products although these products can improve efficiency and reduce costs of the organizations, because there are bound to be various problems in the early application of new technologies. Hence, it is important to find the key influencing factors for the acceptance of complex innovative products by business organizations. The Internet of Things (IoT) is a typical complex innovative product, and this dissertation takes the intelligent IoT system for hog-raising as a case to study the determinants of business organization’s adoption of complex innovative products.

This dissertation aims to explore the antecedents of hog-raising firms’ adoption of the intelligent IoT system based on the technology acceptance model, innovation diffusion theory, and related literature. I propose that technological factors and social factors will influence the behavioral intention to adopt intelligent IoT systems for hog-raising. In terms of technological factors, I explore the influence of relative advantage, compatibility, result demonstrability, and trialability on the behavioral intention to adopt intelligent

IoT systems for hog-raising based on the innovation diffusion theory. In terms of social factors, I investigate the influence of subjective norms and safety on the behavioral intention to adopt intelligent IoT systems for hog-raising. Furthermore, I try to tackle the mechanism behind the relationship based on the technology acceptance model. I argue that relative advantage, compatibility, result demonstrability, and trialability may promote perceived usefulness and further influence the behavioral intention to adopt intelligent IoT systems for hog-raising. Compatibility, result demonstrability, and trialability will promote perceived ease of use and further influence the behavioral intention to use intelligent IoT systems for hog-raising.

Using survey data of 266 hog-raising firms in China, this dissertation tests the hypotheses proposed. The results suggest that relative advantage, result demonstrability, and trialability are positively associated with the behavioral intention to use intelligent IoT systems for hog-raising. The relative advantage, result demonstrability, and trialability of intelligent IoT systems for hog-raising will improve users' perceived usefulness, and further facilitate their adoption intention. The result demonstrability and trialability of intelligent IoT systems for hog-raising will improve users' ease of use, and further promote their behavioral intention to use the intelligent IoT systems. Furthermore, subjective norm and safety will promote the behavioral intention to use intelligent IoT systems for hog-raising. However, when including social factors, the positive impact of trialability is still significant, however, the

positive influence of relative advantage and result demonstrability on the behavioral intention to use intelligent IoT systems for hog-raising becomes not significant anymore.

This dissertation contributes to deepening the understanding of the diffusion of the Internet of Things in a special industry, namely, the hog-raising industry, which offer valuable insights into the development and upgrading of other traditional industry. This dissertation also helps to extend the technology acceptance model and innovation diffusion theory by integrating the two theories. Also, this dissertation offers references to promote the adoption of intelligent IoT systems.

Keywords: Complex innovative product, relative advantage, compatibility, result demonstrability, trialability, subjective norm, safety, perceived ease of use, perceived usefulness.

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1. Introduction

Nowadays, enterprises pay more and more attention to innovation. Innovation has become the source power of sustainable development of enterprises, especially for small and medium-sized enterprises. With the development of science and technology, various opportunities emerged for the application of hot technologies such as artificial intelligence, big data, and the Internet of Things in traditional fields. Firms all hope to improve efficiency and reduce costs through the power of science and technology, but there are bound to be various problems in the early application of new technologies. Many firms are not willing to adopt complex innovation products, and thus miss the opportunity to facilitate their development by applying the new technologies. And the firms that produce complex innovation products may get into difficulty in lack of customers and cash flow. Therefore, it is particularly important to find the key influencing factors for the acceptance of complex innovative products by business organizations.

With the development of technologies, various complex innovative products have emerged, such as the Internet of Things (IoT), artificial intelligence, Chart GPT, and metaverse. The Internet of Things (IoT) is a typical complex innovative product, hence, this dissertation takes it as a case to study the determinants of business organizations' adoption of complex innovative products. With the emergence of high-speed networks, communication technology, and intelligent devices, the Internet of Things (IoT) has developed greatly with promising potential and influence (Hassan & others, 2019). The Internet of Things refers to the network to connect embedded devices or “things” with sensors, and the smart connected devices can be everything ranging from small accessories or massive machines (Khan & Salah, 2018). It is widely used in fields like wearables, healthcare, manufacturing, retail, logistics, agriculture and so on, bringing more smart lives for humans and helping organizations to build close connections with customers and business partners (Wang et al., 2020). The Internet of Things aims to connect and integrate the material world and the virtual space, which stands for the future trend of networking (Ma, 2011), and is an essential part of Industry 4.0 (Khan & Javaid, 2021).

Given the promising benefits brought by the Internet of Things, governments in different countries have actively taken various measures to promote the development of the Internet of Things, such as projects like “Intelligent Earth” (US), “i-Japan” (JPN), and “i2010” (EU) issued since 2008. The Chinese government has identified the Internet of Things as one of five core strategic industries since the promulgation of the IoT project named “To Feel China” in 2009 (Hsu & Lin, 2016), and subsequently issued a series of policies such as the Special action plan for the Internet of Things development in 2013 and Development plan of information and communication industry in the 14th five-year plan in 2021 to facilitate the development of the Internet of Things technologies. The global Internet of Things market has developed greatly in recent years, according to the report of International Data Corporation (IDC), the global expenditure on the Internet of Things is expected to be 754.28 billion dollars in 2021, and is forecasted to achieve 1.2 trillion dollars in 2025. The five-year compound growth rate will be 11.4%. And the market size of the Internet of Things in China is predicted to exceed 300 billion dollars in 2025, which will be the largest market in the world with a market share of about 26.1%[1]. However, there are also high risks of IoT systems such as difficulty in interoperability, lack of data transmission and analysis, and security vulnerability (Wang et al., 2020). The Internet of Things has been included in the list of six "Disruptive Civil Technologies" by US National Intelligence Council given its huge threats of information security (Nic, 2008). Hence, not all organizations are willing to adopt such a complex innovative technology. To promote the diffusion of IoT technologies, it is important to explore the determinants of the adoption of IoT systems by hog-raising firms.

As I am the founder of a science and technology start-up company, the innovative product of my company is the intelligent Internet of Things systems for hog-raising firms, through which the efficiency of hog-raising can be improved. The intelligent Internet of Things systems for hog-raising are very complex involving technologies such as Big data, cloud computing, and artificial intelligence, which are very consistent with the characteristics of

[1]https://recordtrend.com/internet-of-things/it-is-predicted-that-the-global-internet-of-things-expenditure-will-reach-us-754-28-billion-in-2021-from-idc/

complex innovative products. Compared with other industries, the hog-raising industry is a traditional industry in which the adoption of new technology is slow and hard. Extant research has explored several factors that will influence the adoption of IoT systems, including environmental, organizational, and secure dimensions (Hsu & Yeh, 2017), but has not explored the determinants of the adoption of IoT systems by hog-raising firms. What factors will influence the adoption of IoT systems by hog-raising firms still remains to be explored. Hence, I take the intelligent IoT system for hog-raising as a specific case to study the determinants of business organizations' adoption of complex innovative products.

This dissertation aims to explore the determinants of hog-raising firms' adoption of the intelligent IoT system by integrating the technology acceptance model and innovation diffusion theory. I propose that technological factors and social factors will influence the behavioral intention to adopt intelligent IoT systems for hog-raising. In terms of technological factors, I explore the influence of relative advantage, compatibility, result demonstrability, and trialability on the behavioral intention to adopt intelligent IoT systems for hog-raising based on the innovation diffusion theory (Rogers, 1995). In terms of social factors, I investigate the influence of subjective norms and safety on the behavioral intention to adopt intelligent IoT systems for hog-raising. Furthermore, I try to tackle the mechanism behind the relationship based on the technology acceptance model (Davis, 1989). I argue that relative advantage, compatibility, result demonstrability, and trialability may promote perceived usefulness and further influence the behavioral intention to adopt intelligent IoT systems for hog-raising. And compatibility, result demonstrability, and trialability will promote perceived ease of use and further influence the behavioral intention to use intelligent IoT systems for hog-raising.

This dissertation aims to make contributions to prior research in the following aspects. First of all, this dissertation explores the key factors influencing the adoption of intelligent IoT systems for hog-raising, which enriches the studies on the antecedents of organizations' adoption of complex innovative products. As a typical form of complex innovative products, the exploration of the determinants of IoT adoption not only helps to facilitate the diffusion of the Internet of Things, but also offers new insights into the adoption of other complex innovative technologies. Specifically, prior research on IoT adoption is not yet enough and mature, the key factors analysis is critical for the successful and effective adoption of this innovative technology (Hsu & Yeh, 2017). Although several studies have explored some determinants of IoT adoption, most of them focus on the adoption intention of individual users (Hsu & Lin, 2016, 2018), the determinants of organizations' adoption of IoT systems still lack attention. This dissertation focuses on the determinants of the adoption of complex innovations in the hog-raising industries, which deepens our understanding of the diffusion of complex innovative products.

Second, this dissertation focuses on a specific industry, namely, the hog-raising industry, which not only provides references to promote the diffusion of intelligent IoT systems in the hog-raising industry, but also offers new insights into the determinants of the adoption of complex innovative products in other traditional industries. Compared with other industries, the adoption of new technology in the hog-raising industry is slow and hard. The usage of intelligent IoT systems has a huge potential to improve the intelligence and automation level of the hog-raising process (Yongqiang et al., 2019) and promote the upgrading of the hog-raising industry. However, the actual adoption of intelligent IoT systems is still very low in this special industry at the present stage, and it is important to explore the factors that may influence the adoption intention of IoT systems. This dissertation investigates the determinants of the adoption of intelligent IoT systems for hog-raising, deepening our understanding of the new technology diffusion in the hog-raising industry and offering helpful insights into the upgrading of other traditional industries.

Third, this dissertation contributes to extending the technology acceptance model and innovation diffusion theory. Prior research has extended the technology acceptance model by including external predictors to forecast their influence on perceived ease of use and perceived usefulness such as shared belief in the benefits of the technology (Amoako-Gyampah & Salam, 2004), individual characteristics like education and age (Burton-Jones &

Hubona, 2006), and technology anxiety and affect (Saadé & Kira, 2006). This dissertation contributes to extending the technology acceptance model by including the innovation diffusion theory factors. Integrating the technology acceptance model and innovation diffusion theory can offer a more effective model than either single model to predict determinants of an innovation (Wu & Wang, 2005), enabling us to better understand the users' general perception of the new technology or system, as well as the specific characteristics that will attract users' adoption and usage (Min et al., 2019). By investigating the impact of technological factors such as relative advantage, compatibility, result demonstrability, and trialability, on the behavioral intention to use intelligent IoT systems for hog-raising based on the innovation diffusion theory (Rogers, 1995) and exploring the mechanism by which the technological factors influence perceived usefulness/perceived ease of use and further influence the behavioral intention to use intelligent IoT systems for hog-raising based on the technology acceptance model (Davis, 1989), this dissertation contributes to the two theories.

2. Literature review

2.1. Internet of Things (IoT)

The phrase “Internet of Things (IoT)” was first proposed by Kevin Ashton in 1999 under the supply chain management context (Ashton & others, 2009). It refers to a network to connect embedded devices or “things” with sensors (Khan & Salah, 2018). “Things” need to be real objects in the material or physical world, including living things such as plants, animals and people, as well as nonliving things ranging from small accessories or massive machines (Madakam et al., 2015). The connected “things” equipped with sensors help to monitor the surrounding environment, and make decisions independently and intelligently based on the environmental information or assist users to make appropriate decisions based on communications with the other nodes (Wang et al., 2020).

The Internet of Things technology owns three essential characteristics: first, almost all ordinary things, like shoes, tables, screws, and books can be instrumented through information perception technologies; second, autonomic terminals are connected to each other; and third, the intelligent pervasive services enable every instrumented thing to involve in the service flow (Hsu & Yeh, 2017).

The Internet of Things technology is widely used by individual users in domestic and working areas such as e-health, smart home, and enhanced learning as well as business users in fields such as industrial automation, supply chain management, and logistics (Atzori et al., 2010). The use of the

Internet of Things changes peoples' lives and the business world greatly, which helps individuals to improve working efficiency and life quality (Hsu & Lin, 2018), and brings more intelligent lives to humans. The application of the Internet of Things in organizations changes the decision-making processes by generating tons of data (Brous et al., 2019), improves industry efficiency (Khan & Javaid, 2021), and helps organizations to build close connections with customers and business partners (Wang et al., 2020). Therefore, it becomes a trend all over the world.

However, there are also several concerns about the adoption of the Internet of Things including the difficulty in interoperability, lack of data transmission and analysis, and security vulnerability (Wang et al., 2020). Given that most of connected devices in the Internet of Things share information with the cloud, security vulnerability becomes a great concern for the Internet of Things (Wang et al., 2020). Internet of Things devices are more vulnerable to damage and hacker attacks than other terminal equipment such as computers, iPads, or smartphones (Khan & Salah, 2018). Such concerns hinder the adoption of the Internet of Things.

Therefore, whether to adopt the Internet of Things becomes a key issue for organizations, and managers need to trade off the benefits and threats of IoT technology adoption. And the determinants of IoT technology adoption obtained attention in academics, extant research has explored various factors influencing the adoption of IoT technology, but most of these studies focus on the determinants of individuals' adoption of the technology. For example, Gao & Bai (2014) argued that perceived behavioral control, enjoyment, ease of use, usefulness, and social influence will exert a positive impact on the adoption intention of IoT technologies. Hsu & Lin (2016) believed that network externality such as the perceived critical mass, compatibility, and complementarity is positively associated with perceived benefits of IoT adoption, thus facilitating users' continued intention to use IoT technologies; while the concern for information privacy like data collection concerns, inappropriate access, unauthorized use, and errors will negatively influence the adoption of IoT technologies. Hsu & Yeh (2017) argued that environmental, organizational, and secure dimensions are key factors of decision-makers in organizations when deciding whether to adopt the Internet of Things. The environmental dimension includes the concern for government policy, competition pressure, and supporting industries; the organizational dimension includes factors like organizational readiness, top management support, and expected benefits; and the secure dimension includes concerns for system security, institution security, and data security. Hsu & Lin (2018) argued that the trade-off between benefits and sacrifice is an important concern of users when deciding whether to adopt the Internet of Things. The perceived usefulness and enjoyment are the benefits of IoT adoption, which is positively connected with the perceived value of users and thus facilitates their adoption intention of IoT systems; while the perceived privacy risks and fees are the sacrifice, which is negatively connected with the perceived value and hinder the adoption. Karahoca et al. (2018) found that perceived ease of use, advantage, and image facilitate the intention of users to adopt IoT products like healthcare smart devices. Chatterjee et al. (2018) argued that perceived information quality, service quality, system quality and satisfaction facilitate the intention to use IoT in smart cities, and the intention and perceived net benefit of IoT promote the actual usage. Martínez-Caro et al. (2018) proposed that personal self-efficacy and innovativeness facilitate the perceived usefulness of IoT-based healthcare services, thus influencing the satisfaction and loyalty to the IoT technology. Shin et al. (2018) argued that perceived usefulness, compatibility, and perceived ease of use promotes users' purchase intention of smart home, and demographic characteristics like gender, education, age, and income have moderating effects on the positive relationship. Sivathanu (2018) believed the value of openness to change affects individuals' attitudes toward IoT-based wearables for healthcare. Relative advantage, ubiquitous, convenience, and compatibility are the main reasons for users to accept IoT-based wearables, whereas risk barriers, traditional barriers, and usage barriers are the main reasons to reject them. Yang et al. (2018) found that Perceived reliability, controllability, interconnectedness, and automation facilitate individuals' adoption intention of IoT smart homes. Yildirim & Ali-Eldin (2019) argued that trust and perceived usefulness facilitates the usage intention of IoT-based wearable devices in the workplace, while risks are negatively connected with the usage intention. Kasilingam & Krishna (2021) proposed that personal innovativeness, perceived playfulness, and convenience value were key factors influencing customers' intention and attitude to adopt IoT technologies. Innovative individuals are more likely to adopt IoT technologies, perceived playfulness, and convenience value facilitates customers' positive attitudes and adoption intention towards IoT services. Lu (2021) argued that perceived usefulness, perceived ease of use, visibility, result demonstrability, compatibility, and trialability will promote the adoption intention of the IoT.

Prior studies on the determinants of the adoption of IoT systems can be summarized in Table 1.

Table 1 prior research on the antecedents of IoT system adoption

Authors (Year)	**IOT technology**	**Factors**	**Theoretical perspective**
Gao & Bai (2014)	Internet of Things technology	Perceived behavioral control, enjoyment, perceived ease of use, perceived usefulness, social influence	Technology acceptance model (TAM)
Hsu & Lin (2016)	Internet of Things services	Perceived benefits, concern for information privacy	Innovation diffusion theory (IDT) and other literature
Hsu & Yeh (2017)	Internet of Things	Environmental, organizational, and secure dimensions	Technology, organisation and environment (TOE) framework
Hsu & Lin (2018)	Internet of Things services	Benefits, sacrifice, perceived value	Value-based adoption model (VAM)
Shin et al. (2018)	Smart home	Privacy, compatibility, perceived ease of use,	Technology acceptance model (TAM)

		perceived usefulness	
Karahoca et al. (2018)	Internet of Things in healthcare technology products	Relative advantage, compatibility, innovativeness, vulnerability, trialability, image, severity, cost, risk, perceived ease of use, perceived usefulness	Technology acceptance model (TAM), innovation diffusion theory (IDT), technological innovativeness (TI), protection motivation theory and privacy calculus theory
Chatterjee et al. (2018)	Internet of Things in smart cities	Perceived information quality, service quality, system quality, satisfaction, net benefit of IoT	Updated Information System Success Model
Martínez-Caro et al. (2018)	IoT-based healthcare services	Personal innovativeness, self-efficacy, perceived usefulness	Information System success model
Yang et al. (2018)	IoT Smart Home	Perceived reliability, controllability, interconnectedness, automation	Related literature
Roy et al. (2018)	Smart technologies in the retail sector	Technology readiness, perceived ease of use, usefulness, adaptiveness, store reputation, superior functionality	Technology acceptance model (TAM)
Tu (2018)	IoT in logistics and supply chain management	Perceived trustworthiness of technology, benefits, costs, external pressure	Technology, organisation and environment (TOE) framework
Sivathanu (2018)	IoT-based wearables for healthcare	Relative advantage, ubiquitous, convenience, compatibility, risk barrier, traditional barrier, usage barrier, value of openness to change	Innovation diffusion theory (IDT)
Shin (2019)	Living lab of Internet of Things	Relative advantage, observability, compatibility, trialability, complexity	Innovation diffusion theory (IDT)
Yildirim & Ali-Eldin (2019)	Wearable IoT devices	Trust, ethics, risks, and perceived usefulness	Technology acceptance model (TAM),
Pillai & Sivathanu (2020)	IoT in the agriculture industry	Social influence, relative advantage, perceived usefulness, convenience, price, risk, image barrier,	Innovation resistance theory (IRT) and behavioral reasoning theory (BRT)

		technological anxiety	
Kasilingam & Krishna (2021)	Internet of Things services	Personal innovativeness, perceived playfulness, and convenience value	Theory of Reasoned Action
Lu (2021)	Internet of Things	perceived usefulness, perceived ease of use, visibility, result demonstrability, compatibility, and trialability	Technology acceptance model (TAM), innovation diffusion theory (IDT)

Technology acceptance model (TAM) and innovation diffusion theory (IDT) are widely used to explain firms' adoption of new technologies such as the Internet of Things (Hsu & Yeh, 2017; Yuen et al., 2021). This dissertation strives to explore the antecedents of complex innovative products by integrating the technology acceptance model (TAM) and innovation diffusion theory(IDT). And the two perspectives will be reviewed comprehensively in the following sections.

2.2. Technology acceptance model

The technology acceptance model (TAM) is a widely used technology adoption model, which is originated from the psychological theory of planned behavior and reasoned action, which is helpful to explain the behaviors of accepting or rejecting certain technologies (Marangunić & Granić, 2015).

The technology acceptance model argues that perceived ease of use and usefulness influences individuals' attitudes toward the technologies, thus influencing their actual use (Davis, 1989). And ease of use also affects perceived usefulness. Among them, perceived usefulness refers to the extent to which the user thinks that the use of the technology will improve her/his performance. If individuals believe the technology will improve their performance, they will be more likely to adopt the technology. And the perceived ease of use refers to the extent to which the user thinks that it is free of effort to use the technology. The easier the technology to use, the more individuals tend to adopt it. The technology acceptance model proposed by Davis (1989) can be summarized in Figure 1. The model has been tested in a lot of innovation and technology fields (Hu et al., 1999).

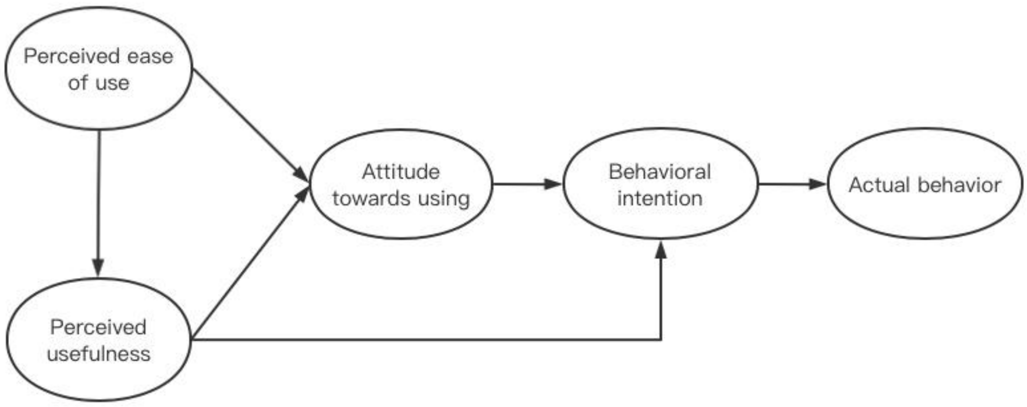

Figure 1 The technology acceptance model (TAM) proposed by Davis (1989)

The original technology acceptance model is simple, and has been modified and extended greatly in prior research (Mao & Palvia, 2006). And the efforts made to extend the technology acceptance model are summarized as follows. First of all, prior research has tried to include external predictors that will influence the perceived ease of use and perceived usefulness to extend the model. Venkatesh & Davis (2000) extended the technology acceptance model by including cognitive instrumental processes and social influence to explain use intentions and perceived usefulness, and the extended model is called TAM 2. The cognitive instrumental processes include factors such as job relevance, result demonstrability, and output quality; whereas the social influence involves subjective norm, image, and voluntariness. From the aspect of personal characteristics, prior research has explored the influence of demographic, psychological characteristics, emotional state, capabilities, and skills on perceived usefulness and ease of use. For example, Burton-Jones & Hubona (2006) found that individuals' system experience, age, and educational level will affect the perceived ease of use or perceived usefulness. Lee et al. (2006) found that self-identity promotes perceived usefulness and ease of use, thus facilitating new technology usage. Park, (2009) argued that self-efficacy is positively connected with perceived ease of use and perceived usefulness. Amoako-Gyampah (2007) argued that user involvement will influence perceived usefulness. Wang et al. (2020) believed that personal innovativeness will promote the perceived ease of use and perceived usefulness. From the aspect of social influence, Lee & Wan (2010) enriched the technology acceptance model by including subjective norms and trust in ability as the antecedents of intention to adopt new technologies. From the aspect of risks, Featherman & Pavlou (2003) argued that perceived risks are negatively connected with perceived usefulness and ease of use. From the aspect of user involvement, Amoako-Gyampah (2007) found that the intrinsic involvement and situational involvement will promote users' perceived usefulness and behavioral intention. The prior studies on the external predictors are summarized in Table 2 as follows.

Table 2 several important studies on external predictors of the technology acceptance model

External predictors	**References**
Users' demographic characteristics (e.g., age, education, gender, etc.)	Venkatesh & Morris (2000); Burton-Jones & Hubona (2006); Alfadda & Mahdi (2021)
Users' psychological characteristics (e.g., self-efficacy, etc.)	Mun & Hwang (2003); Park, (2009); Chow et al. (2012); Portz et al. (2019)
Users' emotional state (e.g., anxiety, affect, etc.)	Saadé & Kira (2006); Portz et al. (2019)
Users' capabilities/skills (e.g. personal innovativeness, computing skills, etc.)	Ndubisi & Jantan (2003); Wang et al. (2020)
Perceived risks (e.g., privacy risks, financial risks, social risks, etc.)	Featherman & Pavlou (2003); Pavlou (2003); Wang et al. (2020)
User involvement	Amoako-Gyampah (2007); Sheng & Zolfagharian (2014)
Social influence (e.g., subjective norm, image, etc.)	Venkatesh & Davis (2000); Lee & Wan (2010); Jan & Contreras (2011); Abbasi et al. (2011)

Second, prior studies have tried to contextual factors influencing the relationship between external predictors and perceived ease of use or perceived usefulness of the technologies or the relationship between perceived ease of use or perceived usefulness and intention to use the technologies. For example, Straub et al. (1997) tested the TAM model in different countries and found differences among them, the model is not fit for all the countries. Huang et al. (2003) found that power distance negatively moderates the relationship between the influence of subjective norms and perceived usefulness, the positive impact of subjective norms on perceived usefulness is weakened when power distance is high. Lee & Wan (2010) argued that subjective norm is positively related to the new technology adoption intention of individuals in collectivist societies, and trust in the ability of the technology is also essential for new technology adoption, especially for individuals who are unfamiliar with the technologies. Padilla-Meléndez et al. (2013) found gender differences in the influence of playfulness on users' intention to a technology. Assaker (2020) argued that gender and age moderate the influence of perceived usefulness and ease of use on the usage intention. Sheng & Zolfagharian (2014) argued that the financial risk level in a purchase attenuates the negative relationship between consumer participation and perceived ease of use, but enhances the positive relationship between consumer participation and perceived usefulness.

The extended technology acceptance model is displayed in Figure 2.

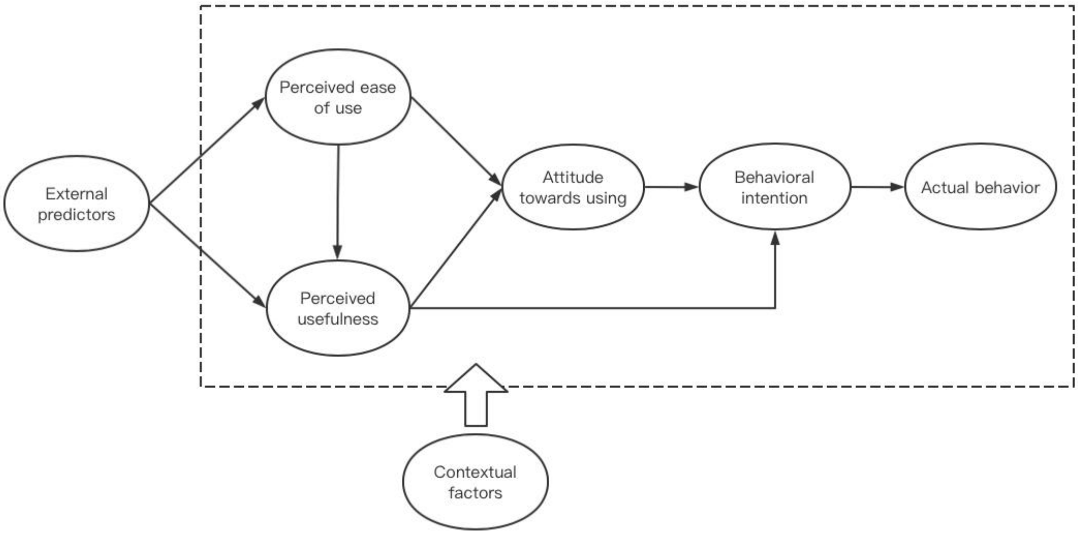

Figure 2 The extended technology acceptance model

2.3. Innovation diffusion theory

Innovation diffusion theory is proposed by Rogers (1995) in the book, *Diffusion of Innovations*, to explain how an innovation diffuses among organizations and individuals. The diffusion reflects the process of an innovation being accepted by individuals or organizations in a social system over time (Valente, 2005). There are four important elements in innovation diffusion, including innovation, social system, time, and diffusion channel (Rogers, 1995).

From the aspect of innovation, relative advantage, complexity, compatibility, observability and trialability are five important attributes of an innovation that will affect its adoption (Rogers, 1995). Among the five attributes, relative advantage is defined as the extent to which the innovation is better than current products. If the new technologies or systems have no relative advantage compared with current ones, potential users may not take them into consideration further. Therefore, relative advantage can be regarded as a sine qua non of the adoption of an innovation (Greenhalgh et al., 2004). Complexity reflects the perceived barrier in using the technology or system. If the potential users think that the technology or system is complex, they are likely to have a low intention of using it (Al-Rahmi et al., 2019). Compatibility refers to the extent to which the innovation is believed to be in line with adopters' prior values, norms and demands. Technologies or systems which are not compatible with users' norms, values and demands will not be accepted as fast as compatible ones (Sonnenwald et al., 2001). Observability indicates the extent to which the innovation results and benefits are easily observed. If potential users can easily observe the result of an innovation, they will more understand it and tend to adopt it (Cheng, 2017). Trialability indicates the chance of testing or trying the innovation before adopting it (Sonnenwald et al., 2001). New technologies or systems which can be tested on a small scale are often more easily and quickly accepted than innovations that can't be tested (Syahadiyanti & Subriadi, 2018). Moore & Benbasat (1991) extended the innovation diffusion theory by renaming complexity as ease of use, dividing observability into visibility and result demonstrability, and adding new attributes of innovation of image and voluntariness. Image indicates the degree to which individuals believe that the innovation will promote their social status or image, and voluntariness reflects the degree to which individuals think that the innovation is adopted out of the free will (Yuen et al., 2021). Therefore, the eight attributes proposed can be summarized as relative advantage, image, compatibility, ease of use, visibility, result demonstrability, trialability, and voluntariness (Moore & Benbasat, 1991).

From the aspect of diffusion channels, interpersonal communication and mass communication are two main categories of diffusion channels. Among them, interpersonal communication is a selective, direct, reciprocal, and double-sided channel, while mass communication is an effective and fast channel (Rogers, 1995).

From the aspect of time, the decision process to accept the innovation needs time, which includes five stages of knowledge, persuasion, decision, implementation, and confirmation. In addition, the increase of proportion in a group to accept the innovation also needs time. The increasing number of users will facilitate other individuals or organizations to accept the innovation. Only if the number of users achieves a certain level can the innovation begin to spread in the social system, so that the innovation diffusion process will become self-sustaining (Cheng, 2017). The innovation adoption process is usually an S-curve. In the beginning, the degree of adoption of individuals or organizations is low, and the acceptance population increases slowly. When the proportion of users in the population achieves the critical level, the speed of diffusion accelerates. However, when the proportion of users in the population exceeds 50%, the diffusion speed decreases again since the system achieves the saturation point. And the innovation may even vanish if the proportion can't achieve a certain level over a long time (Rogers, 1995).

The social system involves characteristics such as social norms, social structure, opinion leaders, and so on. Social norms indicate values shared by the majority in the social structure, which offers guidance for members in the social system (Cheng, 2017). If an innovation is perceived to be against the social norms in a social system, it will be difficult for the innovation to diffuse.

Innovation diffusion theory is the theoretical foundation to study innovation diffusion (Zhang & Vorobeychik, 2019), which is widely used in explaining the adoption of different technologies or systems. For example, Lee (2004) discussed the determinants of nurses' intention to adopt the computerized care plan system, and analyzed the influence of compatibility, relative advantage, complexity, observability, and trialability on their adoption. Ong et al. (2008) used the innovation diffusion theory to explain the factors influencing the adoption of 3G services. Wang et al. (2012) investigated the influence of compatibility, complexity and relative advantage on the adoption of web automatic teller machines based on the innovation diffusion theory. Jamshidi & Hussin (2016) argued that relative advantage and compatibility facilitates the intention to use an Islamic credit card, while complexity negatively affects the intention. Wang et al. (2018) found that perceived compatibility, relative advantage, observability, and trialability positively affect the intention to adopt automated parcel station, while complexity negatively affects the adoption intention. Marak et al. (2019) discussed the impacts of relative advantage, observability, trialability, ease of use, and compatibility on users' adoption of the 3D printing technology on the basis of innovation diffusion theory. Yuen et al. (2020) argued that the public's perceived value of autonomous vehicles mediates the impact of the innovation diffusion attributes such as compatibility, relative advantage, trialability, observability and complexity, on the public acceptance of autonomous vehicles.

2.4. Integrating the technology acceptance model and innovation diffusion theory

The technology acceptance model and innovation diffusion theory are both widely used to explain the determinants of users' adoption of new technologies or systems. The technology acceptance model identifies the essential factors influencing users' acceptance of the new innovation (Venkatesh & Davis, 2000), and the innovation diffusion theory helps to understand innovation characteristics and their impact on innovation adoption (Rogers, 1995). Both of them share similar assumptions that users evaluate innovation based on their perceived characteristics of the innovations, and new technologies or systems with favorable characteristics tend to be more accepted (Al-Rahmi et al., 2019). The two theories complement each other to some extent, and they are regarded to be similar in terms of some constructs such as perceived usefulness and relative advantage, perceived ease of use and complexity (Tobbin, 2010). There are also some differences between the two theories, the innovation diffusion theory is more concrete than the technology acceptance model in the determinants of the innovation adoption from the specific attributes of the innovation, and such attributes can be regarded as antecedents of the technology acceptance model (Min et al., 2019). Therefore, it will be a reasonable assumption that the attributes of innovation will affect individuals' perceived ease of use and usefulness, thus influencing the behavioral intention to adopt new technologies or systems (Yuen et al., 2021). Integrating the two theories may be a good choice, which can offer a more effective model than either single model to predict determinants of innovation diffusion (Wu & Wang, 2005), enabling us to better understand the users' general perception of the new technology or system, as well as the specific characteristics that will attract users' adoption and usage (Min et al., 2019).

Several prior studies have tried to integrate the technology acceptance model and innovation diffusion theory to investigate the determinants of different technologies or systems. For example, Wu & Wang (2005) integrated the two theories to investigate individuals' behavioral intention of adopting mobile commerce, and found that compatibility affects perceived usefulness and behavioral intention to use. Tobbin (2010) argued that relative advantage facilitates perceived usefulness, thus promoting the adoption intention of mobile money transfer services. Oh & Yoon (2014) explored the antecedents of haptic enabling technologies through the integration of innovation diffusion theory and technology acceptance model, and argued that relative advantage and compatibility affect the perceived usefulness and thus affect the intention to adopt the technology. By integrating the technology acceptance model and innovation diffusion theory, Lou & Li (2017) found that compatibility, complexity, and relative advantage will influence the perceived ease of use and usefulness, thus exerting influence on the actual usage of the blockchain technology. Karahoca et al. (2018) argued that trialability, compatibility and image influence the perceived ease of use and usefulness, thus affecting the behavioral intention to use IoT healthcare products. Al-Rahmi et al. (2019) found that relative advantage, tribality, compatibility, observability, and perceived enjoyment influence perceived usefulness; while complexity, relative advantage, compatibility, and enjoyment affect perceived ease of use, thus influencing the students' behavioral intention of e-Learning. Min et al. (2019) proposed that relative advantage, observability, compatibility, and social influence have positive influences on perceived ease of use and usefulness, while complexity has a negative impact, thus influencing users' intention to use the Uber mobile application. Gu et al. (2019) proposed an integrated framework of the technology acceptance model and innovation diffusion theory to explain the determinants of the adoption of mobile tourism shopping. Yuen et al. (2021) argued that six innovation attributes (compatibility, relative advantage, image, visibility, result demonstrability, and trialability) affect perceived ease of use and usefulness, thus influencing the adoption intention of autonomous vehicles. Al-Rahmi et al. (2021) investigated the influencing factors of students' adoption intention of massive open online courses by integrating the two theories.

In a word, prior research has investigated the antecedents of the IoT system adoption. However, the determinants of the adoption of intelligent IoT systems for hog-raising are underexplored. As the animal husbandry and aquaculture industry is a traditional industry compared with other industries, in which the adoption of new technology is slow and hard. It is necessary to explore the determinants of the adoption of intelligent IoT systems for hog-raising in this specific industry to offer valuable insights into the development and upgrading of traditional industry. In addition, technology acceptance model (TAM) and innovation diffusion theory (IDT) are widely used to explain firms' adoption of new technologies such as the Internet of Things (Hsu & Yeh, 2017; Yuen et al., 2021). Scholars have made a lot of effort in extending and improving the two theories. And several studies have tried to integrate the two theories to investigate the determinants of new technologies or products, which can offer a more effective model than either single model to predict the determinants of innovation diffusion (Wu & Wang, 2005). Therefore, this dissertation aims to fill the gap on the underexplored topic about the determinants of the adoption of intelligent IoT systems for hog-raising by integrating the technology acceptance model and innovation diffusion theory .

3. Hypotheses and theoretical model

The Internet of Things technology has been applied to the animal husbandry and aquaculture industry in recent years (Benhai et al., 2015), improving the intelligence and automation level of the raising process through functions such as automated feeding, automatic door closure, and precision feeding (Yongqiang et al., 2019). Especially, pork plays a pivotal role in the food culture of Chinese residents and the hog-raising industry has developed a lot. China has a huge pig market size. According to data from the US Department of Agriculture, China's pig production in 2020 was 565 million heads, accounting for 48.43% of the global, ranking first in the world. In the meat consumption structure, pork is the largest consumer goods category for residents, accounting for 73.42% of consumption in 2020. In recent years, various policies have been issued to promote hog-raising to move towards scale in China, such as subsidies to support the production of large-scale breeding. With the release of the three-child birth in China, it can be expected that the demand for pork will continue to increase in the future. Therefore, the adjustment and upgrading of the industrial structure of China's hog-raising industry is imperative. To improve the efficiency of large-scale breeding, the hog-raising industry is bound to need the intervention and deep integration of artificial intelligence. The traditional hog-raising mode is not able to offer a good growth environment for the pigs, and automated hog-raising mode based on the Internet of Things technology will become a new trend (Hua et al., 2021), which ensures the breeding process monitoring and quality tracing (Ma et al., 2012). And this dissertation pays attention to the determinants of the adoption of intelligent IoT systems for hog-raising.

Given that the industry of intelligent IoT systems for hog-raising has just emerged, and the intelligent IoT systems have not been widely used yet, the actual usage behaviors are difficult to measure. Therefore, the behavioral intention to use intelligent IoT systems for hog-raising is used as a proxy of actual usage behaviors, which can be a strong predictor of the actual behaviors because individuals have a strong desire to adjust their behaviors to be in line with their intention to ease their psychological tension caused by the perceived distance between intention and behaviors (Wang et al., 2018). And the determinants of the intention to use intelligent IoT systems for hog-raising will be discussed in the following parts.

3.1 Factors influencing the behavioral intention to use intelligent IoT systems for hog-raising

3.1.1 Technological factors

According to innovation diffusion theory (Rogers, 1995), relative advantage, image, compatibility, ease of use, visibility, result demonstrability, trialability, and voluntariness are eight attributes of an innovation that will affect its adoption (Moore & Benbasat, 1991). Based on the characteristics of intelligent IoT systems for hog-raising and interviews with several senior managers of hog-raising firms that have adopted intelligent IoT systems for hog-raising, I think relative advantage, compatibility, result demonstrability, and trialability are important factors that will influence the behavioral intention to use intelligent IoT systems for hog-raising. In the following sections, I discussed the specific influence of the four factors on the behavioral intention to use intelligent IoT systems for hog-raising.

(1) Relative advantage

The relative advantage in this research refers to the extent to which individuals believe that intelligent IoT systems for hog-raising are better than other systems in terms of effectiveness, efficiency or other characteristics (Hardgrave et al., 2003). The users' perception of whether the intelligent IoT systems are advantageous determines their adoption intention (Lu, 2021). Users make the overall assessment of an intelligent IoT system's relative advantages by comparing it with other systems that they used before (Min et al., 2019). If the decision-makers in firms believe that the intelligent IoT system is better than other systems or traditional methods in hog-raising, they are more likely to use the system. Compared with traditional systems, the intelligent IoT system for hog-raising helps to reduce the mortality rate of hogs through early detection and prevention of virus transmission, optimize the raising process, reduce raising costs, and improve raising income. The relative advantage of the intelligent IoT system for hog-raising facilitates the behavioral intention to use intelligent IoT systems for hog-raising.

By contrast, if users think the intelligent IoT systems for hog-raising are no better than other systems in enhancing their performance, they are more likely to use the other systems and are less likely to adopt the intelligent IoT systems.

Therefore, I propose the following assumption:

Hypothesis 1: The relative advantage of intelligent IoT systems for hog-raising has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

(2) Compatibility

Compatibility is defined as the extent to which intelligent IoT systems for hog-raising can match with the users' existing norms, prior experience, and needs in hog-raising in this research (Karahoca et al., 2018). A high level of compatibility suggests that the intelligent IoT system is less uncertain to the potential users (Lu, 2021). If the intelligent IoT system is compatible with users' management experience and demands in hog-raising, they do not have to make a lot of change and effort to adapt to the system (Yuen et al., 2021), so they will be more likely to use the system (Lu, 2021).

By contrast, if the intelligent IoT system for hog-raising is not compatible with users' management experience and demands in hog-raising, they need to make much effort to adapt to such a new system. Hence, may hesitate to adopt the system.

Therefore, hypothesis 2 is put forward.

Hypothesis 2: The compatibility of intelligent IoT systems for hog-raising *has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.*

(3) Result demonstrability

Result demonstrability reflects the quantifiable benefits bought by using intelligent IoT systems for hog-raising (Moore & Benbasat, 1991). A high level of result demonstrability indicates that the benefits of intelligent IoT systems for hog-raising are visible and communicable, and users can easily explain and show the benefits to others (Yuen et al., 2021). Users believe that the usage of intelligent IoT systems for hog-raising will bring benefits for their firms in many indicators such as reduced costs, improved efficiency, and reduced death rate of hogs in the raising process, and thereby they are more likely to use the intelligent IoT system. Therefore, the level of result demonstrability is positively connected with the behavioral intention to use intelligent IoT systems for hog-raising.

Therefore, I put forward the following assumption:

Hypothesis 3: The result demonstrability of intelligent IoT systems for hog-raising has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

(4) Trialability

Trialability reflects the level to which users think that intelligent IoT systems for hog-raising are triable before deciding whether to adopt them (Al-Rahmi et al., 2021). A high level of trialability helps to reduce users' perceived uncertainty and further promotes their adoption intention (Dutta & Omolayole, 2016; Lu, 2021). By experimenting with the system in advance, users will learn more knowledge and usage about intelligent IoT systems, learn how the system can benefit firms in many aspects, and are more likely to adopt the systems. Hence, the trialability of intelligent IoT systems for hog-raising facilitates users' behavioral intention to use them.

Therefore, the following assumption is put forward.

Hypothesis 4: The trialability of intelligent IoT systems for hog-raising has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

3.1.2 Social factors

(1) Subject norm

Subject norm is defined as individuals' perception that the majority of people who are important to them believe they should or should not perform the behavior (Lee & Wan, 2010), which reflects the individuals' perception of social pressure (Yang & Jolly, 2009) and the degree of which individuals will be influenced by the perception of others who are important to them (Kaushik et al., 2015). Subject norm is an essential force for firms to adopt new technologies or systems (Fu et al., 2006; Glass & Li, 2010; Hopp, 2013; Lee & Wan, 2010; Schepers & Wetzels, 2007). Individuals perceive that the more people who are important to them think they should engage in a behavior, the more individuals are likely to do so (Choi & Chung, 2013). For hog-raising firms, the competitors, clients, suppliers, and partners are important stakeholders to them, and their perception of pressure from these stakeholders will influence their behavioral intention to use intelligent IoT systems for hog-raising. If the competitors, or the whole industry are using new intelligent IoT systems, or the customers or partners expect the firm to use the intelligent IoT systems, the firm is more likely to adopt it too (Kannabiran & Dharmalingam, 2012). Competitors are important references to firms, who influence firms' subjective norm greatly. Firms will feel a high level of pressure if their competitors adopt new technologies (Low et al., 2011). Such pressure drives firms to adopt new systems or technologies to maintain competitiveness (Alaskar et al., 2021). If firms' clients, partners and suppliers believe that intelligent IoT systems will improve the quality of hogs and expect the firm to adopt the systems, firms are more likely to use the systems in response to their expectations.

Therefore, I argue that subject norm facilitates the intention to adopt intelligent IoT systems for hog-raising. And the following assumption is proposed:

Hypothesis 5: Subject norm has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

(2) Safety

Safety problems such as security vulnerability (Wang et al., 2020) and data leakage are obstacles to hog-raising firms adopting the intelligent IoT systems for hog-raising. In fact, the Internet of Things has been included in the list of six "Disruptive Civil Technologies" by US National Intelligence Council given its huge threats of information security (Nic, 2008). The security issues of the Internet of Things are multifaceted, including traditional network security issues, security issues of computing systems, and special security issues in the perception process of the Internet of Things. Given that privacy is an important concern of users when deciding whether to use an IoT system or not (Karahoca et al., 2018), safety influences users' attitudes towards new technologies (Shin et al., 2018) such as IoT systems. Nowadays, data become a key in competition. Hog-raising firms are worried about data leakage. If the core data of their data is stolen by their competitions, they will lose their competitive advantage in the hog-raising industry. Therefore, they will reject to use the intelligent IoT systems for hog-raising if they have concern about safety problems such as privacy.

By contrast, if they think intelligent IoT systems for hog-raising are safe, they are more likely to adopt them.

Therefore, I argue that safety will facilitates the intention to adopt intelligent IoT systems for hog-raising. And the following assumption is proposed:

Hypothesis 6: Safety has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

3.2 The mechanism behind the relationship between technological factors

and the behavioral intention to use intelligent IoT systems for hog-raising

After discussing the positive impacts of the four technological factors on the behavioral intention to use intelligent IoT systems for hog-raising, namely, relative advantage, compatibility, result demonstrability, and trialability, this dissertation further explores the mechanism behind the relationship between technological factors and the behavioral intention to use intelligent IoT systems for hog-raising. Based on the technology acceptance model (Davis, 1989), perceived usefulness and ease of use will affect the behavioral intention to use new technologies. Scholars also proposed that specific attributes of the innovation can be regarded as antecedents of the technology acceptance model (Min et al., 2019), namely, the attributes of innovation will affect individuals' perceived ease of use and usefulness, and thus influence the behavioral intention to adopt new technologies or systems (Yuen et al., 2021). Therefore, integrating the technology acceptance model (Davis, 1989) and innovation diffusion theory (Rogers, 1995), I argue that relative advantage, compatibility, result demonstrability, and trialability will influence the perceived ease of use and perceived usefulness of key decision-makers in hog-raising firms, and further influence their behavioral intention to use intelligent IoT systems for hog-raising.

In the following sections, I will analyze how the technological factors (including relative advantage, compatibility, result demonstrability, and trialability) influence the perceived ease of use and perceived usefulness of users, and how perceived ease of use and perceived usefulness of users further influence the behavioral intention to use intelligent IoT systems for hog-raising, to reveal the mechanism behind the relationship between the technological factors and the behavioral intention to use intelligent IoT systems for hog-raising.

3.2.1 Technological factors and perceived ease of use/usefulness

(1) Relative advantage and perceived usefulness

Prior studies have confirmed the positive influence of relative advantage on perceived usefulness (Al-Rahmi et al., 2021; Oh & Yoon, 2014). If users compare the intelligent IoT system with other systems that they used before (Min et al., 2019) and find that the intelligent IoT system is better than other systems or traditional methods in hog-raising, they will perceive a higher usefulness of the IoT system (Tobbin, 2010). Therefore, the relative advantage of intelligent IoT systems for hog-raising will facilitate the perceived usefulness of key decision-makers in hog-raising firms, which suggests the following assumption:

Hypothesis 7: The relative advantage of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness.

(2) Compatibility and perceived ease of use/usefulness

Prior research has demonstrated the positive impact of compatibility on perceived usefulness (Al-Rahmi et al., 2021; Min et al., 2019). If intelligent IoT systems are compatible with users' management experience and demands in hog-raising, they will feel a high level of usefulness.

Therefore, hypothesis 8a is put forward.

Hypothesis 8a: The compatibility of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness.

A high consistency between intelligent IoT systems for hog-raising and the users' existing technological and social situations means that users do not have to make a lot of changes to adapt to the new system (Yuen et al., 2021). So it will become easier for users to grasp the usage of intelligent IoT systems for hog-raising, which indicates that a high level of compatibility is positively associated with the perceived ease of use.

Therefore, the following assumption is put forward:

Hypothesis 8b: The compatibility of intelligent IoT systems for hog-raising has a positive influence on perceived ease of use.

(3) Result demonstrability and perceived ease of use/usefulness

High result demonstrability makes users easily explain and show the benefits of intelligent IoT systems for hog-raising to others (Yuen et al., 2021), such as the reduced costs, improved efficiency, and reduced death rate of hogs in the raising process. Users believe that the adoption of intelligent IoT systems for hog-raising will benefit their firms with a high level of result demonstrability, and thus they will feel a higher level of the usefulness brought by the system. Therefore, the level of result demonstrability is positively connected with perceived usefulness.

Therefore, the following assumption is put forward:

Hypothesis 9a: The result demonstrability of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness.

In addition, a high level of result demonstrability indicates that users can obtain knowledge about the benefits and usage of intelligent IoT systems for hog-raising with less effort (Yuen et al., 2021), and thus users will feel a higher level of ease of use.

Therefore, I put forward the following assumptions:

Hypothesis 9b: The result demonstrability of intelligent IoT systems for hog-raising has a positive influence on perceived ease of use.

(4) Trialability and perceived ease of use/usefulness

The usage of intelligent IoT systems is not popular in the field of agriculture at the present stage, and many potential users do not know whether and how intelligent IoT systems for hog-raising can benefit their firms. By experimenting with the system in advance, users can learn more knowledge about intelligent IoT systems, and learn how the system can benefit firms in many aspects. Therefore, the trialability of intelligent IoT systems for hog-raising facilitates users' perceived usefulness, which suggests the following assumption:

Hypothesis 10a: The trialability of intelligent IoT systems for hog-raising *has a positive influence on perceived usefulness.*

Prior experiments will help to familiarize users with intelligent IoT systems for hog-raising, reduce users' efforts to master the usage method of the system, and thus improve their perceived ease of use. Therefore, I hold the view that the tribality of intelligent IoT systems for hog-raising will be positively connected with users' perceived ease of use.

The assumption can be summarized as follows:

Hypothesis 10b: The trialability of intelligent IoT systems for hog-raising has a positive influence on perceived ease of use.

3.2.2 Perceived ease of use/usefulness and the behavioral intention to use intelligent IoT systems for hog-raising

Under the research situation of this dissertation, perceived usefulness refers to the degree to which users believe that the adoption of intelligent IoT systems for hog-raising will improve their performance in hog-raising (Hsu & Lin, 2018). A lot number of prior studies have demonstrated the positive impacts of perceived usefulness on the behavioral intention to adopt new technologies or systems (Alfadda & Mahdi, 2021; Jan & Contreras, 2011; Park, 2009; Wu & Wang, 2005). If the key decision-maker of firms believes that intelligent IoT systems for hog-raising will improve the performance and utility of a firm in hog-raising, the perceived usefulness will motivate them to adopt the intelligent IoT system.

Therefore, the following assumptions are proposed:

Hypothesis 11: Perceived usefulness has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

The perceived ease of use refers to the extent to which users think that intelligent IoT systems for hog-raising are easy to use (Karahoca et al., 2018). Prior research has demonstrated that perceived ease of use will facilitate the behavioral intention to adopt new technologies or systems (Alfadda & Mahdi, 2021; Jan & Contreras, 2011; Park, 2009; Wu & Wang, 2005). Perceived ease of use reduces the decision markers' concerns about the difficulty in using intelligent IoT systems for hog-raising, which enhances their effort and cognitive resources needed for learning to use the system. Therefore, perceived usefulness and ease of use facilitate the behavioral intention to use intelligent IoT systems for hog-raising.

Hence, the following assumptions are proposed:

Hypothesis 12: Perceived ease of use has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising.

The theoretical model of the determinants of business organizations' adoption of IoT systems for hog-raising in this dissertation can be summarized in Figure 3.

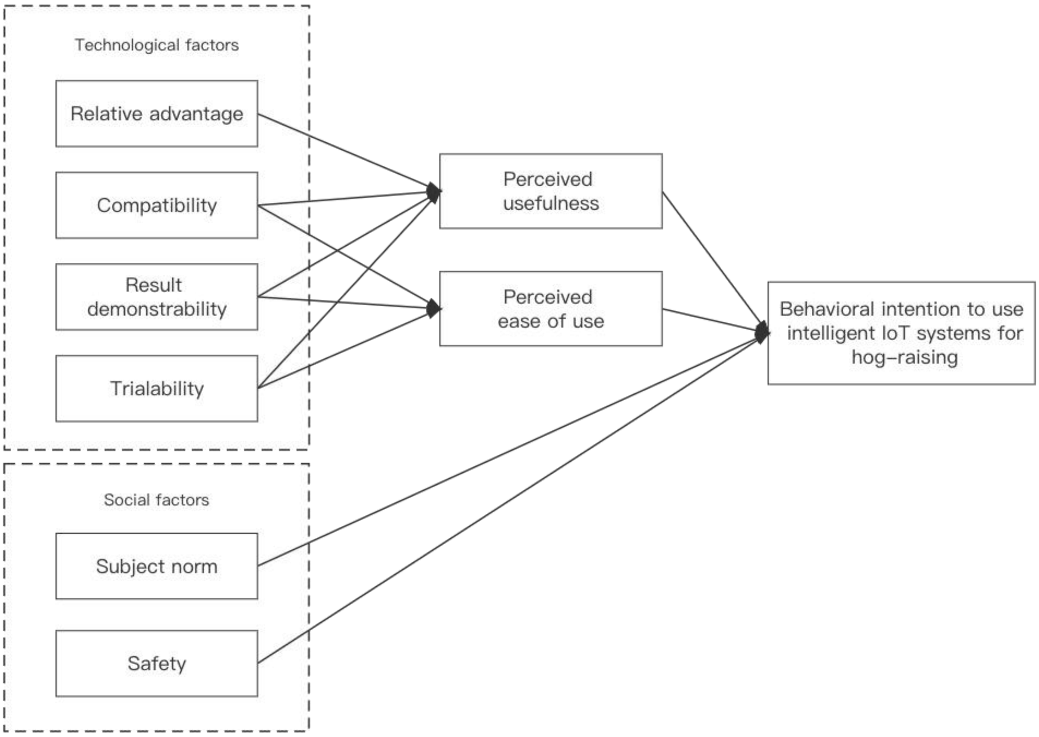

Figure 3 Theoretical model

4. Methods

4.1. Sample and data

In order to test the theoretical model of this dissertation, I collected survey data from senior managers in 400 hog-raising firms. The hog-raising firms were randomly selected from the client lists and potential client lists of Lasset Robot Technology Company, a company focusing on the application of artificial intelligence in the raising industry. The company aims to relieve the "pain point" of the breeding industry by using technologies such as edge computing, machine learning, the Internet of Things, and big data. The company was set up in 2018 in China with workshops of over 8000 square meters and R&D laboratories of more than 1500 square meters. Up to now, it has formed a competitive solution in the intelligent breeding scenario and provided more than 400 systems for the hog-raising industry, aiming to promote the automation, intelligence and IOT of the hog-raising industry.

The company mainly uses three sets of hardware equipment. The first is the visual orbital robot, which can not only reduce pig mortality and improve productivity but also reduce feed waste. The manual real-time remote inspection and intelligent inspection carried out by the equipment can reduce the transmission of diseases and reduce the mortality rate. At the same time, the equipment is also able to carry out behavior recognition and environmental detection, which contributes to automatically alarming and early warning when discovering abnormal symptoms, thereby reducing the case fatality rate. It can also help to achieve intelligent feeding and reduce feed waste. The second is the intelligent precision feeder, which can realize planned intelligent feeding, intelligently adjust the amount of feed and water and reduce feed waste. The third is a handheld intelligent terminal, which can speed up data reading, improve management efficiency, achieve mobile temperature measurement, and take pictures on a large screen. And these functions help to detect abnormalities in time and reduce mortality. Moreover, a set of intelligent management cloud platforms is used by the company, which can realize the linkage management with the above 3 hardware equipment and eventually prevent the outbreak of the epidemic, reduce cost as well as improve the efficiency of the hog-raising.

The clients and potential clients of the company are mature hog-raising firms with stable cash flows, which provides an opportunity to explore the key determinants of adopting the IoT system for hog-raising. Senior managers of these hog-raising firms who can decide whether to adopt new technologies in the firms were invited to participate in this survey. They were invited to complete the questionnaires about the relative advantage, compatibility, result demonstrability, tribality, subjective norm, safety, the perceived usefulness and ease of use of the IoT system for hog-raising, and their intention to adopt the system.

The survey was conducted from July 2022 to May 2023. I asked the employees of Lasset Robot Technology Company for help to send questionnaires. The employees contacted their existing clients to invite them to participate in the survey and sent out questionnaires at industry conferences such as China Animal Husbandry Expo and Allen D. Leman Swine Conference to invite potential clients to join the survey. After a long period of effort, I obtained 400 questionnaires in total. After excluding invalid samples with missing answers, the final sample includes 266 firms. In the final sample, 81.95% of the respondents are male, and 18.05% of them are female.

The distribution of the sample firms in this dissertation is presented in Table 3.

Table 3 Distribution of sample firms

	Characteristics	Percentage
Firm age	younger than 3 years old	3.76%
	3-6 years old	19.92%
	6-9 years old	17.29%
	9-12 years old	14.29%
	12-15 years old	8.27%
	15-18 years old	11.65%
	older than 18 years old	24.81%
Firm size	no more than 50 employees	51.50%
	51-100 employees	16.17%
	101-150 employees	3.76%
	151-200 employees	4.14%
	201-250 employees	0.75%
	more than 250 employees	23.68%
Breeding scale	no more than 2000 pigs	18.05%
	2001-10000 pigs	21.43%
	10001-20000 pigs	23.31%
	20001-500000 pigs	24.81%
	500001-1000000 pigs	4.89%
	more than 1000000 pigs	7.52%

As shown in the Table, the sample firms are very diverse in this dissertation with a wide range of ages, sizes, and breeding scales.

4.2. Measures

The main variables in this dissertation are measured by the mature scales developed in prior research. Five-point Likert scales are used to measure the main constructs.

4.2.1 Behavioral intention

Behavioral intention to use intelligent IoT systems for hog-raising is measured by the scale developed by Yuen et al. (2021), which includes four items as follows:

1) Our firm intends to use intelligent IoT systems for hog-raising in the future.
2) Our firm plans to use intelligent IoT systems for hog-raising in the future.
3) Our firm has positive things to say about intelligent IoT systems for hog-raising.
4) Our firm would encourage others to use intelligent IoT systems for hog-raising.

4.2.2 Perceived usefulness

Perceived usefulness is measured by a four-item scale developed by Venkatesh & Davis (2000). The detailed items are as follows:

1) Using the intelligent IoT system for hog-raising enables us to improve PSY through fat management and accurate feeding, thus improving the

performance of our firms.

2) Using the intelligent IoT system for hog-raising will improve the production environment and reduce the feed-meat ratio through environmental sensing and intelligent control, thus increasing the productivity of our firms through intelligent feeding.
3) Using the intelligent IoT system for hog-raising will reduce pig mortality by reduction of human contact and early detection of epidemic situations, thus enhancing the effectiveness of our firms.
4) Overall, I think the intelligent IoT system for hog-raising will be useful in our firms.

4.2.3 Perceived ease of use

Perceived ease of use is measured by the scale adapted from Venkatesh & Davis (2000). The four items of perceived ease of use are as follows:

1) The interaction with the intelligent IoT system for hog-raising will be clear and understandable.
2) Interacting with the intelligent IoT system for hog-raising will not require a lot of mental effort.
3) The intelligent IoT system for hog-raising will be easy to use.
4) It is easy to get the intelligent IoT system for hog-raising to do what we want it to do.

4.2.4 Relative advantage

Relative advantage is measured by the scale adapted from Pillai &

Sivathanu (2020). The three items of relative advantage are as follows:

1) The intelligent IoT system for hog-raising will provide better help for raising than conventional raising techniques.
2) We feel the use of the intelligent IoT system for hog-raising will take less time and effort for raising than conventional raising.
3) The intelligent IoT system for hog-raising will offer more value than conventional raising.

4.2.5 Compatibility

Compatibility is measured by the three-item scale developed by Shin (2019). The items are as follows:

1) The intelligent IoT system for hog-raising can be freely configured according to our existing breeding logic and be compatible with most aspects of our firm.
2) The intelligent IoT system for hog-raising would fit our work style.
3) The intelligent IoT system for hog-raising would fit well with the way we like to work.

4.2.6 Result demonstrability

Result demonstrability is measured by a three-item scale developed by Yuen et al. (2021). The detailed three items for result demonstrability are as follows:

1) We would have no difficulty telling others about the advantage of the intelligent IoT system for hog-raising.

2) It is easy to explain why taking the intelligent IoT system for hog-raising may be beneficial.
3) The advantages of taking the intelligent IoT system for hog-raising are apparent.

4.2.7 Trialability

Trialability is measured by the scale adapted from Shin (2019). The detailed items are as follows.

1) Our firm wants to be able to use the intelligent IoT system for hog-raising on a trial basis.
2) Our firm wants to be able to properly try out the intelligent IoT system for hog-raising.
3) Our firm wants to be permitted to use the intelligent IoT system for hog-raising, on a trial basis long enough to see what it can do.

4.2.8 Subject norm

Subject norm is measured by a four-item adapted from Looi (2005). The detailed items are as follows.

1) Many of our business competitors are already using the intelligent IoT system for hog-raising.
2) Our suppliers/trading partners are using the intelligent IoT system for hog-raising.
3) Our customers or trading partners expect us to use the intelligent IoT system for hog-raising.

4) Using the intelligent IoT system for hog-raising helps us to compete better with our competitors.

4.2.9 Safety

Safety is measured by a three-item adapted from Karahoca et al. (2018). The detailed items are as follows.

1) It would be safe to disclose the information of our firms to vendors providing intelligent IoT system for hog-raising
2) There would be low potential for loss associated with disclosing information of our firms to vendors providing intelligent IoT system for hog-raising
3) There would be low uncertainty associated with giving information of our firms to vendors providing intelligent IoT system for hog-raising.

4.2.10 Control variable

To control the influence of other factors that may influence the perceived ease of use and usefulness as well as the behavioral intention to use intelligent IoT systems for hog-raising, the firm age, size, and breeding scale is included in the model. Firm age is measured by the logarithm of the number of years since the establishment of the firm. As the age grows, firms may suffer more inertia, which may prevent them from adopting new technologies. Firm size is measured by the logarithm of the number of employees. Larger firms usually have more resources to invest in intelligent IoT systems for hog-raising. The breeding scale is measured by a category variable. Respondents are asked about the number of pigs their firms are breeding (1=no more than 2000 pigs, 2=2001-10000 pigs, 3=10001-20000 pigs, 4=20001-500000 pigs, 5=500001-1000000 pigs, 6=more than 1000000 pigs). A large scale increases the difficulty in breeding, which may increase firms' perceived usefulness and behavioral intention to use intelligent IoT systems for hog-raising.

5. Results

5.1. Reliability and validity

To test the reliability of the measures, Cronbach's alphas of main scales are calculated. The results are displayed in Table 4.

Table 4 Cronbach's alphas of variables

Variable	Cronbach's alphas
Behavioral intention	0.892
Perceived usefulness	0.885
Perceived ease of use	0.850
Relative advantage	0.872
Compatibility	0.762
Result demonstrability	0.822
Trialability	0.870
Subject norm	0.872
Safety	0.833

The results suggest that all Cronbach's alphas of main scales are larger than 0.7 in this dissertation, demonstrating that the variables have a high level of reliability.

I conducted the confirmatory factor analysis (CFA) in this dissertation. A nine-factor CFA model that includes behavioral intention, perceived usefulness, perceived ease of use, relative advantage, compatibility, result demonstrability, trialability, subjective norm, and safety is calculated. The results suggest that the data fits the model ($\chi 2$ (398) =855.142, $p \leq .01$; CFI = 0.922, SRMR = 0.047, RMSEA=0.066).

To test the discriminant validity of the main variables, the nine-factor CFA model (including behavioral intention, perceived usefulness, perceived ease of use, relative advantage, compatibility, result demonstrability, trialability, subject norm, and safety) is compared with other CFA models with fewer factors. And the results are displayed in Table 5.

Table 5 CFA model comparison

Model	**χ2**	**Df**	**CFI**	**SRMR**	**RMSEA**
Nine-factor model	855.142	398	0.922	0.047	0.066
Eight-factor model 1 (behavioral intention and perceived usefulness combined)	1010.005	406	0.897	0.049	0.075
Eight-factor model 2 (behavioral intention and perceived ease of use combined)	922.129	406	0.912	0.049	0.069
Eight-factor model 3 (behavioral intention and relative advantage combined)	1239.826	406	0.857	0.070	0.088
Eight-factor model 4 (behavioral intention and compatibility combined)	1110.625	406	0.879	0.072	0.081
Eight-factor model 5 (behavioral intention and result demonstrability combined)	1138.162	406	0.875	0.066	0.082
Eight-factor model 6 (behavioral intention and trialability combined)	1167.662	406	0.869	0.064	0.084
Eight-factor model 7 (behavioral intention and subject norm combined)	1098.163	406	0.881	0.055	0.080
Eight-factor model 8 (behavioral intention and safety combined)	1029.831	406	0.893	0.053	0.076
Eight-factor model 9 (perceived usefulness and perceived ease of use combined)	1066.201	406	0.887	0.049	0.078

As presented in Table 5, the nine-factor model fits the data better compared with eight-factor models or the one-factor model, demonstrating a high level of discriminant validity.

The convergent validity test result of the main variables is displayed in Table 6. The results show that all the standardized factor loadings in the model exceed the commonly accepted level of 0.50 and significantly loaded on their respective factors, the composite reliabilities (CR) of all variables are above 0.7, and the the average variance extracted (AVE) of all variables are above 0.5, which indicates a high level of convergent validity.

Table 6 Convergent validity test result of the main variables

Variables		Loadings	CR	AVE
Relative advantage	RA1	0.865	0.87	0.7
	RA2	0.827		
	RA3	0.815		
Compatibility	CO1	0.748	0.76	0.51
	CO2	0.739		
	CO3	0.657		
Result demonstrability	RE1	0.727	0.82	0.6
	RE2	0.764		
	RE3	0.826		
Trialability	TR1	0.812	0.87	0.69
	TR2	0.865		
	TR3	0.815		
Subject norm	SN1	0.78	0.88	0.64
	SN2	0.835		
	SN3	0.875		
	SN4	0.703		
Safety	SA1	0.742	0.84	0.63

	SA2	0.803		
	SA3	0.84		
Perceived usefulness	PU1	0.841	0.89	0.67
	PU2	0.893		
	PU3	0.832		
	PU4	0.701		
Perceived ease of use	PE1	0.752	0.85	0.59
	PE2	0.767		
	PE3	0.783		
	PE4	0.763		
Behavioral intention	UI1	0.781	0.89	0.68
	UI2	0.832		
	UI3	0.841		
	UI4	0.833		

5.2. Common method bias

Given that one respondent of each firm answered all questions in the questionnaire, the common method bias will be a problem in my dissertation. To avoid the problem of common method bias, various measures were taken. First, the anonymity of the answers is highlighted during the survey and I request them to fill in the questionnaire according to their true feelings because there are no wrong or true answers in the survey. Such a measure can ensure that respondents can give more accurate answers. Second, I messed up the order of the questions in the questionnaire to prevent respondents from guessing the relationship among the variables. Last, I also used Harman's One Factor Test to test the common method bias in this dissertation. Prior research suggests that the common method bias may be a not serious issue if the variance of the first factor is smaller than 50% in exploratory factor analysis (Fuller et al., 2016). The result demonstrates that the variance of the first factor is 47%, which does not exceed 50%. In this case, the common method bias is not a big problem in this dissertation.

5.3. Descriptive statistics and correlations

Table 7 displays the mean values, min values, max values, and standard deviations of the variables used in this dissertation. The mean value of behavioral intention is 3.807, suggesting a relatively high level of the willingness of the respondents in the sample firms to adopt the intelligent IoT system for hog-raising. The average value of perceived usefulness is 3.783 and that of perceived ease of use is 3.709. The value of relative advantage ranges from 1 to 5 and the mean value is 3.711. Compatibility ranges from 1 to 5 with a mean value of 3.653. Result demonstrability ranges from 1.333 to 5 with a mean value of 3.707 and a standard deviation of 0.874. The mean value of trialability is 3.825, which is larger than the mean value of relative advantage, compatibility, and result demonstrability. The mean value of subject norm is 3.643 and the standard deviation is 0.863. Safety ranges from 1.333 to 5 with a mean value of 3.66 and a standard deviation of 0.872.

Table 7 Descriptive statistics of main variables

Variable	Mean	Std. Dev.	Min	Max
1. Behavioral intention	3.807	0.872	1	5
2. Perceived usefulness	3.783	0.854	1.25	5
3. Perceived ease of use	3.709	0.814	1.25	5
4. Relative advantage	3.711	1.006	1	5

5. Compatibility	3.653	0.852	1	5
6. Result demonstrability	3.707	0.874	1.333	5
7. Trialability	3.825	0.929	1	5
8. Subject norm	3.643	0.863	1.25	5
9. Safety	3.66	0.872	1.333	5
10. Firm age	2.441	0.723	0.693	3.97
11. Firm size	4.286	2.03	0.693	12.111
12. Breeding scale	2.996	1.437	1	6

Note: Observations=266

In Table 8, the correlations between the variables in this dissertation are presented.

As shown in the Table, relative advantage, compatibility, result demonstrability, trialability, subject norm, safety, perceived ease of use, and perceived usefulness are positively associated with the behavioral intention to use the system. Relative advantage, compatibility, result demonstrability, and trialability are positively associated with perceived usefulness and perceived ease of use.

Table 8 Correlations between main variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Behavioral intention	1.000											
2. Perceived usefulness	0.724***	1.000										
3. Perceived ease of use	0.742***	0.673***	1.000									
4. Relative advantage	0.451***	0.493***	0.456***	1.000								
5. Compatibility	0.473***	0.485***	0.498***	0.676***	1.000							
6. Result demonstrability	0.528***	0.523***	0.520***	0.514***	0.672***	1.000						
7. Trialability	0.559***	0.565***	0.557***	0.602***	0.657***	0.715***	1.000					
8. Subject norm	0.622***	0.693***	0.633***	0.541***	0.557***	0.634***	0.603***	1.000				
9. Safety	0.609***	0.658***	0.588***	0.440***	0.464***	0.592***	0.524***	0.699***	1.000			
10. Firm age	0.037	0.001	-0.011	0.104*	0.081	-0.021	0.072	-0.006	0.015	1.000		
11. Firm size	0.054	0.114*	0.028	0.125**	0.095	0.093	0.136**	0.083	0.042	0.432***	1.000	
12. Breeding scale	0.111*	0.135**	0.108*	0.206***	0.155**	0.129**	0.200***	0.162***	0.095	0.349***	0.723***	1.000

*** p<0.01, ** p<0.05, * p<0.1

5.4. Hypothesis test

Before hypothesis testing, I tested the multicollinearity by using the variance inflation factor (VIF) test (Wooldridge, 2010). The results are displayed in Table 9.

Table 9 VIF test

Variable	VIF
Perceived usefulness	2.62
Perceived ease of use	2.18
Relative advantage	2.13
Compatibility	2.62
Result demonstrability	2.83
Trialability	2.7
Subject norm	2.9
Safety	2.39
Firm age	1.28
Firm size	2.33
Breeding scale	2.2

The results demonstrate that the minimum value of VIF is 1.28, the maximum value of VIF is 2.9, and the mean value of VIF is 2.38, which do not exceed the accepted level of 5. Therefore, multicollinearity is not a big problem in this dissertation (Chatterjee & Hadi, 1977).

To test the hypotheses proposed in this dissertation, the Ordinary Least Squares (OLS) regression model is adopted.

5.4.1 Regression results on the relationship between technological factors and behavioral intention

Table 10 shows the regression results on the relationship between four factors and the behavioral intention to use intelligent IoT systems for hog-raising.

Table 10 Regression results on the relationship between technological factors and behavioral intention

	Model (1)
Relative advantage	0.113*
	(0.061)
Compatibility	0.041
	(0.082)
Result demonstrability	0.227***
	(0.078)
Trialability	0.276***
	(0.074)
Constant	1.344***
	(0.253)
Control variables	Yes
N	266
R^2	0.362

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In Model (1), relative advantage is positively associated with behavioral intention (b=0.113, p<0.1), indicating that relative advantage has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising, offering support for Hypothesis 1.

Hypothesis 2 proposes that the compatibility of intelligent IoT systems for hog-raising has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. In Model (1), the coefficient of compatibility is positive but not significant (b=0.041, p>0.1), which fails to provide empirical support for Hypothesis 2. The reason may be that the compatibility of intelligent IoT systems with their existing norms and prior experience may not bring direct benefits for firms, so it may not be a key determinant of users' adoption of intelligent IoT systems and the positive relationship between compatibility and the behavioral intention is not significant.

Hypothesis 3 forecasts that result demonstrability has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. In Model (1), the coefficient of result demonstrability is positive and significant at 1% significance level ($b=0.227$, $p<0.01$), which offers empirical evidence for Hypothesis 3.

Hypothesis 4 argues that trialability has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. In Model (1), trialability is positively related to the behavioral intention to use intelligent IoT systems for hog-raising at 1% significance level ($b=0.276$, $p<0.01$), which provides empirical support for Hypothesis 4.

In summary, among the four technological factors, relative advantage, result demonstrability, and trialability are key innovation diffusion theory factors influencing the behavioral intention to use intelligent IoT systems for hog-raising.

5.4.2 Regression results on the mechanisms behind the relationship between technological factors and behavioral intention

Given that the regression results in Table 10 do not support the positive influence of compatibility on the behavioral intention to use intelligent IoT systems for hog-raising, I no longer investigate the influence of compatibility on perceived usefulness and perceived ease of use to reveal the mechanism behind the relationship between compatibility and the behavioral intention to use intelligent IoT systems for hog-raising. So Hypothesis 6a and Hypothesis 6b do not obtain empirical support.

To reveal the mechanism behind the influence of relative advantage, result demonstrability, and trialability on the behavioral intention to use intelligent IoT systems for hog-raising, I run the regressions on the relationship between three factors and perceived usefulness/ease of use as well as the relationship between perceived usefulness/ease of use and behavioral intention to use intelligent IoT systems for hog-raising.

Table 11 shows the regression results on perceived usefulness.

Table 11 Regression results on perceived usefulness

	Model (2)
Relative advantage	0.185^{***}
	(0.053)
Result demonstrability	0.192^{***}
	(0.070)
Trialability	0.270^{***}
	(0.070)
Constant	1.445^{***}
	(0.241)
Control variables	Yes
N	266
R^2	0.380

Standard errors in parentheses

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

In Model (2), relative advantage is positively related to perceived usefulness (b=0.185, p<0.01), which demonstrates that the relative advantage of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness, offering support for Hypothesis 7.

Hypothesis 9a states that the result demonstrability of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness. The regression results in Table 11 show that the coefficient of result demonstrability is positive and significant (b=0.192, p<0.01), which provides empirical support for Hypothesis 9a.

Hypothesis 10a proposes that the trialability of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness. In Model (2), trialability is positively and significantly related to perceived usefulness (b=0.270, p<0.01), indicating that the trialability of intelligent IoT systems for hog-raising has a positive influence on perceived usefulness, supporting Hypothesis 10a.

Table 12 displays the regression results on perceived ease of use.

Table 12 Regression results on perceived ease of use

	Model (3)
Result demonstrability	0.230^{***}
	(0.067)
Trialability	0.333^{***}
	(0.064)
Constant	1.668^{***}

	(0.232)
Control variables	Yes
N	266
R^2	0.346

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Hypothesis 9b states that the result demonstrability of intelligent IoT systems for hog-raising has a positive influence on perceived ease of use. In Model (3) of Table 12, result demonstrability is positively and significantly related to perceived ease of use (b=0.230, p<0.01), offering support for Hypothesis 9b.

In Model (3), trialability is positively and significantly correlated to perceived ease of use (b=0.333, p<0.01), which demonstrates that the trialability of intelligent IoT systems for hog-raising has a positive influence on perceived ease of use, supporting Hypothesis 10b.

And I further investigate the influence of perceived usefulness and perceived ease of use on the behavioral intention to use intelligent IoT systems for hog-raising. The regression results are displayed in Table 13.

Table 13 Regression results on the relationship between perceived usefulness/ease of use and behavioral intention

	Model (4)
Perceived usefulness	0.424^{***}
	(0.052)
Perceived ease of use	0.497^{***}
	(0.054)
Constant	0.251

	(0.196)
Control variables	Yes
N	266
R^2	0.646

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As shown in Model (4) of Table 13, perceived usefulness is positively connected with the behavioral intention to use intelligent IoT systems for hog-raising at the significance level of 1% (b=0.424, p<0.01), suggesting that perceived usefulness has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. The result offers support for Hypothesis 11.

In Model (4) of Table 13, the coefficient of perceived ease of use is positive and significant (b=0.497, p<0.01), indicating that perceived ease of use has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising, supporting Hypothesis 12.

Taken together, perceived usefulness and perceived ease of use are two important mechanisms by which relative advantage, result demonstrability, and trialability influence the behavioral intention to use intelligent IoT systems for hog-raising. Relative advantage, result demonstrability, and trialability influence the behavioral intention to use intelligent IoT systems for hog-raising by influencing perceived usefulness. Result demonstrability and trialability will influence perceived ease of use and further influence the behavioral intention to use intelligent IoT systems for hog-raising.

5.4.3 Regression results on behavioral intention by adding social factors

To explore the factors influencing the behavioral intention to use intelligent IoT systems for hog-raising comprehensively, I further include the social factors in the model, namely, subjective norm and safety. The new regression results on behavioral intention by including social factors are displayed in Table 14.

Table 14 Regression results on behavioral intention by including social factors

	Model (5)
Relative advantage	0.032
	(0.057)
Compatibility	0.031
	(0.074)
Result demonstrability	0.015
	(0.075)
Trialability	0.193***
	(0.068)
Subject norm	0.260***
	(0.072)
Safety	0.284***
	(0.065)
Constant	0.776***
	(0.239)
Control variables	Yes
N	266
R^2	0.485

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As we can see in Table 14, trialability is positively associated with the behavioral intention to use intelligent IoT systems for hog-raising (b=0.193, p<0.01), suggesting that trialability has a positive impact on the behavioral intention, which is in line with the regression results that did not include social factors.

Hypothesis 5 indicates that subject norm has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. In model (5), subject norm is positively related to the behavioral intention to use intelligent IoT systems at the significance level of 1% ($b=0.260$, $p<0.01$), offering support for Hypothesis 5.

Hypothesis 6 indicates that safety has a positive influence on the behavioral intention to use intelligent IoT systems for hog-raising. In model (5), safety is positively related to the behavioral intention to use intelligent IoT systems at the significance level of 1% ($b=0.284$, $p<0.01$), providing support for Hypothesis 6.

Taken together, subjective norm and safety are two important factors that may positively influence the behavioral intention to use intelligent IoT systems for hog-raising.

However, when including social factors, the influence of relative advantage ($b=0.032$, $p>0.1$) and result demonstrability ($b=0.015$, $p>0.1$) become not significant anymore and the influence of compatibility is still not significant ($b=0.031$, $p>0.1$). The reason for the change may be that when considering the social factors such as subject norm and safety, the technological factors such as relative advantage and result demonstrability become not as important as before. In Chinese management practice, the decisions to adopt new technological systems of many firms are not absolutely rational. Many firms tend to use competitors as a reference and are more likely to follow suit. If other competitor firms adopt the intelligent IoT systems for hog-raising, firms will be afraid of falling behind, and may tend to adopt the system too, even if the relative advantage and result demonstrability of the system are not as superior as they expect. Therefore, the coefficient of relative advantage and result demonstrability become not significant when controlling social factors such as subject norm.

6. Conclusion and Discussion

6.1 Conclusions

This dissertation explores the determinants of business organization's adoption of complex innovative products. Taking the intelligent IoT system for hog-raising as an example, this dissertation puts forward a theoretical model of the technological/social factors influencing the behavioral intention to use intelligent IoT systems for hog-raising and further explores the mechanism behind the relationship between technological factors and the behavioral intention. Using survey data of 266 hog-raising firms in China, this dissertation tests the hypotheses proposed.

Specifically, this dissertation finds that relative advantage, result demonstrability, and trialability are important technological factors that will influence the behavioral intention to use intelligent IoT systems for hog-raising. Furthermore, I find that perceived usefulness and perceived ease of use are important mechanisms through which technological factors influence behavioral intention. The relative advantage, result demonstrability, and trialability of intelligent IoT systems for hog-raising will improve users' perceived usefulness, and further facilitate their adoption intention. The result demonstrability and trialability of intelligent IoT systems for hog-raising will improve users' ease of use, and further promote their behavioral intention to use the intelligent IoT systems. Compatibility does not show a significant and positive impact on the behavioral intention to use intelligent IoT systems for hog-raising as we expected. The reason may be that the compatibility of intelligent IoT systems with their existing norms and prior experience may not bring direct benefits for firms, so it may not be a key determinant of users' adoption of intelligent IoT systems.

In addition, this dissertation also finds that subjective norm and safety will promote the behavioral intention to use intelligent IoT systems for hog-raising. However, when including social factors, the positive influence of relative advantage and result demonstrability on the behavioral intention to use intelligent IoT systems for hog-raising become not significant anymore, the positive impact of trialability is still significant, and the influence of compatibility is still not significant. This reflects an interesting phenomenon in China, namely, the decisions to adopt new technological systems of many firms are not absolutely rational, and many firms tend to follow suit. Therefore, when considering the social factors such as subject norm and safety, the technological factors such as relative advantage and result demonstrability become not as important as before.

The conclusions of this dissertation are not only applicable to the hog-raising industry, but also offer new insights into business organizations' adoption of other complex innovative products. As shown in our results, technological factors are very important to promote the adoption of intelligent IoT systems. The diffusion of new technologies such as Big data, cloud computing, artificial intelligence, Chart GPT, and metaverse, is largely dependent on their technological characteristics. The relative advantage, result demonstrability, and trialability of these new technologies facilitate more business organizations to adopt them. Specifically, the adoption of complex innovative products, especially in traditional industries, may not only depend on technological factors. The diffusion of new technologies in the traditional industries is slow and hard, given that most organizations in the traditional industries are already accustomed to the old technologies and are not willing to change. Hence, social factors may become more important factors in determining business organizations' adoption of complex innovative products in these industries.

6.2 Theoretical contributions

This dissertation contributes to prior literature in the following three aspects.

First of all, this dissertation analyzes the key determinants of the adoption of intelligent IoT systems for hog-raising, deepening the understanding of the diffusion of complex innovative products. The Internet of Thing is a good case of complex innovative technologies. Although several prior studies have discussed some antecedents of IoT adoption, most of them focus on the adoption intention of individual users (Hsu & Lin, 2016, 2018), which is not yet mature enough. And the determinants of organizations' adoption of IoT system, still needs further exploration. To enrich the related research, this dissertation analyzes the influence of relative advantage, result demonstrability, and trialability on the adoption of intelligent IoT systems for hog-raising in hog-raising firms, which provides new insights into the complex innovation adoption of organizations and helps to broaden our knowledge of the successful and effective adoption of the innovative technology (Hsu & Yeh, 2017). Especially, we found that subjective norm and safety are two important factors that may positively influence the behavioral intention to use intelligent IoT systems for hog-raising, and after controlling the two factors, the influence of relative advantage and result demonstrability on the behavioral intention to use intelligent IoT systems for hog-raising become not significant anymore. The results offer new insights into the adoption of new technologies in Chinese special contexts, which suggest that the decisions to adopt new technological systems of many firms are not absolutely rational, and many firms tend to follow suit, hence, social factors are very important when exploring the determinants of the adoption of intelligent IoT systems for hog-raising in China. My dissertation contributes to a deep understanding of firms' adoption of complex innovative technologies in China.

Second, this dissertation pays attention to the antecedents of new technology adoption in a specific industry, namely, the hog-raising industry, offering new insights into the determinants of the adoption of complex innovative products in traditional industries. Compared with other industries, the hog-raising industry is a traditional industry in which the adoption of new technology is slow and hard. However, it is also an important industry in

Chinese people's daily life given that pork plays a pivotal role in the food culture of Chinese residents and the hog-raising industry has developed a lot. The usage of intelligent IoT systems has a huge potential to improve the intelligence and automation level of the raising process through functions such as automated feeding, automatic door closure, and precision feeding (Yongqiang et al., 2019), thus facilitating the upgrading of the industry. However, the actual adoption of intelligent IoT systems is still very low in this special industry at the present stage. What factors will influence the adoption intention of intelligent IoT systems still remains to be explored. This dissertation investigates the determinants of the adoption of intelligent IoT systems for hog-raising in China, which not only deepens our understanding of the new technology diffusion in the hog-raising industry, but also offer valuable insights into the development and upgrading of other traditional industries. Since most organizations in traditional industries are already accustomed to the old technologies and are more unwilling to use new technologies, social factors may become more important factors influencing the adoption of complex innovative products in these industries.

Third, this dissertation helps to extend the technology acceptance model and innovation diffusion theory by integrating the two theories. Scholars have made efforts to extend the technology acceptance model by including external predictors to forecast their influence on perceived ease of use and perceived usefulness. For example, Prior research has argued that shared belief in the benefits of the technology (Amoako-Gyampah & Salam, 2004), individual characteristics like education and age (Burton-Jones & Hubona, 2006), and technology anxiety and affect (Saadé & Kira, 2006) will affect the perceived ease of use and perceived usefulness and further influence the adoption of new technologies. Complementing prior research, this dissertation tries to include the innovation diffusion theory factors to extend the technology acceptance model, in order to provide a more effective model to predict determinants of an innovation (Wu & Wang, 2005). Based on the innovation diffusion theory (Rogers, 1995), this dissertation argues that relative advantage, result demonstrability, and trialability will influence the adoption intention of intelligent IoT systems for hog-raising. Integrating with the technology acceptance model (Davis, 1989), this dissertation argues that the innovation diffusion theory factors will influence the perceived usefulness and perceived ease of use, and further influence the adoption intention of intelligent IoT systems for hog-raising. By integrating the two theories, this dissertation contributes to a comprehensive understanding of how the specific characteristics of innovation and the users' general perception of the new technology or system influence users' adoption intention (Min et al., 2019), and extends the two theories.

6.2 Practical contributions

This dissertation also provides rich practical contributions to facilitate the adoption intention of intelligent IoT systems for hog-raising as well as other complex innovative products. With the increasing demand for pork, the adjustment and upgrading of the industrial structure of China's hog-raising industry is imperative. To improve the efficiency of large-scale breeding, the hog-raising industry is bound to need the intervention and deep integration of artificial intelligence. So it is very important to promote the adoption of intelligent IoT systems for hog-raising to facilitate upgrading of the industrial structure of China's hog-raising industry. As I am the founder of a science and technology start-up company, the innovative product of my company is the intelligent Internet of Things systems for hog-raising firms, through which the efficiency of hog-raising can be improved. My firm faces great challenges and difficulties in promoting our intelligent IoT systems for hog-raising. The results of this dissertation not only provide valuable suggestions for manufacturers like my firm that produce intelligent IoT systems for hog-raising to promote the diffusion of products, but also offer references for other industries to promote the diffusion of new technologies and products. The main suggestions are as follows.

First of all, the results of this dissertation suggest that relative advantage helps to facilitate the behavioral intention to use intelligent IoT systems for hog-raising, hence, manufacturers of intelligent IoT systems for hog-raising need to improve their technological level and enhance the relative advantage of their systems. Compared with traditional systems, the intelligent IoT system for hog-raising has advantages in reducing the mortality rate of hogs through early detection and prevention of virus transmission, optimizing the raising process, reducing raising costs, and improving raising income. Manufacturers of intelligent IoT systems for hog-raising should make efforts to improve the performance of the intelligent IoT system produced by them, making the intelligent IoT system not only better than traditional systems but also better than intelligent IoT systems produced by other firms. They should take various measures to surmount technical difficulties and raise the system performance, such as investing more resources in the research and development (R&D) activities, encouraging R&D employees to track and learn cutting-edge knowledge to improve their ability and expertise, cooperating with universities or other firms, thus improving the relative advantage of the system and users' perceived usefulness, and further enhancing users' behavioral intention to use the intelligent IoT system produced by them.

Second, this dissertation finds that result demonstrability is positively connected with the behavioral intention to use intelligent IoT systems for hog-raising. Therefore, manufacturers of intelligent IoT systems for hog-raising should take measures to improve the result demonstrability of the system to improve the adoption intention of potential users. For example, when promoting the intelligent IoT system for hog-raising, firms that produce intelligent IoT systems for hog-raising can communicate the benefits of the system in an easy-to-understand and concise way to enhance the demonstration of the reliability of the results and ensure potential users understand these benefits. Also, when designing the intelligent IoT systems for hog-raising, firms that produce intelligent IoT systems for hog-raising can improve the visibility of these benefits, to intuitively display the degree to which the system can benefit the hog-raising firms and attract potential users.

Third, the results of this dissertation indicate that trialability has a positive impact on the behavioral intention to use intelligent IoT systems for hog-raising. Given that hog-raising firms are not familiar with the function and usage of intelligent IoT systems for hog-raising, it is necessary to provide trial opportunities for them to better know about the system and improve their behavioral intention to use the system. Hence, manufacturers of intelligent IoT systems for hog-raising can offer trial opportunities for hog-raising firms. During the probationary period, manufacturers of intelligent IoT systems for hog-raising can send technical instructors to hog-raising firms to teach the expertise and usage methods of the intelligent IoT systems and spread the word about the benefits of intelligent IoT systems for hog-raising. With the help of technical instructors, hog-raising firms can obtain professional guidance and problem-solving during the probationary period, better master the usage of intelligent IoT systems for hog-raising, and know more about the benefits of the systems in their operations. In this way, hog-raising firms will feel a higher level of usefulness and ease of use, and are more likely to adopt the intelligent IoT systems for hog-raising.

Fourth, the results of this dissertation suggest that subjective norms and safety will promote the behavioral intention to use intelligent IoT systems for hog-raising, and these social factors may even make the technological factors become less important in the decision to adopt intelligent IoT systems for hog-raising. To promote the upgrading of the traditional hog-raising industry, measures can be taken to improve the subjective norm faced by hog-raising firms and the safety of intelligent IoT systems for hog-raising. In terms of subjective norms, manufacturers of intelligent IoT systems for hog-raising can promote the benefits of intelligent IoT systems in the hog-raising process to a wider group. Some relevant departments or customers who learn these benefits may expect the hog-raising industries to adopt the system to promote the quality of hogs. They can also promote the case of famous big hog-raising firms using intelligent IoT systems for hog-raising to put pressure on hog-raising firms that have not adopted the system. In terms of safety, in order to reduce the concerns of hog-raising firms on safety problems such as data leakage, manufacturers of intelligent IoT systems for hog-raising need to invest more in improving the safety of the IoT system. They should ensure that the following security tests have been conducted on the application/firmware code before entering the market.

6.2 Limitation and future direction

There are also several limitations in this dissertation, which need future studies to extend.

First of all, although I take different measures to avoid the common method bias, the self-reported data in the survey may still result in the problem of the common method bias. Future studies can improve the survey design to minimize such a bias. For example, senior managers of each hog-raising firm can be invited at different time points to participate in the survey to evaluate different variables. Such a measure can prevent senior managers from guessing the potential relationship between different variables and reduce the risk of the common method bias. Furthermore, future studies can use other methods such as the experiment to collect data to avoid the shortcoming of the survey method.

Second, although I have made great efforts to collect data, the sample size of this dissertation is still not large enough due to the difficulty in collecting data. To improve the reliability of the conclusions in this dissertation, future studies can enlarge the sample size and test my theoretical model using large sample data.

Third, I collected survey data in China. Whether my conclusions can apply to hog-raising firms in other countries or regions is still unknown. To improve the universality of the conclusions in this dissertation, future studies can collect data from other countries or regions to test my theoretical model.

Last but not least, the determinants of business organizations' adoption of complex innovative products deserve further exploration. This dissertation takes the intelligent IoT systems for hog-raising as an example and investigates the key factors influencing the behavioral intention to use intelligent IoT systems for hog-raising based on the technology acceptance model and innovation diffusion theory. There are also a lot of other factors that may influence the behavioral intention to adopt complex innovative products. Future studies can explore other determinants of business organization’s adoption of complex innovative products from other theoretical perspectives, to enrich the related research.

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Appendix:

SURVEY TO SENIOR MANAGERS:

Company Name:_______________

BACKGROUND INFORMATION ABOUT YOUR COMPANY

1. The establishment year of your company： _______

2. The registered address of your company:_________(Province)_________ (City)

3. The number of employees in your company:___________。

4. The number of hogs in your company?

no more than 2000 hogs　　　2001-10000hogs

10001-20000 hogs　　　20001-500000 hogs

500001-1000000 hogs　　　more than 1000000 hogs

5. Did your company adopt advanced technologies for hog-raising (e.g. Internet of things) ? ☐YES　　NO

6. Is your company using advanced technologies for hog-raising (e.g. Internet of things) now? ☐YES　　NO

PERCEPTION OF IoT

1. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree			Strongly agree	
1)The intelligent IoT system for hog-raising will provide better help for raising than conventional raising techniques.	1	2	3	4	5
2)We feel the use of the intelligent IoT system for hog-raising will take less time and efforts for raising than conventional raising.	1	2	3	4	5
3)The intelligent IoT system for hog-raising will offer more value than conventional raising.	1	2	3	4	5

2. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree			Strongly agree	
1)The intelligent IoT system for hog-raising can be freely configured according to our existing breeding logic and be compatible with most aspects of our firm.	1	2	3	4	5
2)The intelligent IoT system for hog-raising	1	2	3	4	5

would fit the work style in our firm.					
3)The intelligent IoT system for hog-raising would fit well with the way people like to work in our firm.	1	2	3	4	5

3. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree Strongly agree				
1)We would have no difficulty telling others about the advantage of the intelligent IoT system for hog-raising.	1	2	3	4	5
2)It is easy to explain why taking the intelligent IoT system for hog-raising may be beneficial.	1	2	3	4	5
3)The advantages of taking the intelligent IoT system for hog-raising are apparent.	1	2	3	4	5

4. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree Strongly agree				
1)Our firm wants to be able to use the intelligent IoT system for hog-raising on a trial basis.	1	2	3	4	5
2)Our firm wants to be able to properly try out the intelligent IoT system for hog-raising.	1	2	3	4	5
3)Our firm wants to be permitted to use the intelligent IoT system for hog-raising, on a trial basis long enough to see what it can do.	1	2	3	4	5

5. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree Strongly agree				
1)Our firm intends to use the intelligent IoT systems for hog-raising in the future.	1	2	3	4	5
2)Our firm plans to use the intelligent IoT systems for hog-raising in the future.	1	2	3	4	5
3)Our firm has positive things to say about the intelligent IoT systems for	1	2	3	4	5

hog-raising.					
4)Our firm would encourage others to use the intelligent IoT systems for hog-raising.	1	2	3	4	5

6. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree				Strongly agree
1)Using the intelligent IoT system for hog-raising enables us to improve PSY through fat management and accurate feeding, thus improving the performance of our firms.	1	2	3	4	5
2)Using the intelligent IoT system for hog-raising will improve the production environment and reduce the feed meat ratio through environmental sensing and intelligent control, thus increasing the productivity of our firms through intelligent feeding.	1	2	3	4	5
3)Using the intelligent IoT system for hog-raising will reduce pig mortality by reduction of human contact and early detection of epidemic situations, thus enhancing the effectiveness of our firms.	1	2	3	4	5
4)Overall, I think the intelligent IoT system for hog-raising will be useful in our firms.	1	2	3	4	5

7. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree				Strongly agree
1)The interaction with the intelligent IoT system for hog-raising will be clear and understandable.	1	2	3	4	5
2)Interacting with the intelligent IoT system for hog-raising does will not require a lot of the mental effort.	1	2	3	4	5
3)The intelligent IoT system for hog-raising will be easy to maintain.	1	2	3	4	5
4)It is easy to get the intelligent IoT	1	2	3	4	5

system for hog-raising to do what we want it to do.					

8. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree				Strongly agree
1) It would be safe to disclose the information of our firms to vendors providing intelligent IoT system for hog-raising	1	2	3	4	5
2) There would be low potential for loss associated with disclosing information of our firms to vendors providing intelligent IoT system for hog-raising	1	2	3	4	5
3) There would be low uncertainty associated with giving information of our firms to vendors providing intelligent IoT system for hog-raising.	1	2	3	4	5

9. To what extent do you agree with the following statements ? (1= Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree				Strongly agree
1) It would be safe to disclose the information of our firms to vendors providing intelligent IoT system for hog-raising	1	2	3	4	5
2) There would be low potential for loss associated with disclosing information of our firms to vendors providing intelligent IoT system for hog-raising	1	2	3	4	5
3) There would be low uncertainty associated with giving information of our firms to vendors providing intelligent IoT system for hog-raising.	1	2	3	4	5

10. To what extent do you agree with the following statements ? (1=

Strongly disagree, 3 = Neutral, 5 = Strongly agree).

	Strongly disagree				Strongly agree
1) Many of our business competitors are already using the intelligent IoT system for hog-raising.	1	2	3	4	5
2) Our suppliers/trading partners are using the intelligent IoT system for hog-raising.	1	2	3	4	5
3) Our customers or trading partners expect us to use the intelligent IoT system for hog-raising.	1	2	3	4	5
4) Using the intelligent IoT system for hog-raising helps us to compete better with our competitors	1	2	3	4	5