What Drives IoT-Based Smart Pet Appliances Usage Intention? The Perspective of the Unified Theory of Acceptance and Use of Technology Model

Chia-Chen Chen*, Chia-Pei Lin

National Chung Hsing University, Taichung City 402 (Taiwan)

* Corresponding author: emily@nchu.edu.tw

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Abstract

The advancement of IOT (Internet of Things) has facilitated the development of smart pet appliances, and the market for these products has growing rapidly, this study seeks to identify key factors for pet owner adoption of "smart" pet appliances. The Unified Theory of Acceptance and Use of Technology (UTAUT) a well-established model in the field of IOT research is used as the main framework, integrating brand trust, perceived value and perceived enjoyment as the basis for hypothesis formulation and testing based on data collected through questionnaires distributed through online social platforms. Reliability analysis, validity analysis and structural equation model analysis were carried out through confirmatory factor analysis to test the variables and research hypotheses. Results for the UTAUT indicate that effort expectancy has a direct impact on performance expectancy, while performance expectancy, effort expectancy and facilitating condition all have a positive impact on intention. While social influence does not directly or significantly affect use intention, it can indirectly affect intention through perceived value and perceived enjoyment. Brand trust does not have a significant impact on use intention, but can indirectly affect use intention through perceived value. This study further compares user age and number of smart pet home appliances owned to better understand the impact of demographic factors. Findings indicate that, for users under the age of 30, effort expectancy has no significant impact on use intention, while brand trust has no significant impact on perceived value among users over 30. Among the research results based on age as a basis, the impact of hardships in the ethnic group in the age of 30 is not significant, nor do facilitating conditions or perceived value have significant impact on use intention. For users with one smart pet device at home, neither favorable conditions not perceived value have significant impact on use intention, while for users with two smart pet devices, perceived enjoyment does not significantly impact use intention. These finding have potential reference value for future related research in the IOT or smart pet home appliance research field.

Keywords

Brand Trust, Internet Of Things (IoT), Perceived Value, Perceived Enjoyment, Smart Pet Appliances, Unified Theory Of Acceptance and Use Of Technology (UTAUT), Use Intention.

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I. Introduction

THE rapid development of wireless networks in recent years has driven the popularization of new technologies in the home. Such "Smart Family" technologies use wireless communications to integrate and coordinate smart appliances and devices (e.g., cameras, locks, kitchen appliances, speakers, etc.) to be monitored and controlled in real time using mobile phones or tablets. A report by the OMDIA research agency found that, from 2020 to 2025, the global smart home industry has a compound annual growth rate of 24.1%. In 2020, the global smart home market was valued at US$60.8 billion, and was projected to reach US$178 billion by 2025 [1], reflecting the rapid growth of this sector.

According to statistics from the Taiwan Council of Agriculture, the market value of the pet industry in Taiwan is projected to reach NT60 billion in 2022. Data from the Ministry of Finance indicates that the pet-related industry in Taiwan has been experiencing continuous growth in recent years. The total number of businesses in this sector has increased from 6,486 in 2018 to 8,335 in 2022, representing a growth rate of approximately 28.5%. Moreover, the sales revenue has risen from NT26.58 billion to NT38.7 billion, marking a significant growth rate of 45.7% [2]. With the rapid development of the economy and the rise in people's living standards, more and more individuals are choosing to keep pets for emotional companionship [3]. A 2020 report by the Market Intelligence & Consulting Institute (MIC) found that medical care and

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basic physiological needs (food, snacks and other daily necessities) accounted for the majority of pet owner spending, averaging more than NT$8,000 annually per pet owner, while the top three non-essential expense categories were grooming and accommodation (40.6%), home supplies (38.8%), entertainment and toys (37.6%). Thus, pet owners spend significantly on non-essentials [4].

This expansion of the pet supply market has also driven the development of new pet-oriented "smart" home appliances purporting to help pet owners enhance care convenience and safety. Nearly 40% of pet owners in Taiwan report having used some form of smart pet home appliance (e.g., water dispensers, litter boxes, interactive cameras, etc.). Online retailer PCHOME 24H found that pet owners are more willing to buy products they believe will help improve pet health and quality of life. In addition to smart appliances related to daily feeding, sales of other types of appliances are also growing rapidly, with overall sales jumping 30% in June, and sales for "black technologies" increasing 75% in the same period [5]. These developments reflect the growing opportunities in the pet supply market, particularly in terms of pet-oriented smart appliances.

Many studies in the literature on the Internet of Things (IoT) use the Unified Theory of Acceptance and Use of Technology (UTAUT) as the main architecture [6]-[9], with many such studies applying this model to integrate Perceived Value [10]-[13]. However, the existing literature on technology acceptance does not address the recent development of new smart pet home products. The authors have many pets at home and they and their friends use many types of smart pet home appliances and similar products, including automatic feeders, interactive pet cameras, and automatic litter boxes. However, while smart pet appliances have been proven to alleviate the burden on pet owners [14], most research literature focuses on the development of related technologies, with less emphasis on user intention [15]-[17]. Based on this experience and the related literature, this study uses UTAUT to integrate brand trust, perceived value, and perceived enjoyment to explore the factors that affect the use of smart pet home appliances. The study seeks to make the following contributions:

- Determine whether the UTAUT (Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions) can explain the use intention of smart pet home appliances.
- Determine whether brand trust affects use intention.
- Determine whether perceived value and perceived enjoyment affect use intention.

II. Literature Review

A. Pet Technology

Aashish (2022)[18] refers to smart pet home appliances as the use of technology products to improve the basic physiological care of pets, to monitor their health and safety, and to improve their overall quality of life. Such technologies can include the use of robotics, big data analysis, artificial intelligence, and others such as:

- Pet training equipment: Tools and equipment used to improve and modify pet behavior.
- Automatic feeding systems: Using sensors and remote monitoring to feed pets without direct human intervention.
- Pet monitoring equipment: Helping owners determine pet health and activity by remote.
- Pet toys: Entertainment and stimulation aids, or modes of remote interaction with owners.
- Wearable tracking devices: Small wearable devices to track pet health, activity and location.

Smart home appliances, integrated with IoT technology, have gained popularity among many people. By simply connecting to the internet, they can effectively automate various household activities [19]-[21]. Similarly, smart pet appliances assist pet owners in caring for their pets more efficiently. Apart from providing precise feeding, they also record the pet's behavior and analyze the data, enabling early detection and prevention of potential health issues [3], [22]. However, there is limited existing research specifically focusing on smart pet appliances. Therefore, this study will center on the topic of smart pet appliances.

B. Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) combines eight research models related to the Technology Acceptance Model (Combined TAM and TPB, C-TAM-TPB) and Social Cognitive Theory (SCT), including the components Theory of Reasoned Action (TRA) and Theory of Planning Behavior (TPB) by Venkatesh et al. (2003) [23], along with Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), Motivational Model (MM), Model of PC Utilization (MPCU), and Planned Behavior Theory. Individually, these theories provide explanatory power in different fields, which Venkatesh et al. (2003) [23] integrated into four main facets:

- Performance Expectancy: the degree to which users believe that using new information technology can improve work performance.
- Effort Expectancy: the degree to which user believe an information system is easy to use.
- Social Influence: the degree to which users are aware of how others view their use of a new information technology.
- Facilitating Condition: the degree to which users believe that existing organizational or technical infrastructure supports the use of new information technologies.

In previous research, the Unified Theory of Acceptance and Use of Technology (UTAUT) has been applied to examine the usage behavior of smart home devices, which utilize IoT technology, such as health care systems, home appliances, security systems, and more. [24]-[26]. These studies found that factors like performance expectancy, effort expectancy, social influence, and facilitating conditions significantly influence users' intention to use and actual usage behavior [27], leading to improved personal well-being [28]. If a technology can improve individual performance or reduce inconvenience, people will have a higher willingness to use it [29]. However, few studies have extended this line of research to smart home appliances for pets, so this study applies UTAUT theory to examine user intention to use such pet-oriented devices.

C. Brand Trust

"Trust" has long been regarded as a catalyst for transactions between two parties. When a consumer does not have particular insight into a product, trust in the seller can reduce their purchasing uncertainty [30]-[32]. In the field of information technology, trust indicates the degree to which a user's expectations are met [33], and has an important impact on consumer behavior. Gefen (2000) [34] confirmed that trust helps consumers accept Internet technologies. Luor et al. (2015) [35] found a positive relationship between the extent of a user's trust in smart home appliances and their service attitudes towards such devices. Mashal & Shuhaiber (2019) [36] found that "trust", as a personal factor, affects the user's purchasing intention for smart home equipment, along with such factors as personalization and cost. Shuhaiber & Mashal (2019) [21] and Shomakers, Beirmann and Ziefle (2021) [37] also found that trust is an important factor in determining user intention to use smart home appliances. Therefore, this study uses the dimension of brand trust to explore degree of user trust in particular suppliers of smart pet home appliances.

D. Perceived Value

Perceived value means that consumers' decisions involve cost/benefit calculations [38]-[40] where such costs and benefits extend beyond monetary considerations. From a non-monetary perspective, the value dimension can be divided into the following five categories: functional value [41], [42], social value [42], cognitive value [41], affective value [41], [42] and conditional value [43]. In research related to information technology, Pitchayadejanant (2011) [11] found that performance expectancy, effort expectancy, and social influence do not directly affect usage intention, but indirectly affect usage intention through perceived value. Alwahaishi and Snasel (2013) [12] found that perceived value will affect consumer intention to use specific communication technologies. Xie et al. (2021) [13] also found that perceived value will positively enhance user intention to use financial technology platforms. Therefore, this study explores the impact of perceived value on use intention for pet-oriented smart home appliances.

E. Perceived Enjoyment

According to the third-generation Technology Acceptance Model (TAM) proposed by Mashal & Shuhaiber (2019) [36] and Venkatesh & Bala (2008) [44], perceived enjoyment is defined as system interaction stimulating feelings of interest, imaginativeness, meaning and creativity on the part of the user. Previous studies have found that perceived enjoyment can motivate users to adopt new information technologies. For example, Park et al. (2016) [45] found that perceived enjoyment has a significant impact on the willingness to use paid LTE services, while Mashal, Shuhaiber & Daoud (2020) [46] and Shuhaiber & Mashal (2019) [21] found that perceived enjoyment will positively affect users' attitudes towards the use of smart home appliances, which then affect usage intention. Mashal & Shuhaiber (2019) [36] found that perceived enjoyment will positively increase users' willingness to purchase smart home appliances, while Al Amri & Almaiah (2021) [47] found that perceived enjoyment is directly and positively correlated to learners' intention to use smart educational technologies. This study explores the impact of perceived enjoyment on use intention for pet-oriented smart home appliances.

F. Operational Variable Definitions

The research dimensions examined in this study include performance expectancy, effort expectancy, social influence, facilitating conditions, brand trust, perceived value, perceived enjoyment and sue intention, assessed using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). These variables are defined as follows:

- Performance Expectancy: The degree to which consumers believe that the use of smart pet appliances can improve quality of life.
- Effort Expectancy: The degree of ease consumers experience using smart pet appliances.
- Social Influence: The degree to which consumers are influenced by the opinions of others when using smart pet appliances.
- Facilitating Conditions: The extent to which the technical knowledge or infrastructure required by consumers to use smart pet appliances is available.
- Perceived Enjoyment: The degree of pleasure consumers feel when using smart pet appliances.
- Perceived Value: The subjective value consumers feel through the use of smart pet appliances.
- Brand Trust: Consumers' trust in smart pet appliance suppliers.
- Intention to use: The possibility of consumers using smart pet appliances in the future.

III. Research Method

A. Research Constructs

This research explores people's willingness to use smart pet appliances, mainly through the Unified Theory of Acceptance and Use of Technology (UTAUT), integrating brand trust, perceived value, and perceived enjoyment, because trust can reduce consumers' uncertainty about using products [30]-[32], while perceived value allows consumers to assess the benefits of their decision-making behavior (i.e., performance expectancy) and decision-making effort (i.e., effort expectancy) of the decision-making result [38], and perceived enjoyment can motivate users to adopt new information technologies [45]. Based on the above, the research framework is as shown in Fig. 1.

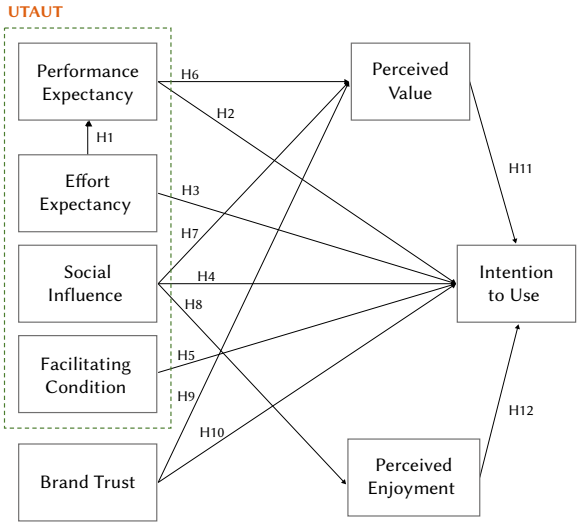

Fig. 1. Research Model.

B. Research Hypotheses

This study will employ a questionnaire survey method to collect data and validate the research hypotheses. Additionally, the samples will be divided into groups based on age and the number of different types of smart pet appliances used, and further analysis will be conducted on each group individually [9], [23], [48], [49]. Based on the literature review and research framework, this study develops 12 research hypotheses as follows:

1. Relationship Between Performance Expectancy and Effort Expectancy

In previous research on the Internet of Things and smart homes, perceived usefulness is defined as the degree to which users think that using smart homes will improve their quality of life, and perceived ease of use is defined as the degree to which users think that using smart homes does not require physical or mental labor. Perceived ease of use is also positive correlated with perceived usefulness [21], [50]-[52]. Based on the technology acceptance model and related research, we propose the following hypothesis:

H1: Effort expectancy will positively affect consumers' performance expectancy.

2. Relationship Between UTAUT and Usage Intention

In the IoT context, perceived usefulness is the degree to which the consumer perceives the technology as improving his or her overall performance in everyday situations [53]. Perceived ease of use is defined as the degree to which a person perceives that using a system

requires no mental effort [54]. Venkatesh et al. (2003) [23] define social influence as other people's perceptions of whether consumers should use new technologies. Facilitating condition is defined as the consumers' perception of resources and support available to perform behaviors [23]. Regarding the use of digital technology or Internet of Things (IoT) technologies, previous research has confirmed that Performance expectancy, Effort expectancy, Social influence, and Facilitating conditions are all important factors influencing users' intention to use [27], [55]-[59]. Based on the above, this study suggests that consumers' intention to use smart pet home appliances will be affected by UTAUT, and proposes the following hypotheses:

H2: Performance expectancy will positively impact consumers' use intention.

H3: Effort expectancy will positively impact consumers' use intention.

H4: Social influence will positively impact consumers' use intention.

H5: Facilitating conditions will positively impact consumers' use intention.

3. Effect of Performance Expectancy on Perceived Value and Use Intention

According to Venkatesh et al. (2012) [60], performance expectancy describes the degree to which individuals believe that they will secure benefits from using new technologies. For Xie et al. (2021) [13], performance expectancy refers to the degree to which individuals believe that they benefit from using online wealth management platforms, and these benefits are perceived value. Performance expectancy, which reflects the actions individuals take based on their desire for extrinsic rewards [23], are related to the "received" part of perceived value, so it is argued that performance expectancy affects perceived value in the same way. Based on the above, the following hypothesis is proposed:

H6: Performance expectancy will positively impact consumers' perceived value.

4. Effect of Social Influence on Perceived Value, Perceived Enjoyment and Use Intention

Social influence refers to the degree to which consumers are influenced by the opinions of others to change their original attitudes or behavioral intentions [23]. In our daily lives, receiving positive feedback about the use of a particular product from those whose opinions we value will positively impact our opinion towards the product. Such people indicating they feel that the product presents good value-for-money or can provide enjoyment, will also positively affect our feelings towards the product [61]. Based on the above, we propose the following hypotheses:

H7: Social influence will positively impact consumers' perceived value.

H8: Social influence will positively affect consumers' perceived enjoyment

5. Effect of Brand Trust on Perceived Value and Use Intention

Studying the use of IoT products in the agricultural sector, Ha & Stoel (2009) [62] found that trust plays a more critical role in IoT-related IT services than in brick-and-mortar industries, due to the inherent intangibility of IoT services and the lack of face-to-face interaction between technology suppliers and users. In a study of global B2B services, Doney et al. (2007) [63] found a positive relationship between perceived value and trust. Based on the above, we propose the following hypotheses:

H9: Brand trust will positively impact consumers' perceived value.

H10: Brand trust will positively impact consumers' use intention.

6. Effect of Brand Trust on Perceived Value and Use Intention

Studying the use of IoT products in the agricultural sector, Ha & Stoel (2009) [62] found that trust plays a more critical role in IoT-related IT services than in brick-and-mortar industries, due to the inherent intangibility of IoT services and the lack of face-to-face interaction between technology suppliers and users. In a study of global B2B services, Doney et al. (2007) [63] found a positive relationship between perceived value and trust. Based on the above, we propose the following hypotheses:

H11: Perceived value will positively impact consumers' use intention.

H12: Perceived enjoyment will positively impact consumers' use intention.

IV. Results

A. Descriptive Statistical Analysis

The questionnaire was constructed and hosted using Surveycake. According to data statistics, the main age group that primarily uses smart home appliances, internet technology, or digital technology falls within the 18-34 age range [64]-[66]. The resulting data set was analyzed using IBM SPSS 25 to obtain respondents' descriptive statistics, including gender, age, and number of smart pet appliances used. The results are presented in Table I.

TABLE I. Descriptive Statistics

Item	Response	n	%
Gender	Male	46	16.5%
	Female	233	83.5%
Age	< 30	146	52.3%
	>= 30	133	47.7%
Number of Smart Pet Appliances Used	One	140	50.2%
	Two and more	139	49.8%

B. Reliability

Reliability analysis mainly seeks to determine whether the items in each research construct of the questionnaire are consistent, stable and reliable, wherein a Cronbach's α threshold value of 0.7 indicates adequate reliability [67]. The Cronbach's α values for each facet of our questionnaire are shown in Table II.

TABLE II. Reliability Analysis Results

Research Construct	Cronbach's α
Performance Expectancy	0.898
Effort Expectancy	0.878
Social Influence	0.866
Facilitating Conditions	0.786
Brand Trust	0.950
Perceived Value	0.865
Perceived Enjoyment	0.854
Intention To Use	0.893

C. Convergent Validity

Convergent validity analysis uses factor loading, composite reliability (CR), and average variation extracted (AVE) as three indicators to measure whether the degree of correlation between items in the same facet converges sufficiently. Fornell & Larcker (1981) [68] suggest a minimum factor loading of 0.5, a minimum composite reliability of 0.7, and a minimum AVE of 0.5. As shown in Table III, the results for the research constructs in the present study all present good convergent validity.

TABLE III. Convergent Validity Results

Research Construct		Factor Loading	CR	AVE
Performance Expectancy (PE)	PE1	0.824	0.8471	0.6487
	PE2	0.794		
	PE3	0.798		
Effort Expectancy (EE)	EE1	0.837	0.8777	0.7051
	EE2	0.853		
	EE3	0.829		
Social Influence (SI)	SI1	0.811	0.8422	0.6418
	SI2	0.873		
	SI3	0.711		
Facilitating Conditions (FC)	FC1	0.837	0.8164	0.5986
	FC2	0.691		
	FC3	0.786		
Brand Trust (BT)	BT1	0.867	0.9358	0.7848
	BT2	0.908		
	BT3	0.889		
	BT4	0.879		
Perceived Value (PV)	PV1	0.730	0.7071	0.5470
	PV2	0.749		
Perceived Enjoyment (PENJ)	PENJ1	0.753	0.7587	0.5203
	PENJ2	0.845		
	PENJ3	0.529		
Intention To Use (ITU)	ITU1	0.704	0.7847	0.5488
	ITU2	0.768		
	ITU3	0.749		

D. Discriminant Validity

Discriminant validity analysis tests whether correlations can be distinguished between the constructs, seeking a higher correlation between questionnaire items within a single construct, and a lower correlation between items in different constructs. Fornell & Larcker (1981) [68] suggest the square root of the AVE for each construct should exceed the Pearson Correlation Coefficient of each construct. The results in Table IV show that the questionnaire used in this study has good discriminant validity.

TABLE IV. Correlation Coefficient Matrix for Each Construct

	BT	PE	EE	SI	ITU	FC	PENJ	PV
BT	0.886							
PE	0.388	0.805						
EE	0.343	0.448	0.840					
SI	0.377	0.481	0.395	0.801				
ITU	0.358	0.649	0.487	0.534	0.741			
FC	0.404	0.403	0.399	0.384	0.463	0.774		
PENJ	0.464	0.470	0.367	0.576	0.637	0.393	0.721	
PV	0.428	0.620	0.436	0.501	0.677	0.401	0.676	0.740

Note: The diagonal line is the square root of the AVE for each construct.

E. Model Fit

Structural equation modeling is a statistical method that uses factor and path analysis to verify research hypotheses. It explores the causal relationship and degree of influence among variables, and uses model fitness to evaluate the fit between the research framework model and sample data. Following Hair et al. (1998) [69], we use Absolute Fit Measures, Incremental Fit Measures and Parsimonious Fit Measures, with the model satisfying 11 measurement indicators, indicating that the research model presents adequate model fitness.

F. Hypothesis Validation

Following verification of reliability, validity and model fitness, this study uses AMOS 24 for structural analysis. To explore the relationship between the various model constructs, a structural model was established to test the various hypotheses, with the standardized path coefficients and hypothesis validation results shown in Fig. 2. Positive and significant impacts are found for effort expectancy on performance expectancy ($\beta = 0.490$, $p < 0.001$; H1), performance expectancy on use intention ($\beta = 0.345$, $p < 0.001$; H2), effort expectancy on use intention ($\beta = 0.125$, $p < 0.001$; H3), facilitating conditions on use intention ($\beta = 0.114$, $p < 0.001$; H5), performance expectancy on perceived value ($\beta = 0.470$, $p < 0.001$; H6), social influence on perceived value ($\beta = 0.271$, $p < 0.001$; H7), social influence on perceived hedonic ($\beta = 0.654$, $p < 0.001$; H8), brand trust on perceived value ($\beta = 0.186$, $p < 0.001$; H9), perceived value on use intention ($\beta = 0.226$, $p < 0.001$; H11) and perceived enjoyment on use intention ($\beta = 0.359$, $p < 0.001$; H12). However, the two hypotheses regarding the impact of social influence on use intention (H4) and brand trust on use intention (H10) are not supported.

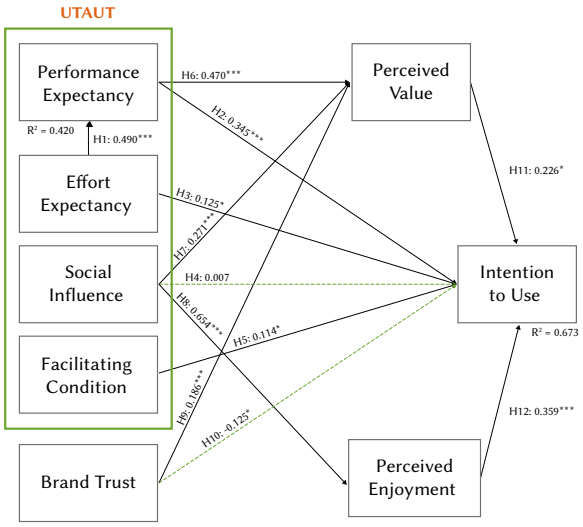

Fig. 2. Path Analysis Results.

G. Comparative Results for Age

Previous studies on the adoption of IoT services found that the impact of consumer age on behavioral attitude and response is subject to a variety of [6], [9], [70]. Chua (2004) [71] noted that most East Asian pop culture consumption occurs among people under the age of 30. This study uses 30 as the cutoff age for group analysis, and the results presented in Fig. 3 and Fig. 4 show the following differences in the use intention for smart pet appliances among different age groups:

1. Among users under 30, performance expectancy is the most important factor influencing use intention, which means that these users are mainly concerned with the usefulness of smart pet appliances. The secondary factor affecting usage intention is perceived value, and the main factor affecting perceived value is social influence, indicating that these users are sensitive to peer attitudes towards smart pet appliances, which in turn will affect perceived value, and finally willingness to use.
2. Among user over 30, perceived enjoyment is the most important factor affecting use intention, and the main factor affecting perceived enjoyment is social influence, which means that this group is affected by peer attitudes regarding hedonic emotions, which then affects use intention. The secondary reason affecting use intention is the implications of effort expectancy on perceived ease of use. Previous studies found that older people tend to

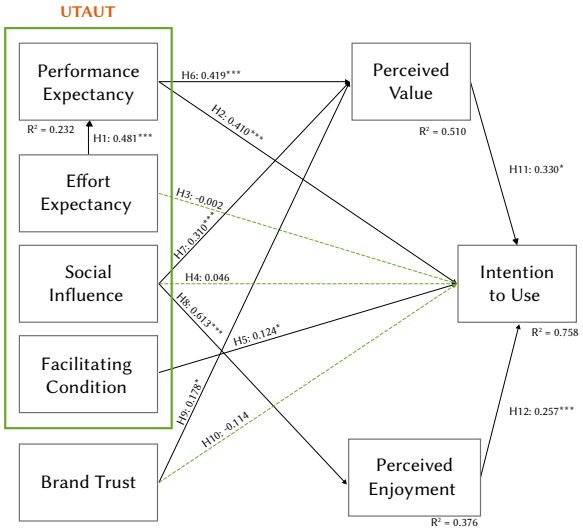

Fig. 3. Path analysis results (under 30 years old).

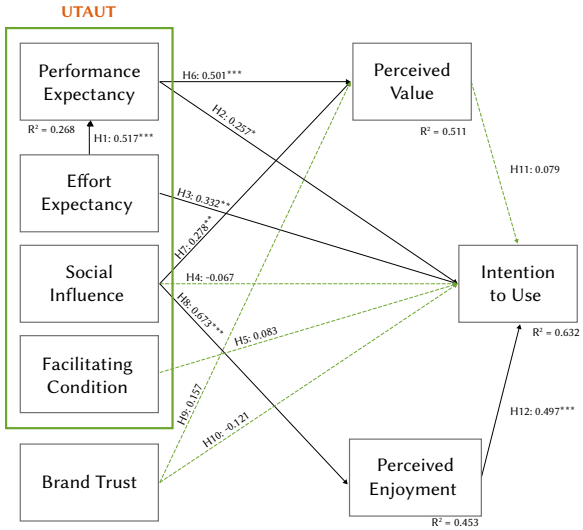

Fig. 4. Path analysis results (over 30 years old).

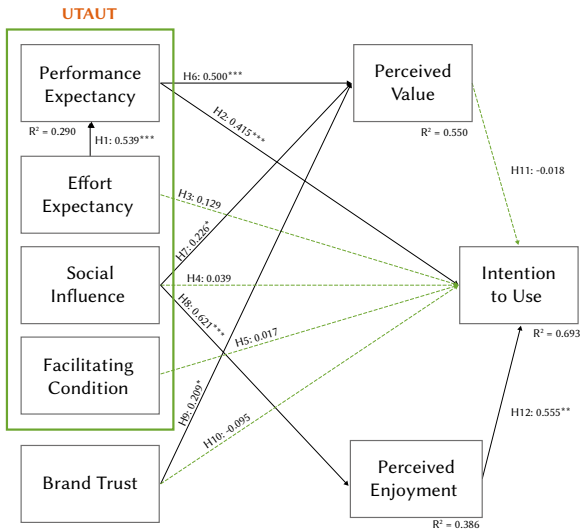

Fig. 5. Path analysis results (one appliance).

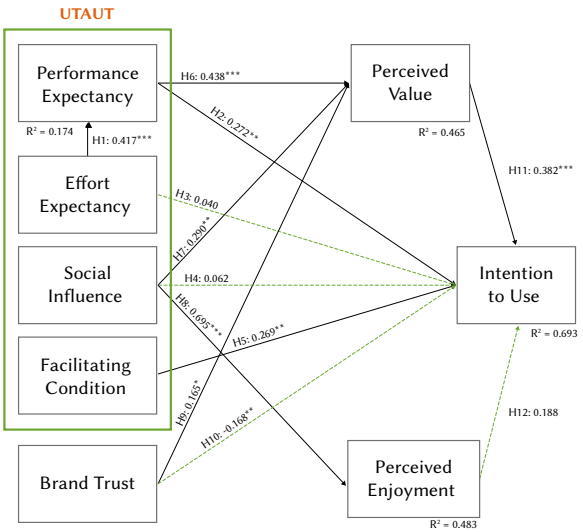

Fig. 6. Path analysis results (two or more appliance).

experience relatively higher levels of anxiety when learning to use computers [23], therefore, effort expectancy plays a very important role in the use intention of this group.

3. Social influence affects performance expectancy among users under 30, and performance expectancy is the most important factor affecting use intention; in users over 30, social influence affects perceived enjoyment, which in turn is the key impact factor for use intention While social influence does not directly affect the use intention, peer opinions are an important component for other use factors.

H. Number of Appliances in Use

According to the third-generation technology acceptance model (Venkatesh & Bala, 2008) and the Unified Theory of Acceptance and Use of Technology (UTAUT) [23], use experience will impact use intention. Previous research on Internet of Things applications suggest that user experience will affect users' willingness to adopt [9], [48], [49], thus this study conducted grouping and hypothesis verification analysis on users in terms of numbers of smart pet appliances used, with results for various classifications shown in Fig. 5 and Fig. 6. In terms of users with different numbers of smart pet appliances (1 vs. 2 or more), a significant difference was found in terms of use intention:

1. For owners of a single smart pet appliance, perceived enjoyment has a strong direct impact on use intention, and the main factor affecting perceived enjoyment is social influence. This shows that such users are sensitive to peer opinion, which affects their enjoyment usage motivation, which in turn affects their use intention. The second factor that affects use intention performance expectancy, thus in addition to the enjoyment they derive from using smart pet appliances, these users place significant value on increasing their convenience in caring for their pets and enhancing their quality of life.
2. Among users with two or more smart pet appliances at home, the most important factor affecting use intention is performance expectancy, which means that their main goal in using multiple smart pet appliances is to improve the efficiency of pet care and pet quality of life. The second factor affecting use intention is perceived value, which in turn is affected by performance expectancy. Thus, the product usefulness is the key factor impacting use intention among this group of users.
3. While there are differences in the impact factors between these two groups of users, overall performance expectancy and effort expectancy still play a major role in adoption for both groups.

V. Conclusions And Recommendations

A. Conclusions

This study uses the Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh et al. (2003) [23], combining three variables (brand trust, perceived value and perceived enjoyment) to explore factors impacting consumers' intentions to use smart pet appliances.

Previous research on the Internet of Things found that effort expectancy has a significant impact on performance expectancy [21], [50]. In the present study, overall sample analysis or clustering results both indicate that effort expectancy positively impacts consumers' performance expectancy. If users feel new technologies will be easy to use, and can increase productivity without excessive additional effort, they will perceive such technologies as having high perceived usefulness.

In terms of the relationship between UTAUT and use intention, the results of this study show that performance expectancy impacts the use intention of smart pet appliances, indicating that product usefulness is an important consideration in determining product usage. These findings are consistent with those of Gao & Bai (2014) [72], who found that usefulness is an important driver of IoT technology adoption, and Kowatsch & Maass (2012) [53] who found that users adopt IoT technologies perceived as being conducive to promoting work productivity. In addition, effort expectancy is found to be a factor affecting use intention for smart pet home appliances, where ease of learning and use correlates with increased willingness to adopt. Yong et al., (2011) [57] found that ease of use is an important determinant for the acceptance of new technologies, particularly among older users, which is consistent with the present finding that ease of use is a particular consideration for users over the age of 30. Facilitating conditions are found to have a positive impact on use intention for smart pet appliances, consistent with the findings of Abushkra et al., (2019) [8] that adoption is effectively promoted by access to sufficient technical knowledge or infrastructure support [8]. However, this result does not hold for users under the age of 30 or those who only have one smart pet home appliance. This is possibly explained because single-device use does not require technical acumen or support including integration, device cross-compatibility, WiFi networking, or integration with mobile apps. Overall sample analysis and clustering results do not support the influence of social influence on usage intention. Venkatesh et al. (2003) [23] note the impact of social influence is weaker in regards to new technologies in early development stages. Rogers (2003) [73] also notes that, given the limited number of users of emerging technologies, the impact of social influence remains low until the technology matures.

On the other hand, performance expectancy is found to impact perceived value in both the overall sample and group analysis results. Consumers who use smart pet appliances feel they are useful and can effectively help them overcome challenges. This is consistent with Kim & Chan (2007) [74] who found that performance expectancy has a positive impact on perceived value. The results also show that social influence impacts perceived value and perceived enjoyment, consistent with Li (2011) [75] and Pitchayadejanant (2011) [11] who found that social influence indirectly enhances use intention through perceived value and perceived enjoyment. That is, social influence affects the degree of perceived value and perceived enjoyment. One's peers expressing positive attitudes towards the value or enjoyment derived from the use of smart pet appliances will positive impact one's use intention.

The influence of brand trust on use intention is not established in the overall sample or group analysis results, possibly because smart pet appliances are a relatively recent product category, and are not in widespread use, thus consumers have not had time or exposure needed to acquire relevant information or develop brand loyalty. Therefore, brand trust does not constitute an influencing factor for use intention.

Perceived value has a positive impact on use intention among users over the age of 30 and among users with two or more such appliances. However, perceived enjoyment was found to have a significant impact on use intention for users both above and below the age of 30, along with users who only have one smart pet appliance. The group analysis presented in the previous chapter shows that the factor with the greatest effect on the impact of perceived value and perceived enjoyment on use intention is social influence, which means that consumers' use intention is influenced by peer attitudes.

B. Research Contributions

The increasing ubiquity of advanced technologies has driven increasing research on topics related to the Internet of Things and smart home appliances. A recent addition to this product category is smart pet home appliances, for which little research has been conducted. Motivated by the authors' own experience and that of their peer group, this study examines factors that may influence consumers when adopting smart pet home appliances. Data collection and analysis potentially provide a better understanding of the future of consumer adoption patterns in this product segment, and the study makes the following contributions:

1. Expanding the application scope of the Unified Theory of Acceptance and Use of Technology (UTAUT) to the domains of IoT, smart home appliances, and smart pet appliances. Additionally, this study includes Brand trust, Perceived Value, and Perceived Enjoyment as additional factors within the research model for investigation.
2. Identifying factors that affect perceived value and perceived enjoyment.
3. Establishing the importance of brand trust on perceived value.
4. The research findings can serve as a valuable reference for developers or manufacturers in the smart home appliance and IoT technology industry, enabling them to develop products that better meet the expectations and needs of the researchers.

C. Limitations and Future Work

This study seeks to identify factors that affect the use intention of smart pet appliances, but such factors operate on multiple levels. Despite the rigor of the research design, the contribution of many factors remains ambiguous, thus the research results should be interpreted with caution and future work should seek further clarification by:

1. Increasing sample diversity: Survey respondents were largely between 20 and 33 years old, with a significant gender imbalance, which could potentially result in insufficient sample representativeness. Therefore, future work should seek to broaden the age range of respondents and normalize the gender distribution, thereby avoiding excessive data concentration in the resulting clusters.
2. Evaluate and select influencing factors: Consumer use intention is subject to a wide range of influencing factors. However, due to time constraints and other considerations, the present study selected only eight factors in the final model. Future work should seek to incorporate other theoretical perspectives to increase the comprehensiveness of research findings.
3. Enrich data analysis clustering criteria: Regarding the clustering analysis of data, this study solely focuses on conducting comparative analysis of data concerning different age groups and the quantity of smart pet appliances used. In future research,

it would be valuable to expand the analysis by incorporating variables such as usage duration or gender, as these factors may also impact the user experience and yield different research outcomes.

Appendix

Research Questionnaire

Construct	Item	Reference
Performance Expectancy (PE)	*(PE1)* Using smart pet appliances can improve my efficiency. *(PE2)* Using smart pet appliances will improve my quality of life. *(PE3)* Using smart pet appliances saves time in pet care.	Davis et al. (1989) [54], Moore & Benbasat (1991) [76]
Effort Expectancy (EE)	*(EE1)* Smart pet appliances are easy to learn to use. *(EE2)* Smart pet appliances are easy to operate. *(EE3)* I don't need help to use smart pet appliances.	Davis et al. (1989) [54], Moore & Benbasat (1991) [76]
Social Influence (SI)	*(SI1)* There are many online recommendations for smart pet appliances. *(SI2)* My peers recommend the use of smart pet appliances. *(SI3)* My peers support my use of smart pet appliances	Venkatesh et al. (2003) [23], Venkatesh & Zhang (2010) [77], Foon & Fah (2011) [78]
Facilitating Condition (FC)	*(FC1)* I have the required network environment to use smart pet appliances. *(FC2)* I have the knowledge needed to use smart pet appliances. *(FC3)* Smart pet appliances are compatible with my other devices (e.g., mobile apps).	Ajzen (1991) [79], Taylor & Todd (1995) [80]
Perceived Enjoyment (PE)	*(PENJ1)* I enjoy interacting with my pet using smart pet appliances. *(PENJ2)* I enjoy using smart pet appliances. *(PENJ3)* Using smart pet appliances is worth the required time.	Venkatesh et al. (2012) [60]
Perceived Value (PV)	*(PV1)* Using smart pet appliances is worth the required effort. *(PV2)* Using smart pet appliances is worth the required time.	Sweeney & Soutar(2001) [81]
Brand Trust (BT)	*(BT1)* I trust the brand of smart pet appliances I use. *(BT2)* I think smart pet appliance brands are reliable. *(BT3)* The smart pet appliance brand I use is trustworthy. *(BT4)* I have confidence in the brand of smart pet appliance I use.	Hsu et al. (2014) [82], Delgado-Ballester (2004) [83]
Intention to Use (ITU)	*(ITU1)* I am willing to use smart pet appliances. *(ITU2)* I will probably use smart pet appliances in the future. *(ITU3)* I plan to use smart pet appliances.	Davis et al.(1989) [54], Venkatesh &Zhang (2010) [77]

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Chia-Chen Chen

Dr. Chen is a Distinguished Professor of Management Information Systems at National Chung Hsing University, Taiwan. Her current research interests focus on information management, educational technology, deep learning, human behavior, and social interactions. Dr. Chen's has been named to the prestigious World's Top 2% Scientists list published by Stanford University in 2021, 2022, & 2023.

Chia-Pei Lin

Miss Lin received the M.S. degree with the Department of management information systems at National Chung Hsing University, Taiwan. She is interesting on information management, human behavior, and social interactions.