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Study on wearable device users' willingness to continue using —ECM-IS based on the expansion model

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ABSTRACT

Based on the Expectation Confirmation Model of Information System(ECM-IS), three personal characteristic factors of self-efficacy, privacy concerns, and innovation as well as two external environmental factors of subjective reference and switching costs were introduced to construct a model of factors affecting users' continuance intention of wearable devices from the perspective of "technology-individual-environment". 356 valid samples were collected through the questionnaire for empirical analysis. The results of the study show that self-efficacy, switching costs, and perceived usefulness in the ECM-IS model have a significant effect on users' continuance intention at $p<0.001$ level while innovativeness and subjective references affect users' continuance intention at $p<0.05$, but privacy concerns have no effect on continuance intention.

Keywords: wearable devices; continuance intention; expectation confirmation model of information system (ECM-IS)

1. Introduction

With the strong promotion of information technology and Internet of things industry, wearable devices, as a new generation of portable electronic devices, have attracted extensive attention and are rapidly renovating consumer technology products. Wearable devices take intelligent hardware as the carrier, combined with application software and data interaction to realize the functions of business communication, health monitoring, leisure and entertainment. According to the report of Internet Data Center (IDC), the total sales volume of the global wearable device market in the third quarter of 2017 reached 26.3 million units, an increase of 7.5% over the same period of last year. Among them, Xiaomi, Fitbit and apple ranked among the top three in global market share respectively. Sutu Research Institute predicts that the market scale of wearable devices will reach 32 billion yuan in 2018 and will continue to expand.

At present, the research on wearable devices mainly focuses on design and function, and few scholars explore it from the user level. A few existing literatures only consider the initial acceptance and adoption behavior of users. For example, Yang et al. discussed the impact of perceived benefits and risks on the perceived value and use intention of wearable device users, and found that perceived usefulness and entertainment have a greater impact

on perceived value than perceived risk[1]; Gu et al. discussed the initial trust of consumers in pervasive commerce from the perspective of wearable devices based on UTAUT 2 model, and stressed the need to focus on improving the entertainment, convenience and privacy of wearable commerce[2]; Wu Jiang et al. used meta-analysis to explore the impact of ten factors on wearable device users' attitude and adoption intention, and found that perceived usefulness had the most significant impact on users' adoption behavior[3]. Although the current wearable devices have a good prospect, there are still some problems such as serious homogenization, low user stickiness and high loss rate. According to Gartner's survey, although wearable devices initially attracted a large number of consumers due to their fashionable appearance and novel functions, about 1/3 of wearable device users will choose to give up after a period of time. Therefore, in today's highly competitive market environment, grasping the initial intention of users is only the first step to success. How to retain users and promote their sustainable use is the way to win for a long time.

Bhattacherjee proposed the famous information system continuous use model (ECM-IS)[4] on the basis of Expectation Confirmation Theory (ECT), which is used to explain the behavior of users who continue to use or give up using a certain information system. After reviewing the relevant literature, it is found that there are still many gaps in the research of applying ECM-IS model to the wearable field. In addition, the extended models of ECM-IS are mostly from the perspective of technical characteristics or a single perspective. With the socialization and application of wearable technology, internal personal factors and external environmental factors are also very important for emerging information technologies focusing on user experience such as intelligent wearable.

Therefore, according to the special situation of wearable devices, this paper expands the ECM-IS model, introduces self-efficacy, privacy concern and innovation to explore the user's perception of personal characteristics, subjective reference and

transformation into the user's perception of external environmental factors, so as to adapt to the continuous use situation of wearable devices, and constructs the research model from the comprehensive perspective of "technology individual environment", explore what factors will affect the sustainable use intention of wearable device users, so as to provide sustainability suggestions for device providers in excavating product R & D and design priorities and improving operation and marketing strategies.

2. Literature review and research hypothesis

2.1. Technical characteristic factors in the context of wearable devices

The ECM model has been widely used in the field of marketing. The model shows that the continuous use intention of is users is determined by two post adoption variables, namely perceived usefulness and satisfaction, which in turn depend on the expected confirmation, as shown in **Figure 1.**
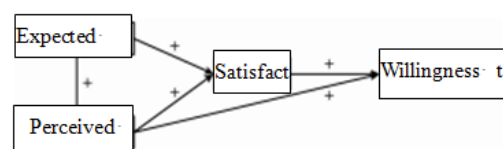

Figure 1. Information system continuous use model (ECM-IS).

The author believes that the relationship between expected confirmation and perceived usefulness, satisfaction and sustainability intention can be further applicable to the situation of sustainable use of wearable devices. Therefore, hypothesis H1: Users' expected confirmation of wearable devices is positively correlated with perceived usefulness. H2: Users' expectation confirmation of wearable devices is positively correlated with satisfaction. H3: Users' perceived usefulness of wearable devices is positively correlated with satisfaction. H4: Users' perceived usefulness of wearable devices is positively correlated with their willingness to continue using them. H5: Users' satisfaction with wearable devices is positively correlated with their willingness to continue using them.

After the ECM-IS model was proposed, scholars improved and expanded it in different situations, integrated it with other theoretical models or introduced different variables into the model to explore the continuous use intention of is users. At present, the expansion of ECM-IS model is mostly from the perspective of technical characteristics. For example, Larsen and others combine ECM-IS model and task technology matching theory (TTF) to explore the continuous use decision of college teachers on e-learning tools. The results show that the variables from ECM-IS and TTF can explain the continuous use intention of is users[5]; Cho conducted path analysis on the integration model of ECM-IS and TAM, and found that the continuous use intention of mobile health applications was positively correlated with perceived ease of use[6]; Taking health app as an example, Yin Meng and Li Qi verified the impact of system quality, information quality and service quality on continuous use intention through expected confirmation and perceived usefulness by integrating ECM-IS and is success model[7]. A few studies expand ECM-IS model from other perspectives. For example, Steelman & Soror explores the driving mechanism of mobile phone users' willingness to continue to use based on ECM-IS model and cognitive dissonance theory. The research results show that psychological states such as technology addiction and excessive technology pressure will affect user experience, and then affect post use feeling and decision-making at cognitive and emotional levels[8]; According to the characteristics of the elderly using the Internet, Liu Q and others added two factors of computer anxiety and physical function decline into the ECM is model. The results showed that the decline of physical function did not have an important impact on the continuous application of the Internet by the elderly[9].

Based on the existing research, it can be seen that the current expansion model of ECM-IS mainly focuses on the technical perspective or a single other perspective, and rarely involves two or more perspectives. With the social popularization and application of wearable devices and the continuous

expansion of audience groups, users' willingness to continue to use will be affected by multi-dimensional factors, so it needs to be discussed from a more comprehensive perspective.

2.2. Personal characteristic factors in the context of wearable devices

Self-efficacy originates from social cognitive theory. It refers to an individual's belief in whether he is able to perform a specific task. It is an important basis for action. A prominent feature of wearable devices in the stage of rapid growth is the continuous influx of new functions. Although it is very attractive to users, users also need to have the corresponding ability to keep up with the pace of upgrading. HSU & Chiu applied the theory of planned behavior (TPB) to the context of is sustainable use and theoretically deduced the model of e-service sustainable use. The results show that users' willingness to continue to use is determined by Internet self-efficacy and satisfaction[10]. Cao et al. constructed the influencing factor model of customers' continuous use of self-service technology (SST) based on attribution theory and expectation inconsistency theory, and found that self-efficacy and satisfaction will significantly affect the willingness to continue to use SST[11]. Zhou took social commerce as the research background and established an empirical model based on content analysis. It was found that cognitive factors such as self-efficacy have a significant positive impact on user stickiness of social media[12]. According to the above research, the author believes that users perceived self-efficacy in the process of using wearable devices will positively affect their willingness to continue to use. Therefore, hypothesis H6: users' self-efficacy of wearable devices is positively correlated with their willingness to continue to use.

Paying attention to users' privacy and security is the basis for the success of emerging Internet technologies. Dong et al. found that privacy protection services have a significant impact on user satisfaction and continuous use intention of social interaction based on social networks[13]. Chen et al.

explored the influence path of cognitive and emotional factors on the willingness of social media service users to continue to use within the framework of "cognition emotion willingness". The results showed that the negative emotion brought by privacy risk had a stronger effect on the willingness to continue to use than the positive emotion[14]. In the context of wearable devices, while collecting the user's regular personal information, the device provider can also collect the wearer's action track information and vital sign data in real time, such as steps, mileage, calorie consumption, heart rate and sleep data. Although this brings great convenience to users, it will also cause users' concerns about personal privacy disclosure, which will affect their experience of wearable devices and their motivation to continue to use them. Therefore, this paper proposes the hypothesis H7: Users' privacy concerns about wearable devices are negatively related to their willingness to continue to use.

Innovation refers to people's willingness to adopt an innovative technology, which reflects the individual's interest in new things such as innovative products or services. In other words, individuals with a high level of innovation are more likely to become innovators or early users of new technologies. Previous empirical research results have confirmed the important role of innovation in new technology adoption and post adoption behavior. For example, Lassar et al. tested the impact of consumers' personality traits on the acceptance of online banking based on TAM model and innovation framework. The results confirmed that consumers' innovation has a significant positive impact on the use intention of online banking[15]; Lu conducted a survey among undergraduate and graduate students in American universities and found that among well-educated mobile e-commerce users, innovation at the level of information technology is a powerful factor affecting users' willingness to continue to use[16]; Lin & Filieri integrated the individual psychological structure into the TAM model and constructed the continuous use intention model of air passengers' online flight boarding service. The results showed that the innovation of Chinese airline passengers

who have experienced online registration service can directly affect their continuous use intention[17]. Researchers in the field of is usually believe that users can continue to discover and use their new functions after adopting the system, which gives users the opportunity to demonstrate their innovation ability in their post adoption behavior. A typical intelligent wearable device is a new type of terminal hardware driven by mobile wearable technology, which has the characteristics of continuous innovation and upgrading at the technical and business levels. In view of the persistence and universality of innovation in trying and accepting a variety of innovative technologies[16], the sustainable use of wearable devices should be affected by user innovation. Therefore, this paper puts forward the hypothesis H8: the innovation of users is positively related to the continuous use intention of wearable devices.

2.3. External environmental factors in the context of wearable devices

Subjective reference is usually defined as the social pressure perceived by individuals to perform or not perform a certain behavior. It is related to the normative beliefs expected from others, also known as subjective norms. Subjective reference reflects the degree to which an individual's attitude, belief and behavior are influenced by others. Lee established a theoretical model for the "acceptance termination" phenomenon among e-learning users to explain and predict users' willingness to continue using e-learning system. The results show that the willingness to continue using e-learning system is significantly affected by subjective norms[18]. Chen et al. explored the mechanism of social factors on Web 2.0 users' satisfaction and willingness to continue to use. The results show that four social factors, including subjective reference, have a direct impact on willingness to continue to use[19]. Many users choose wearable devices because they see the use of their surrounding colleagues, friends or relatives and are recommended. In order to meet the expectations or recognition of the people around them, individuals are usually willing to follow their

opinions. Therefore, the author puts forward the hypothesis that H9: subjective reference is positively correlated with users' willingness to continue to use wearable devices.

Conversion costs refer to the potential costs incurred by users in the process of switching from one service provider to another, including monetary and non-monetary costs (time and energy). For enterprises, the main function of switching cost is to cause customers' active or passive loyalty. Oyeniyi & Abiodun found that the increase of switching costs will increase users' dependence on service providers, which is an important reason for users' retention, according to a questionnaire survey of customers in the mobile communication industry [20]. Deng et al. constructed the influencing factor model of customer loyalty in the context of online shopping. The results show that the switching cost and satisfaction in the online environment significantly affect customer loyalty[21]. In the case of low conversion cost, users will have high conversion motivation due to low conversion barriers. When users' switching power is hindered by high switching cost, the switching cost will not only reduce the switching intention, but also cause users to stay in the hands of existing product or service providers, because changing providers will not benefit users. In the specific context of wearable devices, users' understanding of new devices, the search and evaluation costs to be paid in the conversion process, and the economic risks associated with trying new devices will affect their conversion intention. The higher the perceived transfer cost, the lower the conversion intention, and the stronger the continuous use intention of the original device. Therefore, this paper proposes the hypothesis that H10: conversion cost is positively correlated with users' willingness to continue to use wearable devices.

To sum up, this paper will expand the ECM-IS model from the perspectives of technical characteristics, personal characteristics and external environment to explore the influencing factors of wearable device users' willingness to continue to use. The research framework is shown in **Figure 2**.
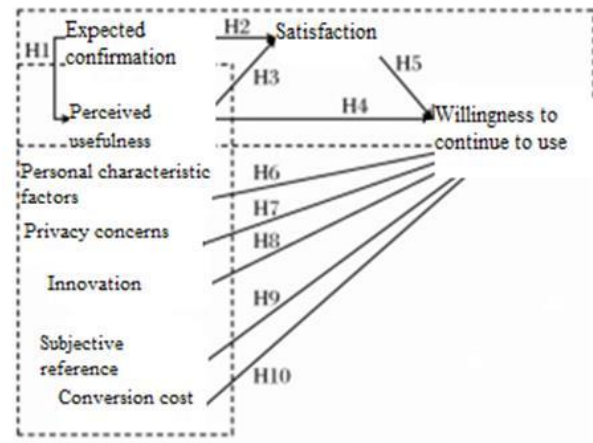

Figure 2. Sustainable use intention model of wearable device users.

3. Research design

This study uses the questionnaire to empirically test the wearable device user's continuous use intention model proposed above. The questionnaire is distributed in the form of a combination of online survey and offline distribution, and the target population is users who have used wearable devices. A screening item is set on the front page of the questionnaire. If participants have never used wearable devices, they will end the answer directly. This study finally collected 453 questionnaires, including 286 online questionnaires and 167 paper questionnaires. After deleting the abnormal answers by SPSS 22.0, the total number of valid questionnaires was 356, with an effective rate of 78.55%.

The questionnaire consists of two main parts. The first part is demographic issues, which aims to collect information on participants' gender, age, occupation and region. In the sample, there are 254 males, accounting for 71.35%, and 102 females, accounting for 28.65%; There are 11 people under the age of 18, accounting for 3.09%, 103 people from 18 to 24, accounting for 28.93%, 148 people from 25 to 30, accounting for 41.57%, 76 people from 31 to 40, accounting for 21.35%, and 18 people over 40, accounting for 5.06%; There are 162 students, accounting for 45.51%, 97 employees, accounting for 27.25%, 58 employees, accounting for 16.29%, 27 self-employed, accounting for 7.58%,

and 12 employees in other occupations, accounting for 3.37%. There are 78 people in the first-tier cities, accounting for 21.91%. There are 121 people in second tier cities, accounting for 33.99%, and 157 people in third tier and below cities, accounting for 44.10%. According to the 2016 intelligent hardware industry insight report released by talking data, the proportion of men and women of wearable device users in 2016 was 75%: 25%. Young users under the age of 35 are the main user group of wearable devices, accounting for 76.5% of all age groups; The occupations with the highest proportion of users are college students and office workers. The proportion of users in first tier cities, second tier cities, third tier cities and below is 16.1%, 36.5%, 47.4%. Therefore, by comparing with the user portrait in the report, the sample data used in this study is in line with the user characteristics of China's current wearable device market.

The second part consists of the items of each variable in the research framework of this paper. The design of the topic draws lessons from the maturity scale widely adopted in the current foreign research, and makes targeted adjustments according to the recommendations of the expert group and the characteristics of wearable devices, so as to ensure the reliability and validity of the measurement results.

The final scale includes 9 variables and 30 items. Among them, expectation Confirmation (EC), perceived usefulness (PU), satisfaction (SA) and willingness to continue use (CI) refer to the scale of Bhattacherjee[4], self-efficacy (SE) and subjective reference (SN) refer to the scale of HSU & Chiu (2004)[10], privacy concern (PC) refer to the scale of son & Kim (2008)[22], innovation (in) refer to the scale of Lassar et al.[15], and switching cost (SC) refer to the scale of Jones et al.[23]. The option is scored with Likert 7 scale, reminding participants to answer according to their actual feelings. A score of 1~7 means from "very agree" to "very disagree".

4. Research results

4.1. Reliability and validity test

Firstly, this paper uses SPSS 22.0 to carry out KMO and Bartlett test on the data. The results show that the KMO value of the sample is 0.901, the chi square of Bartlett sphericity test is 4700.081, and the significance level is 0.000, indicating that this scale is suitable for factor analysis. Confirmatory factor analysis (CFA) can be used to test the reliability and validity of the scale. The results are shown in **Table 1** and **Table 2**.

Table 1. Analysis of reliability and convergent validity of measurement model

Factor	Item	Factor load	Cronbach's α	CR	AVE
EC	EC1	0.716	0.878	0.820	0.603
	EC2	0.802			
	EC3	0.808			
PU	PU1	0.750	0.868	0.862	0.610
	PU2	0.785			
	PU3	0.790			
	PU4	0.797			
SA	SA1	0.729	0.854	0.835	0.559
	SA2	0.762			
	SA3	0.729			
	SA4	0.770			
SE	SE1	0.802	0.856	0.822	0.606
	SE2	0.818			
	SE3	0.712			
PC	PC1	0.812	0.841	0.896	0.742
	PC2	0.899			
	PC3	0.871			
IN	IN1	0.797	0.812	0.889	0.727
	IN2	0.876			
	IN3	0.882			
SN	SN1	0.751	0.770	0.864	0.680
	SN2	0.864			
	SN3	0.854			
SC	SC1	0.813	0.756	0.846	0.647
	SC2	0.794			
	SC3	0.806			
CI	CI1	0.751	0.903	0.878	0.644
	CI2	0.840			
	CI3	0.794			
	CI4	0.822			

Table 2. Discriminant validity analysis of measurement model

Factor	EC	PU	SA	SE	PC	IN	SN	SC	CI
EC	0.777								
PU	0.642	0.781							
SA	0.585	0.574	0.748						
SE	0.328	0.317	0.321	0.778					
PC	-0.121	-0.163	-0.199	-0.153	0.861				
IN	0.234	0.286	0.290	0.257	-0.106	0.853			
SN	0.166	0.230	0.178	0.107	-0.048	0.244	0.825		
SC	0.235	0.216	0.280	0.225	-0.047	0.102	0.135	0.804	
CI	0.306	0.600	0.597	0.580	-0.205	0.353	0.335	0.556	0.809

4.2. Hypothesis test

Amos24 was used in this study 0 software to test the hypothesis of the model. The results of goodness of fit index are shown in **Table 3**, χ 2. RMSEA (root mean square of approximate error), CFI (Comparative fitting index), IFI (incremental fitting index), GFI (goodness of fit index), AGFI (adjusted goodness of fit index), NFI (benchmark fitting index), NNFI (non-standard fitting index) and SRMR (root mean square of standardized residual error) are all within the recommended value range, indicating that the fitting degree of the research model and sample data is good.

Table 3. Fitting index results of research model

Fitting index	χ^2/df	RMSEA	CFI	IFI	GFI	AGFI	NFI	NNFI
Recommended value	≤2	≤0.1	≥0.9	≥0.9	≥0.9	≥0.8	≥0.9	≥0.9
Model fitting value	1.731	0.045	0.972	0.972	0.923	0.899	0.937	0.967

The hypothesis test results of structural equation model are shown in **Table 4** and **Figure 3**. Among the 10 hypotheses, only one hypothesis is not supported, that is, the negative impact of privacy concerns on sustainable use intention is not significant. The innovation of the perspective of personal characteristics and the subjective reference of the perspective of external environment have a significant impact on the willingness to continue to use at the level of P less than 0.05, and the other paths are significant at the level of P less than 0.001. The variance explained by perceived usefulness, user satisfaction and continuous use intention were 44%, 40% and 54%, respectively.

Table 4. Hypothesis test results of research model

Hypothesis	route	Path coefficient	P value	conclusion
H1	Expected confirmation → perceived usefulness	0.645	***	support
H2	Expectation Confirmation → satisfaction	0.351	***	support
H3	Perceived usefulness → satisfaction	0.327	***	support
H4	Perceived usefulness → willingness to continue to use	0.461	***	support
H5	Satisfaction → willingness to continue to use	0.384	***	support
H6	Self-efficacy → willingness to continue to use	0.344	***	support
H7	Privacy concerns → willingness to continue to use	-0.080	0.113	I won't support it
H8	Innovation → willingness to continue to use	0.170	0.021	support
H9	Subjective reference → willingness to continue to use	0.164	0.032	support
H10	Conversion cost → willingness to continue to use	0.313	***	support

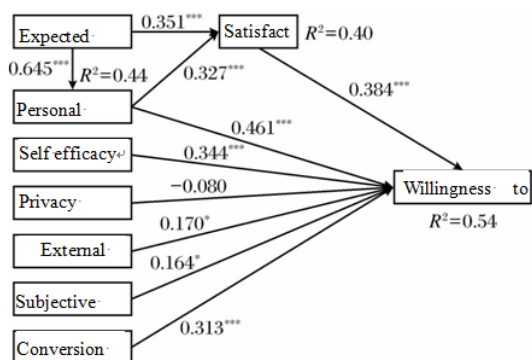Note: ***, **, and * are significant at the levels of 0.001, 0.01 and 0.05 respectively

Figure 3. Analysis results of research model.

As shown in the chart, expected confirmation has a significant impact on perceived usefulness (0.645), expected confirmation (0.351) and perceived usefulness (0.327) have a positive impact on user satisfaction, and perceived usefulness (0.461) and user satisfaction (0.384) have a positive impact on users' willingness to continue to use; Users' self-efficacy (0.344), innovation (0.170), subjective reference (0.164) and conversion cost (0.313) significantly affect their willingness to continue to use; The impact of privacy concerns (-0.080) on continued use intention is not supported. In conclusion, perceived usefulness, self-efficacy and switching cost have the strongest positive impact on wearable device users' willingness to continue to use, followed by switching cost and innovation, and privacy concerns have no negative impact on wearable device users' willingness to continue to use.

5. Conclusions

On the basis of summarizing and sorting out the existing relevant literature at home and abroad, this paper establishes a research model for the sustainable use intention of wearable device users, expands the ECM-IS model from the comprehensive perspective of "technology personal environment", and explores the impact of technical characteristics, personal characteristics and external environmental factors on users' sustainable use intention to varying degrees. Through empirical test, all hypotheses except H7 are supported. The specific analysis of the research results is as follows.

(1) This study confirms the basic assumptions

of ECM-IS model and shows that it is applicable in the context of wearable devices. Therefore, at the level of technical characteristics, efforts to improve users' useful perception of wearable devices can enhance their willingness to continue to use. This means that the developers and designers of wearable devices should focus on the practical value of the device, constantly optimize the functional design and operation interface, improve the quality of hardware and information system, make it meet the multi-directional needs of users, and finally retain users.

(2) The factors of personal characteristics and external environment are not often considered in the previous literature. From the perspective of personal characteristics, firstly, the results of this study show that users' perception of the ability to freely use wearable devices has a significant impact on their willingness to continue to use. Since the perceived self-efficacy of users will change with the accumulation of experience, device operators can try to enhance users' confidence in self-ability by means of easy to understand operation instructions, or use intuitive publicity means to enable users to obtain reliable information, so as to improve their sense of self-efficacy and the possibility of continuous use of wearable devices. Secondly, the relationship between privacy concerns and willingness to continue to use has not been confirmed. This may be because, on the one hand, the current privacy protection measures for wearable devices are relatively perfect, making users less worried about the leakage of private information; on the other hand, the purpose of tracking and collecting users' personal privacy by wearable devices is mostly to provide users with more accurate personalized services. The positive benefits obtained by users from wearable devices exceed the negative losses caused by submitting privacy information, so it has no negative impact on their willingness to continue to use. Thirdly, this paper confirms the positive impact of innovation on sustainable use intention. Equipment providers can adopt differentiated marketing methods according to users' innovation ability. Highly innovative individuals tend to have

strong curiosity about emerging technologies and new things, and will attract the attention of people around them when using wearable devices, which is conducive to promoting the promotion of wearable devices. Therefore, when carrying out marketing activities to such user groups, we should focus on the innovation of wearable technology. At the same time, when releasing new functions, we should pay attention to the guidance of individuals with high innovation, so as to drive individuals with relatively low innovation. Individuals with relatively low innovation tend to have low acceptance of new products and conservative ideas. Therefore, we should focus on the security measures of wearable devices to these users and reduce users' anxiety.

(3) From the perspective of external environment, the continuous use intention of wearable device users is directly affected by subjective reference. Wearable users will change their beliefs and behaviors according to the expectations of important people in the life circle or work circle. When users obey the opinions of others under pressure, it will directly affect their willingness to continue to use wearable devices. Therefore, it is suggested that operators adopt a variety of incentives to encourage them to share information about equipment with others, do a good job in word-of-mouth marketing and improve the reputation of enterprises. In addition, switching cost has a significant positive impact on users' retention intention. Therefore, enterprises should use resources to increase the conversion cost, make users feel that the conversion will face higher risks, and then become a barrier that prevents users from leaving.

Conflict of interest

The authors declare no conflict of interest.

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