Pers Ubiquit Comput (2013) 17:741–748
DOI 10.1007/s00779-012-0613-3

ORIGINAL ARTICLE

Understanding the effect of flow on user adoption of mobile games

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Received: 15 March 2012 / Accepted: 21 September 2012 / Published online: 23 October 2012

Abstract Mobile games as an emerging service have not received wide adoption among users; especially, presenting a compelling experience to users may be crucial to their usage. Drawing on the flow theory, this research identified the factors affecting user adoption of mobile games. The results indicated that perceived ease of use, connection quality and content quality affect flow. Among them, content quality has the largest effect. Flow, social influence and usage cost determine usage intention. The results imply that service providers need to improve users' experience in order to facilitate their adoption and usage of mobile games.

Keywords Mobile games · Flow · Perceived ease of use · Usage cost

1 Introduction

Mobile internet has been developing rapidly in the world. According to a report issued by China Internet Network Information Center (CNNIC) in July [5], the number of mobile internet users in China has exceeded 388 million, accounting for 72 % of its internet population (538 million) [5]. Faced with the great market, service providers have released a variety of mobile services, such as mobile instant messaging, mobile news, mobile payment and mobile games. Among them, a few services have received wide adoption among users. For example, about 83 % of mobile users have ever used mobile instant messaging [5]. In comparison, only 30 % of them have adopted mobile games, which represent an entertainment application. Figure 1 shows mobile game user adoption in several countries. Service providers need to understand the factors affecting user behavior. Then, they can employ effective measures to facilitate user adoption and usage of mobile games, which is critical to the success.

Compared to traditional online games, a main advantage of mobile games is ubiquity. With the help of mobile networks and terminals, users have been freed from the temporal and spatial constraints. They can connect to mobile internet and play mobile games at anytime from anywhere. This may improve users' experience and facilitate their behavior. However, the constraints of mobile terminals such as small screens and inconvenient input may undermine user experience [24]. Compared to desktop computers, mobile terminals such as mobile phones have smaller screens and lower resolution. This may affect visual presentation of mobile games. Although a few mobile phones support touch control, many users still need to rely on small keys to input information. In addition, the unreliable network connection may also negatively affect user experience. For example, users may encounter service interruption and unavailability when they use mobile games on movement. If service providers cannot present a compelling experience to users, they may be unwilling to adopt and use mobile games.

Extant research has used multiple information systems theories, such as the technology acceptance model (TAM) [41], innovation diffusion theory (IDT) [25], task technology fit (TTF) [43] and the unified theory of acceptance and use of technology (UTAUT) [37] to examine mobile user behavior. Factors including perceived usefulness, relative advantage, task technology fit and performance expectancy are identified to affect user adoption. However,

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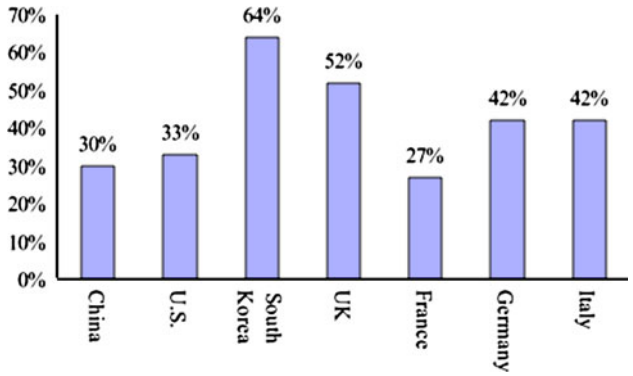

Fig. 1 Ratio of mobile game adoption. *Source* CNNIC, ComScore

these factors are mainly instrumental beliefs, and they represent extrinsic motivations. The effect of intrinsic motivation such as user experience on mobile user behavior has seldom been examined. Extrinsic motivation emphasizes usage outcomes, whereas intrinsic motivation emphasizes usage process. Both extrinsic and intrinsic motivations have effects on user's behavioral intention [7]. In this research, we measured user experience with flow, which represents an optimal experience and has been found to affect user behavior [13]. Perceived ease of use, connection quality and content quality are proposed to affect flow. In addition to flow, we also included social influence and usage cost into the model. Social influence reflects the effect of other important people's opinion on individual user, and usage cost reflects the effect of facilitating conditions. The effects of social influence and facilitation conditions on user behavior have been noted in UTAUT [38]. Thus, we involved both factors into the model.

The rest of this paper is organized as follows. Section 2 reviews related literature on flow and mobile user adoption. Section 3 develops the research model and hypotheses. We report instrument development and data collection in Sect. 4. Section 5 presents the results, followed by a discussion of these results in Sect. 6. Section 7 presents the theoretical and managerial implications. Section 8 concludes the paper.

2 Literature review

2.1 Flow

The concept of flow is originated from psychology, and it reflects a holistic sensation that people feel when they act with total involvement [6]. Hoffman and Novak [12] defined flow as a state that is characterized by (a) a seamless sequence of responses facilitated by machine interactivity; (b) intrinsic enjoyment; (c) a loss of self-consciousness; and (d) self-reinforcement. Flow reflects a balance between users' challenges and skills. When challenges exceed skills, users feel anxious. In contrast, when skills exceed challenges, users feel bored. When both challenges and skills are below the threshold values, users feel apathy. Only when both challenges and skills exceed the threshold values and have a fit will users experience flow.

As an illusive concept, flow includes multiple components. Guo and Poole [9] noted that online shoppers' flow includes six dimensions: concentration, perceived control, mergence of action and awareness, transformation of time, transcendence of self and autotelic experience. Hausman and Siekpe [10] reported that online flow includes challenge, concentration, control and enjoyment. Wang et al. [39] suggested that flow includes control, interest, attention and curiosity. Among these various components, perceived enjoyment, perceived control and attention focus are three often-used factors. Perceived enjoyment reflects the pleasure and enjoyment derived from using an information technology. Perceived control reflects the feelings of control over the activity and surrounding environment. Attention focus reflects user immersion and involvement with using an information technology.

In the information systems field, flow has been used to understand user adoption of online shopping [9], virtual worlds [2], instant messaging [45], sporting team websites [31] and e-learning [11]. Perceived complexity, interactivity, sociability and telepresence are identified to affect flow. Recently, flow has also been used to examine mobile user behavior. For example, Jung et al. [15] noted that content quality affects flow in using mobile TV. Zhou and Lu [46] found that flow and network externality affect mobile instant messaging users' flow.

2.2 Mobile user adoption

Due to the low adoption rate of mobile services, extant research has tried to identify the factors affecting user behavior. Information systems theories such as TAM, IDT, TTF and UTAUT are often used as the theoretical bases. TAM proposes that perceived usefulness and perceived ease of use are two main factors affecting user adoption of an information technology. Due to its parsimony and effectiveness, TAM has been widely used to examine user adoption of various mobile technologies, such as mobile health care [41], mobile payment [18] and mobile internet [35]. IDT notes that five characteristics, namely relative advantage, compatibility, perceived complexity, trialability and observability, affect user adoption of an innovation. Extant research has used IDT to explore usage intention of mobile banking [25] and mobile payment [29]. TTF suggests that only when task characteristics fit technology characteristics will users adopt an information technology.

TTF has been employed to examine user adoption of mobile work [43], mobile securities systems [26] and locatable information systems [16]. UTAUT states that four factors, namely performance expectancy, effort expectancy, social influence and facilitating conditions, determine user adoption. UTAUT was used to examine user behavior in the contexts of mobile data services [37] and mobile technologies [32].

3 Research model and hypotheses

3.1 Perceived ease of use

Perceived ease of use is a main component of TAM, and it reflects the difficulty of using an information technology. The constraints of mobile terminals such as small screens and inconvenient input may increase the difficulty of operating mobile games. If mobile games are difficult to use, users may feel lack of control. They also cannot acquire enjoyment. In addition, flow reflects a balance between challenges and skills. Perceived ease of use may decrease users' perceived challenges and help them achieve flow. Extant research has identified the effect of perceived ease of use on flow in the contexts of online communication [4] and online games [14]. Guo and Poole [9] also found that perceived complexity affects online shoppers' flow. Consistent with these studies, we propose

H1: Perceived ease of use is positively related to flow.

3.2 Connection quality

Connection quality reflects the access speed and stability. It is identified as a component of mobile internet's service quality [19]. Mobile networks and terminals enable users to play mobile games at anytime from anywhere. They may expect to acquire a seamless and fluid experience. If network connection is slow and instable, users cannot have a good experience. For example, users may often need to wait for the loading when playing mobile games on movement. Under some circumstances, they may be unable to connect to mobile game servers. This may negatively affect their experience. They cannot be immersed in using mobile games. Thus,

H2: Connection quality is positively related to flow.

3.3 Content quality

Content quality reflects the content attractiveness, timeliness and personalization. In addition to ease of use and reliable connection, users may also expect to enjoy mobile games with rich contents. If the plot of a mobile game is not attractive, users may feel bored as there exist many homogeneous games in the market. In addition, mobile games need timely update and personalization to provide an engaging experience to users. Service providers may collect information about individual user's preferences based on his or her usage history. Then, they can recommend relevant games and scenes to the user. Prior research has identified the effect of content quality on mobile TV user's flow [15] and the effect of communication performance (similar to content quality) on e-service user's flow [3]. Thus, we suggest

H3: Content quality is positively related to flow.

3.4 Social influence

Social influence reflects the effect of other important people's opinion on individual user. It is similar to subjective norm of the theory of planned behavior. When a user's friends and peers recommend him or her to use a mobile game, the user may comply with their opinions and adopt the game even he or she has not formed positive attitude toward the game. UTAUT argues that social influence is a significant determinant of user adoption [38]. Extant research has also uncovered the effect of social influence on behavioral intention in the contexts of mobile data services [37], instant messaging [34] and multimedia messaging services [20]. In line with these studies, we propose

H4: Social influence is positively related to usage intention.

3.5 Flow

Flow reflects an optimal experience. When users experience flow, they are immersed in using mobile games and feel great enjoyment. They are unconcerned with the surrounding environment and time elapses rapidly for them. This optimal experience may facilitate their usage intention. Extant research has reported the effect of flow on user behavior in the contexts of mobile TV [15], sporting team websites [31] and online shopping [10]. Based on these studies, we suggest

H5: Flow is positively related to usage intention.

3.6 Usage cost

Usage cost reflects the costs derived from using mobile games, such as communication fees and transaction fees. These fees mean a burden for most users. If they feel that mobile games are expensive to use, they may be unwilling to adopt and use the games. Usage cost is similar to facilitating conditions, which are a component of UTAUT and have a significant effect on user adoption [38].

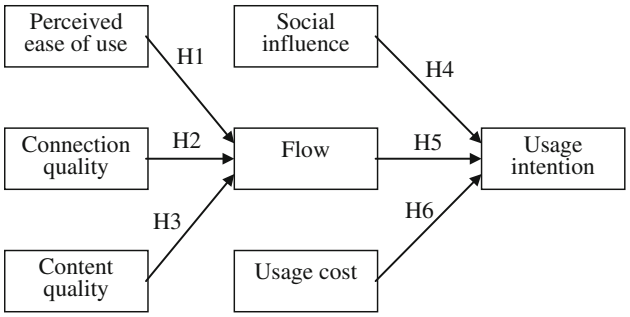

Fig. 2 Research model

Previous research has reported the effect of usage cost on user adoption of mobile web browsing services [44], m-commerce [40], short message services [27] and 3G mobile value-added services [21]. Thus,

H6: Usage cost is negatively related to usage intention.

Figure 2 presents the research model.

4 Method

The research model includes seven factors. Each factor was measured with multiple items. All items were adapted from extant literature to improve content validity [36]. These items were first translated into Chinese by a researcher. Then, another researcher translated them back into English to ensure consistency. When the instrument was developed, it was tested among ten users with mobile game usage experience. Then, according to their comments, we revised some items to improve the clarity and understandability. The final items and their sources are listed in "Appendix." Each item was measured with a seven-point Likert scale ranging from strongly disagree (1) to strongly agree (7).

Items of perceived ease of use and content quality were adapted from Jung et al. [15]. Items of perceived ease of use reflect the difficulty of learning to use and skillfully using mobile games. Items of content quality reflect content attractiveness, timeliness and personalization. Items of connection quality were adapted from Kim and Hwang [19] to reflect connection speed and stability. Items of social influence were adapted from Venkatesh et al. [38] to reflect the effect of other important people's opinion on individual user. Items of flow were adapted from Lee et al. [22] to measure perceived enjoyment, concentration and perceived control. Items of usage cost were adapted from Wu and Wang [42] to reflect communication fees and transaction fees derived from using mobile games. Items of usage intention were adapted from Lee [23] to reflect user intention to use and continue using mobile games.

Data were collected at a university and a service outlet of China Mobile, which is the largest mobile communication operator in China. Both the university and the service outlet are located in an eastern China city, where mobile internet is relatively better developed than in other regions. We contacted users and inquired whether they had mobile game usage experience. Then, we asked those with positive answers to fill the questionnaire based on their usage experience. We scrutinized all responses and dropped those with too many missing values. As a result, we obtained 231 valid responses. Among them, 62.8 % were male and 37.2 % were female. In terms of age, a majority of the respondents (69.7 %) were between 20 and 29 years old. And over half of them (55.8 %) held bachelor's and higher degree.

To examine the common method variance, we conducted two tests. First, we performed a Harman's single-factor test [33]. The results indicated that the largest variance explained by individual factor is 12.759 %. Thus, none of the factors can explain the majority of the variance. Second, we modeled all items as the indicators of a factor representing the method effect and re-estimated the model [28]. The results indicated a poor fitness. For example, the goodness-of-fit index (GFI) is 0.579 (<0.90). The root mean square error of approximation (RMSEA) is 0.196 (>0.08). With both tests, we feel that common method variance is not a significant problem in our research.

5 Results

Following the two-step approach recommended by Anderson and Gerbing [1], we first examined the measurement model to test reliability and validity. Then, we examined the structural model to test research hypotheses and model fitness.

First, we conducted a confirmatory factor analysis to examine the validity. Validity includes convergent validity and discriminant validity. Convergent validity measures whether items can effectively reflect their corresponding factor, whereas discriminant validity measures whether two factors are statistically different. Table 1 lists the standardized item loadings, the average variance extracted (AVE), the composite reliability (CR) and Cronbach's alpha values. As listed in the table, all item loadings are larger than 0.7. The T values indicate that these item loadings are significant at 0.001. All AVEs exceed 0.5 and CRs exceed 0.7. Thus, the scale has a good convergent validity. In addition, all alpha values are over 0.7, suggesting a good reliability [30].

To examine the discriminant validity, we compared the square root of AVE and factor correlation coefficients. As listed in Table 2, for each factor, the square root of AVE is significantly larger than its correlation coefficients with other factors. This suggests a good discriminant validity [8].

Table 1 Standardized item loadings, AVE, CR and alpha values

Factor	Item	Standardized loading	AVE	CR	Alpha
Perceived ease of use (PEOU)	PEOU1	0.802	0.72	0.88	0.88
	PEOU2	0.846			
	PEOU3	0.887			
Connection quality (CNQ)	CNQ1	0.825	0.61	0.83	0.82
	CNQ2	0.709			
	CNQ3	0.811			
Content quality (CTQ)	CTQ1	0.748	0.59	0.81	0.82
	CTQ2	0.715			
	CTQ3	0.837			
Social influence (SOI)	SOI1	0.938	0.75	0.85	0.85
	SOI2	0.783			
Flow (FLOW)	FLOW1	0.757	0.60	0.82	0.81
	FLOW2	0.800			
	FLOW3	0.757			
Usage cost (COST)	COST1	0.867	0.73	0.89	0.88
	COST2	0.931			
	COST3	0.748			
Usage intention (USE)	USE1	0.858	0.73	0.89	0.89
	USE2	0.841			
	USE3	0.870			

Table 2 Square root of AVE (shown as bold at diagonal) and factor correlation coefficients

	PEOU	CNQ	CTQ	SOI	FLOW	COST	USE
PEOU	**0.846**						
CNQ	0.514	**0.783**					
CTQ	0.326	0.489	**0.768**				
SOI	0.177	0.330	0.468	**0.864**			
FLOW	0.473	0.510	0.550	0.256	**0.772**		
COST	−0.124	−0.211	−0.174	0.153	−0.234	**0.852**	
USE	0.303	0.337	0.558	0.334	0.410	−0.218	**0.856**

Second, we adopted structural equation modeling software LISREL 8.7 to estimate the structural model. Figure 3 presents path coefficients and their significance. Table 3 lists the recommended and actual values of some fit indices. Except GFI, other fit indices have better actual values than the recommended values. This indicates a good fitness of the research model [8]. The explained variance of flow and usage intention is 54.7 and 29 %, respectively.

6 Discussion

As shown in Fig. 3, all path coefficients are significant, suggesting that H1–H6 were supported. Perceived ease of use, connection quality and content quality affect flow, which further affects usage intention. In addition, social influence and usage cost also affect usage intention.

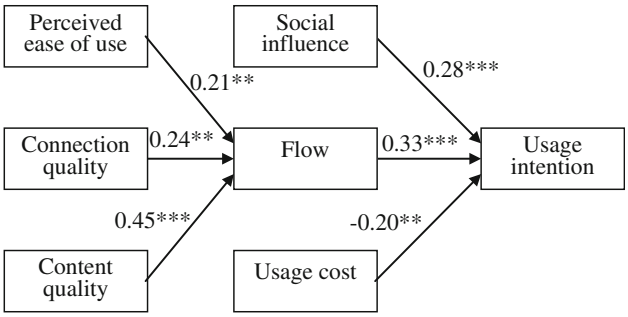

Fig. 3 Results estimated by LISREL. Note: $^{**}P < 0.01$; $^{***}P < 0.001$

Among the factors affecting flow, content quality has the largest effect ($\gamma = 0.45$). This provides support to Jung et al. [15], which identifies the effect of content quality on mobile TV user's flow. This suggests that users expect to experience mobile games with attractive and quality contents. Service providers need to develop mobile games with engaging topics and plots. Otherwise, users may feel bored when they have used the game for a period. In addition, service providers need to update mobile games according to user suggestions and comments. Service providers can also provide personalized contents to users based on their usage history and preferences. As it is difficult for users to search for information on the mobile internet, these personalized contents may help reduce their effort investment and improve their experience.

Connection quality also affects flow. Compared to other mobile services such as mobile news and search, mobile games need to download more data into mobile terminals. This requires that service providers offer a reliable and rapid connection to users. Otherwise, users may be frequently interrupted when they play mobile games. This may undermine user experience. In addition, mobile games may have thousands of players online simultaneously. To improve connection quality, service providers need to enhance their back-end servers and optimize mobile game design. For example, mobile games can download most data in the initialization phase. When users are playing games, they only need to download necessary data. This may help improve connection quality and user experience.

In addition to content quality and connection quality, perceived ease of use also affects flow. This is consistent with extant findings [4, 9]. Compared to desktop computers, mobile terminals have their constraints such as small screens and inconvenient input. This highlights the need to provide an easy-to-use interface to users. In addition, there exist multiple mobile terminal brands in the market, such as Apple, Samsung and Nokia. They have different

Table 3 Recommended and actual values of fit indices

Fit indices	χ^2/df	GFI	AGFI	CFI	NFI	NNFI	RMSEA
Recommended value	<3	>0.90	>0.80	>0.90	>0.90	>0.90	<0.08
Actual value	1.78	0.893	0.855	0.972	0.940	0.966	0.058

χ^2/df is the ratio between chi-square and degrees of freedom

GFI goodness-of-fit index, *AGFI* adjusted goodness-of-fit index, *CFI* comparative fit index, *NFI* normed fit index, *NNFI* non-normed fit index, *RMSEA* root mean square error of approximation

operation systems and screen resolution. This presents a challenge to service providers. They need to develop various versions of mobile games to suit user terminals. However, this investment may be worthy as users can more easily use mobile games and this helps them obtain a better experience. In addition, service providers can provide online tutorial to familiarize users with mobile games operation. This may also enhance their perceived ease of use.

Flow has a strong effect on usage intention. This provides support to extant results [17, 31]. This indicates that users are concerned with usage experience when determining to adopt mobile games, which represent an entertainment application. For this category of mobile services, users may not expect to acquire positive utility such as performance improvement. They pay more attention to usage experience to determine using mobile games.

Besides flow, social influence and usage cost also affect usage intention. Social influence reflects a process of compliance. When individual user's friends and peers recommend him or her to use a mobile game, the user may comply with their opinions. Service providers need to provide quality services in order to build a positive word of mouth, which may affect late users' adoption. In addition, service providers can also encourage extant users to invite their friends to join the game with incentives such as points and member level. The effect of usage cost on behavioral intention is negative. Users need to pay communication fees and transaction fees when playing mobile games. As communication fees are controlled by mobile operators, service providers can lower transaction fees to reduce usage cost. At present, many mobile games adopt free strategies to encourage user participation. They can make profit by charging for game props. On the other hand, service providers need to improve charge transparency. They cannot charge users without their knowledge or cheat them in paying for mobile games.

7 Theoretical and managerial implications

From a theoretical perspective, this research examined the effect of flow on user adoption of mobile games. As noted earlier, extant research has focused on examining mobile user behavior from information technology perspectives, such as TAM, IDT, TTF and UTATU. These perspectives are mainly concerned with the effects of extrinsic motivations such as perceived usefulness and performance expectancy on user behavior. However, the effect of intrinsic motivation such as flow has seldom been examined. This research tries to fill the gap. The results indicated that flow has a significant effect on mobile game user behavior. This suggests that researchers need to pay more attention to user experience when examining mobile user behavior, especially in the context of mobile entertainment services, such as mobile games. We found that perceived ease of use, connection quality and content quality have significant effects on flow. These results enrich extant research on flow and advance our understanding of user experience. Both social influence and usage cost are found to affect usage intention. This provides further support to UTAUT, which has been validated in the contexts of mobile data services and mobile technologies.

From a managerial perspective, our results imply that service providers need to improve users' experience in order to facilitate their adoption and usage of mobile games. We found that content quality, connection quality and perceived ease of use affect flow. This indicates that service providers should offer mobile games with attractive and rich contents to users. They also need to simplify mobile games operation and provide reliable connection to users. Otherwise, users' experience may be undermined, and they may drop using mobile games. The results also indicate that social influence and usage cost affect usage intention. Service providers can use word-of-mouth effect to encourage user adoption of mobile games. They also need to reduce usage cost such as transaction fees and improve charge transparency.

8 Conclusion

As an emerging service, mobile games have not received wide adoption among users. Drawing on the flow theory, this research identified the factors affecting mobile game user behavior. The results indicated that perceived ease of use, connection quality and content quality affect flow. Among them, content quality has the largest effect. Flow,

social influence and usage cost determine usage intention. The results imply that service providers need to attach importance to users' experience in order to facilitate their adoption and usage of mobile games.

This research has the following limitations. First, this research is conducted in China, where mobile internet is developing rapidly but still in its early stage. Thus, our results need to be generalized to other countries that had developed mobile internet. Second, besides flow, social influence and usage cost, there exist other factors such as trust and switching cost that possibly affect user behavior. Future research can explore their effects. Third, we mainly conducted a cross-sectional study. However, user behavior is dynamic. Thus, a longitudinal research may provide more insights into user behavior development.

Acknowledgments This work was partially supported by a grant from the National Natural Science Foundation of China (71001030) and a grant from Zhejiang Provincial Zhijiang Social Science Young Scholar Plan (G94).

Appendix: Measurement scales and items

Perceived ease of use (PEOU) (adapted from Jung et al. [15])
PEOU1: Learning to use this mobile game is easy for me.
PEOU2: Skillfully using this mobile game is easy for me.
PEOU3: I find this mobile game easy to use.

Connection quality (CNQ) (adapted from Kim and Hwang [19])
CNQ1: This mobile game has a rapid initial connection speed.
CNQ2: This mobile game has a rapid data transferring speed.
CNQ3: This mobile game has a stable connection.

Content quality (CTQ) (adapted from Jung et al. [15])
CTQ1: This mobile game provides up-to-date contents.
CTQ2: This mobile game provides attractive contents.
CTQ3: This mobile game provides contents pertaining to my needs.

Social influence (SOI) (adapted from Venkatesh et al. [38])
SOI1: People who influence my behavior think that I should use this mobile game.
SOI2: People who are important to me think that I should use this mobile game.

Flow (FLOW) (adapted from Lee et al. [22])
FLOW1: When using this mobile game, my attention is focused on the activity.
FLOW2: When using this mobile game, I feel in control.
FLOW3: When using this mobile game, I find a lot of pleasure.

Usage cost (COST) (adapted from Wu and Wang [42])
COST1: The access cost of using this mobile game is expensive.
COST2: The transaction fee of using this mobile game is expensive.
COST3: I feel that the usage cost of this mobile game is expensive.

Usage intention (USE) (adapted from Lee [23])
USE1: Given the chance, I intend to use this mobile game.
USE2: I expect my use of this mobile game to continue in the future.
USE3: I have intention to use this mobile game.

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