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LONG PAPER

Middle-aged adults' attitudes toward health app usage: a comparison with the cognitive-affective-conative model

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Abstract
Middle-aged adults have a stronger sense of urgency about health apps that not only enhance their health management but also help them administer self-treatment. However, middle-aged adults' attitudes toward health app usage have received surprisingly little scholarly attention, which has hampered the promotion of this kind of apps among them. To remedy this deficiency, this research specifically investigated this vital issue and presents findings contributory to promoting health apps. Our research findings indicated that (1) middle-aged adults with no health management habit tend to find health apps valuable and get a favorable impression about them, while those who already have the habit do not; (2) most middle-aged adults do not decide to use health apps out of sentimental reasons; and (3) middle-aged adults' confidence in using smartphones significantly influences their cognitive evaluation of health apps. In sum, these research findings suggested that middle-aged adults look at health apps in a non-affective manner, and their confidence in using smartphones facilitates their use of health apps.

Keywords Middle-aged adult · Attitude · Health app · Cognitive-affective-conative model

1 Introduction

People have set greater store by health management in recent years, because it not only helps them maintain their health, but also assists patients in treating their illnesses [7, 25, 36]. Health management refers to the process in which people gather, store, manage, and use health information to maintain a healthy lifestyle and reach desired health outcomes [30, 34]. Health management has proven to be useful for patients who want to treat their chronic illnesses caused by obesity, high blood pressure, diabetes, etc. [7]. For example, if patients with diabetes could record the connections between their blood sugar level and their diet, they would be able to control the former by adjusting the latter based on the record [36]. In this sense, health management plays a crucial role in preventing, early detecting, and managing chronic diseases, especially as the age of chronically ill patients decreases [9, 25].

Health apps have been regarded as a sort of the most convenient and useful tools for assisting people with their health management [10, 44]. Health apps generally refer to any app run on mobile devices that provides users with health or medical functions [4]. With the popularization of mobile devices and the increase of health awareness, this kind of apps has achieved explosive growth and amounted to tens of thousands in number on Apple App Store and Google Play [4, 44]. Attention has, therefore, shifted to the improvement of these apps' usefulness and usability through user-centered design [35]. Specifically, the primary function of health apps is to allow the users to record and manage their health information, thereby enabling

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them to establish their own medical histories or monitor their health conditions [6, 44]. More importantly, health apps can chart the users' health information, which further helps them detect the change in their health conditions and take self-care accordingly [10, 25]. Furthermore, the information collected through this kind of apps can be a valuable source of reference for clinicians to make clinical decisions [9, 10]. In sum, we may use health apps as a convenient way to manage our own health information, so as to reach our desired health conditions and particularly to raise our health awareness [18].

When it comes to health apps, middle-aged adults are the most suitable users for they not only care about their own health, but also predisposed toward this kind of new technologies. On a more specific basis, middle-aged adults are well aware that they will soon encounter the health problems plaguing the elderly [9]. Meanwhile, as social pressure increases and the environment deteriorates, the age of middle-aged adults with chronic illnesses decreases while their number increases [9]. Therefore, it is urgent for middle-aged adults to manage their health, since prevention is better than cure, and health apps will serve to facilitate the prevention and early detection of chronic illnesses [9, 25]. Unlike the elderly, middle-aged adults use mobile devices more frequently [9] and are more willing to accept new technologies [7]. As a result, promoting the use of health apps among middle-aged adults demands immediate attention because they are more concerned with their own health conditions than young people and are more willing to try new technologies than the elderly.

In this context, investigations into middle-aged adults' attitude toward health app usage are urgently required because they will help facilitate the universal access to this kind of apps among middle-aged adults. Universal access means enabling everybody to access technology [27, 38], so that middle-aged adults' attitudes toward health apps can be used as a criterion to assess whether they are prepared to use this kind of technologies [1]. As a matter of fact, every technology successfully applied to real life entails users' positive attitudes toward it, which is why the users are willing to try it and make it part of their quotidian existence [21–23, 28, 40]. In other words, middle-aged adults, who have been more willing to embrace new technologies than the elderly [7], will be neither positive nor willing to use technologies that are not useful, usable, and easily accessible [19]. Accordingly, investigating middle-aged adults' attitudes toward new technologies is essential, for they help identify the key factors that affect middle-aged adults' attitudes toward health apps. More importantly, the research findings in this regard not only help developers improve the universal access of these apps, so as to meet the users' needs of all stripes and enable middle-aged adults to be assisted by such apps [1, 33], but also allow their promoters to formulate effective promoting strategies for the practical application of such apps [24].

Bearing these issues in mind, this research seeks not only to investigate middle-aged adults' attitudes toward health app usage but also to identify the decisive factors behind their attitudes. To fulfill this objective, this research adopted the cognitive-affective-conative (CAC) model [12] and treated facilitating conditions and smartphone self-efficacy as the external and internal factors, respectively. A research model was developed comprising facilitating conditions, smartphone self-efficacy and the CAC model, and sophisticatedly designed a questionnaire based on the research model to investigate the subjects' opinions on the health app introduced to them. The data collected from the questionnaire were used for analyzing the subjects' attitudes toward the health app, including the influences of facilitating conditions and smartphone self-efficacy. The research undertook two pioneering efforts. The first is adopting the CAC model to depict middle-aged adults' attitudes toward health app usage, and the second is investigating the factors that influence their attitudes toward this type of apps. The two efforts are of great significance because, on the one hand, few studies gave prominence to this issue, and, on the other, the findings of this research contribute to the theoretical development of this field and its practical promotion.

2 Theoretical background and related studies

The CAC model is an age-old theory [12] that has been widely used to depict the formation of attitude [2, 11, 31]. The term attitude refers to "a person's general feeling of favorableness or un-favorableness toward some stimulus object" [12: 216]. To put it another way, attitude can be construed as a person's overall evaluation of an object, and the estimation is based on personal affective, cognitive, and conative responses [12, 31]. Affective response refers to "a person's feelings toward and evaluation of some object, person, issue, or event" [12: 12]. Accordingly, affective response can be treated as a person's emotional response to an information system [29], which may be positive or negative feelings that lead to favorable or unfavorable evaluation of the system [26]. Cognitive response refers to a person's knowledge, opinions, beliefs, and thoughts about a given object [12: 12], which can be viewed as a person's perception of an information system [26], and the perception consists of perceived ease of use and perceived usefulness [29, 31]. Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free from effort", and perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance"

[8: 320]. Conative response refers to a person's behavioral intentions and his/her actions with respect to or in the presence of a given object [12: 12]. Thus, conative response can be deemed as a person's behavioral intention of using an information system [26]. Behavioral intention is defined as "a person's subjective probability that he will perform some behavior" [12: 288], in other words, the possibility for a person to use the system. Based on these definitions, we may notice that cognitive response directly influences affective response, which in turn affects conative response [26, 29, 31]. For instance, if a person holds a positive belief and perception about a given technology, he/she would have a positive feeling and evaluation of the technology, based on which he/she reinforces his/her behavioral intention of using the technology (i.e., cognition → affect → conation).

The successful development of the CAC model has prompted many researchers to employ it to investigate users' attitudes toward information systems, that is, to explore the relationships among cognition, affect, and conation. Combining the CAC model, social influence, and so forth, for example, Li [29] developed a model to investigate what factors significantly influence employees' conative response when firms introduce new information systems. In Li's study, perceived ease of use and perceived usefulness of the information system served as cognitive response, while social influence as external factors. Her research not only revealed that social influence has direct effects on cognitive response and affective response, but also produced an unexpected outcome, that is, affective response exerts no significant influence on conative response. This is because when we simultaneously examine the influences of cognitive response and affective response on conative response, the influence of cognitive response may occasionally override that of affective response on conative response, making affective response play no role at all. This situation occurs especially when an information system is going to be used in an organization for a long time, because functions are the overriding consideration of its users, who would not use the system if it failed to perform the functions they need, even though they have a positive affective response to it. Similarly, Kim et al. [26] used the CAC model as their theoretical framework to reveal the determinants of users' conative response to the use of mobile technology, in which utilitarian and perceived values served as cognitive response, hedonic motivation and satisfaction as affective response, and users' engagement intention as conative response. Their results showed that conative response is significantly influenced by the perceived value of cognitive response and the satisfaction of affective response. Lin [31] also employed the CAC model, and the uses and gratifications theory (a theory explaining why people seek out specific media to satisfy their specific needs) to discover the reason why people have an intention to read pieces of citizen journalism. Specifically, he used five gratifications (i.e., pastime, entertainment, relaxation, escape, and surveillance motives for local news) as cognitive response and examined their effects on affective and conative responses. The results of his study suggest that all gratifications except escape have direct effects on people's attitudes toward reading pieces of citizen journalism (i.e., affective response), which in turn influences their intention to read these pieces of news (i.e., conation response).

3 Research design

3.1 Research questions

Our investigation was structured around the following research questions:

1. What are the middle-aged adults' attitudes toward health app usage?
2. Do the middle-aged adults who are in a health management habit and those who are not share a common attitude toward health app usage?

3.2 Research model and hypotheses

Figure 1 shows the research model developed based on the CAC model. Our research model exhibits two unique characteristics. First, it is different from other commonly applied models such as the technology acceptance model [8, 21–24]. In our research model, perceived ease of use and perceived usefulness jointly operate as a second-order formative construct. Since perceived ease of use and perceived usefulness represent users' perception of an information system, i.e., their subjective evaluation of the system [29, 31], the two constructs may also serve as the indicators of middle-aged adults' cognitive response to health apps. The two separate constructs operating as a single second-order formative construct made this research distinct from previous studies. This approach simplified the research model so that we could focus our attention on the relationships among cognitive, affective, and conative responses. Nonetheless, since the relationships among perceived ease of use, perceived usefulness, affective response, and conative response have been extensively and deeply investigated in previous studies [8, 21–24], carrying out a similar investigation would be equal to reinventing the wheel. Second, our research model modified the CAC model by including the constructs of facilitating conditions and smartphone self-efficacy, rendering itself more adequate for the task of investigating middle-aged adults' attitudes toward health app usage. Specifically, smartphones are not as popular among middle-aged adults as they are among young people, which implies

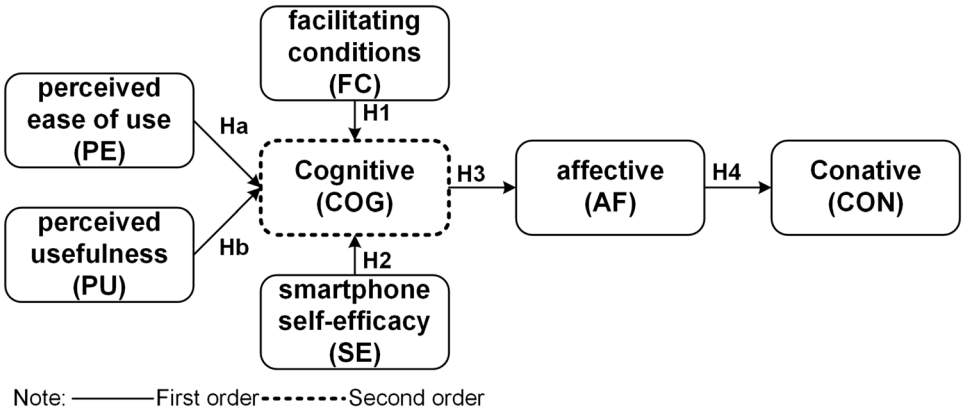

Fig. 1 Research model

that the former's attitudes toward health app usage may be influenced by other factors. For instance, if they are offered assistance to solve problems (i.e., external factors) they have in using a health app, their negative attitudes would be mitigated because problems were solved. Similarly, if they have greater confidence in using smartphones (i.e., internal factors), they would overcome the problems on their own and immerse themselves in the health app. As a result, we treated facilitating conditions and smartphone self-efficacy, respectively, as the external and internal factors that affect middle-aged adults' attitudes toward health app usage in our model. In sum, four hypotheses were formulated accordingly and explicated below.

Facilitating conditions denote any supporting measure for assisting users in using an information system, such as problem-solving program or educational training [39]. Therefore, facilitating conditions are often regarded as an important factor that influences users' willingness to use the technology in question. For example, users would continue to use a given technology if someone can help them solve the problems they encounter when using it. Alternatively, providing users with educational tutorials before they use the technology may also familiarize them with it more quickly. Thus, researchers often investigate the influence of facilitating conditions on users' cognitive response to an information system [21, 39, 41, 42]. For instance, Teo [39] found that facilitating conditions play a significant and positive role in practicing teachers' cognitive response to new technologies, i.e., their perceived ease of use and perceived usefulness. Huang [21] also proved that facilitating conditions indeed positively and significantly affect users' perceived ease of use and perceived usefulness of a given technology. Similarly, Terzis and Economides [41] showed that facilitating conditions significantly affect users' perceived usefulness of a computer-based assessment, while Terzis et al. [42] further identified that facilitating conditions have a significant influence on users' perceived ease of use of a computer-based assessment. Accordingly, the first hypothesis of this research is formulated as follows.

H1. Facilitating conditions has a positive effect on cognitive response.

Smartphone self-efficacy is a construct derived from the concept of self-efficacy. The concept refers to a person's belief in his/her own ability to perform a certain task [3]. Smartphone self-efficacy is defined as a person's belief in his/her ability to carry out a certain task with a smartphone. Studies have pointed out that people's experience may influence their self-efficacy, which will in turn affect the outcome of the task they undertook [3, 15, 17]. For example, users with previous exposure to technology were better able to perform usability tests, with only 25% overestimating their own results, whereas more than half of users without previous experience overestimated their own results [20]. In addition, higher self-efficacy breeds stronger confidence, which implies that the person will believe much firmly that he/she can handle this task, will not give up easily when confronting problems, and will eventually outperform those who have lower self-efficacy. For example, Teo [39] found that computer self-efficacy has a significant influence on practicing teachers' perceived usefulness because the teachers who have higher computer self-efficacy do not give up using a given technology easily and tend to discern the usefulness of that technology. Wang et al. [43] also discovered that computer self-efficacy significantly influences teachers' perceived ease of use about cloud services, and Liu and Huang [32] proved that computer self-efficacy has a positive and significant influence on users' perceived ease of use and perceived usefulness (i.e., their cognitive response) about simulation technology. Based on the abovementioned studies, we formulated the second hypothesis as follows.

H2. Smartphone self-efficacy has a positive effect on cognitive response.

The CAC model has been widely applied to analyze people's attitudes, including cognitive, affective, and conative responses [2, 11, 31]. Many studies have revealed that users' cognitive evaluation of a given technology may influence their affective evaluation of that technology, by which their conative evaluation of it will be affected [2, 11, 31]. For

instance, when users have a positive cognitive response to a technology, say, they perceive it as easy to use or useful, they will make a positive affective response to that technology, i.e., they will prefer to use it or find delight in using it. Then, their positive affective response will generate their positive conative response. In other words, they will continually use that technology. Based on the literature review of the CAC model, we formulated the third and fourth hypotheses as follows.

H3. Cognitive response has a positive effect on affective response.

H4. Affective response has a positive effect on conative response.

3.3 Measurement

A structured questionnaire was developed by reference to some previous studies [8, 29, 32, 39, 41, 43]. The questionnaire includes six constructs: to wit, facilitating conditions, smartphone self-efficacy, perceived ease of use, perceived usefulness, affective response, and conative response. These questions were designed by reference to the studies in recent years [29, 39, 41], in which each construct contains 2–4 questions. We ergo adopted the middle value and developed three items for each construct in our model. The final questionnaire was distributed to the subjects who were asked to indicate their level of agreement with the statements using a five-point Likert scale (Table 1).

3.4 Health app

We applied an app called "Little Health Secretary" to this research. The app was developed by a renowned pharmaceutical company according to the data (e.g., health information) derived from the Ministry of Health and Welfare, Taiwan, ROC. The source of data lent high credibility to this research. The app provides multiple functions such as health record, medication reminder, health news, self-diagnosis, and health encyclopedia. Health record enables the users to record the data of their health management, including body weight, blood pressure, blood sugar level, allergy, and daily record (illustrated in Fig. 2). Medication reminder allows the users to set the time for taking medicine, and the app will inform the users at the designated time. Health news provides the users with health-related news, so that they can obtain updated health information. Self-diagnosis offers the users several scales such as the questionnaire concerning tobacco addiction, which allows the users to make self-diagnosis for early detection and treatment. Health encyclopedia gives the users instant and direct access to information

Table 1 The final questionnaire

Construct	Item	References
Facilitating conditions	(FC1) When I need help to use the app, someone is there to help me (FC2) When I need help to learn how to use the app, someone is there to teach me (FC3) When I need someone to demonstrate how to use the app, someone is there to help me	Teo [39], Liu and Huang [32], Wang et al. [43]
Smartphone self-efficacy	(SE1) I can use a smartphone to find any information I need (SE2) I was fully able to use a smartphone before I began using the app (SE3) I could complete a task using a smartphone if someone showed how to do it first	Liu and Huang [32], Terzis and Economides [41], Wang et al. [43]
Perceived ease of use	(PE1) I think that the app is easy to use (PE2) I think that learning to use the app is easy (PE3) I think that the operation of the app does not require too much time	Davis [8], Liu and Huang [32], Wang et al. [43]
Perceived usefulness	(PU1) I think that the app is useful to assist me in managing my health record (PU2) I think that the app is useful to assist me in managing my health record conveniently (PU3) I think that the app can increase my efficiency in managing my health record	Davis [8], Liu and Huang [32], Wang et al. [43]
Affective	(AF1) I think that the app makes the management of health record more interesting (AF2) I think that using the app is fun (AF3) I like using the app to manage my health record	Li [29], Liu and Huang [32], Wang et al. [43]
Conative	(CON1) I intend to use the APP in the next <n> months (CON 2) I predict I would use the system in the next <n> months (CON 3) I plan to use the system in the next <n> months	Li [29], Liu and Huang [32]

Fig. 2 Screenshot of the health app

about common illnesses, such as the symptom description of hypertension or the reasons why people have hypertension, through which the users may deepen their understanding of these illnesses.

3.5 Participants and procedure

The subjects who volunteered to participate in this research were 90 adults, of which six adults were invalid subjects due to their age (over 65 years). As a result, a total of 84 middle-aged adults (i.e., valid subjects) were included in this study, their age ranging from 45 to 65. Since this research was conducted in a Tainan-based university, we randomly sampled the faculty members of the university and the residents living in the vicinity qualified as middle-aged adults. Table 2 shows the statistical data about the subjects. We developed a questionnaire to collect the information about the subjects, including their age, gender, educational background, and whether they have a health management habit, indicated by yes/no options. Among the subjects, females are roughly proportionate to males. Most of them reach the education levels of senior high school and university, and nearly half of them have a health management habit.

The data collection proceeded in three steps. First, we selected the subjects randomly and asked them about their age. We explained the purpose of this research to those who meet the criteria of middle-aged adult and asked whether they are willing to participate. Second, we provided each of the volunteered subjects with a smartphone on which the Little Health Secretary was installed; then we explained its functions, and instructed them to use it. We then asked the subjects to operate each function of the app personally and helped them overcome the difficulties in using it, so as to ensure that they gained a comprehensive understanding of this app. The orientation session lasted for approximately 30 min. Finally, after the subjects were familiarized with the app's operation, we requested them to fill in the questionnaire to know their opinions about it.

Table 2 Sample descriptive statistics

	Count	(%)
Gender		
Male	45	53.57
Female	39	46.43
Education level		
Elementary school	5	5.95
Junior high school	9	10.71
Senior high school	43	51.19
University	20	23.81
Master	3	3.57
Ph.D	4	4.76
Health management habit		
Yes	44	52.38
No	40	47.62

4 Results

The partial least squares approach (PLS) was adopted to analyze the data collected from the questionnaire. It is a multivariate analysis more suitable than structural equation modeling (SEM) for tackling non-normal distributed samples or a small sample size [5]. The SmartPLS 3 software was applied to perform the PLS, which includes the measurement and the structural models. The measurement model was employed to examine both the reliability and the validity of the questionnaire, and the structural model to explore the relationships among the hypotheses formulated according to the research model.

4.1 Measurement model

This research assessed the measurement model in terms of item loadings, reliability of measures, convergent validity, and discriminant validity. An item would be viewed as reliable if its loading is greater than 0.7 [5]. The reliability of

Table 3 The item loadings of the measurement model

Construct	Items	Loading	Standard error	*p* value
Facilitating conditions	FC1	0.94	0.06	0.00
	FC2	0.94	0.10	0.00
	FC3	0.94	0.10	0.00
Smartphone self-efficacy	SE1	0.92	0.03	0.00
	SE2	0.85	0.05	0.00
	SE3	0.91	0.03	0.00
Perceived ease of use	PE1	0.92	0.02	0.00
	PE2	0.92	0.03	0.00
	PE3	0.87	0.03	0.00
Perceived usefulness	PU1	0.91	0.03	0.00
	PU2	0.93	0.02	0.00
	PU3	0.93	0.02	0.00
Affective	AF1	0.92	0.02	0.00
	AF2	0.94	0.02	0.00
	AF3	0.92	0.02	0.00
Conative	CON1	0.98	0.01	0.00
	CON2	0.99	0.01	0.00
	CON3	0.99	0.01	0.00

Table 4 Reliability of measures and convergent validity of the measurement model

Construct	Reliability		Convergent validity
	Composite reliability	Cronbach's alpha	AVE
Facilitating conditions	0.97	0.95	0.90
Smartphone self-efficacy	0.92	0.87	0.80
Perceived ease of use	0.93	0.89	0.82
Perceived usefulness	0.95	0.91	0.85
Affective	0.95	0.92	0.86
Conative	0.99	0.98	0.97

measures was evaluated by composite reliability with its minimum value of 0.7 and Cronbach's alpha with its minimum value of 0.6 [14]. We employed the average variance extracted (AVE) to assess the convergent validity, and the value has to exceed the standard minimal level of 0.5 [14] to make the assessment significant and acceptable. The discriminant validity was assessed by the square root of AVE and latent variable correlations. To make the assessment significant and acceptable, each construct's square root of AVE must exceed its correlation coefficient with the other constructs in the model [13]. Tables 3, 4, and 5 indicate that the results delivered by the measurement model are significant and acceptable, since all the values meet the required standards.

4.2 Structural model

The structural model was employed to test the hypotheses developed in the research model. The test was based on the path coefficients and the R^2 values, in which the former served as the indicator for the statistical significance of the hypotheses, and the latter revealed the model's ability to explain the variation in the dependent variables [5]. Four path coefficients are demonstrated in Fig. 3. First, the path coefficient between facilitating conditions and cognitive response was 0.14, $p > 0.05$, effect size 0.02 s; second, the path coefficient between smartphone self-efficacy and cognitive response was 0.36, $p < 0.05$, effect size 0.13. Third, the path coefficient between cognitive response and affective response was 0.76, $p < 0.05$, effect size 1.35. Fourth, the path coefficient between affective response and conative response was 0.60, $p < 0.05$, effect size 0.55. Figure 3 shows the results of the structural model that highlighted the rejection of H1 and confirmed the other three hypotheses. It also illustrates that this model explained 19% of the variation in cognitive response, 58% in affective response, and 36% in conative response.

In addition to assessing middle-aged adults' attitudes toward health app usage, this research investigated the difference in attitude between adults with and without a health management habit. The structural models for the middle-aged adults with and without the habit, along with their results, are shown in Figs. 4 and 5, respectively. Furthermore, we employed the partial least square for multi group analysis (PLS-MGA) [16, 37] to examine whether the path coefficients in the two models differ. The results shown in Table 6 reveal that only one path coefficient (COG→AF)

Table 5 The discriminant validity of the measurement model

Construct		1	2	3	4	5	6
Facilitating conditions	1	0.95					
Smartphone self-efficacy	2	0.41	0.89				
Perceived ease of use	3	0.32	0.56	0.90			
Perceived usefulness	4	0.22	0.21	0.67	0.92		
Affective	5	0.26	0.39	0.68	0.70	0.93	
Conative	6	0.22	0.46	0.49	0.53	0.60	0.99

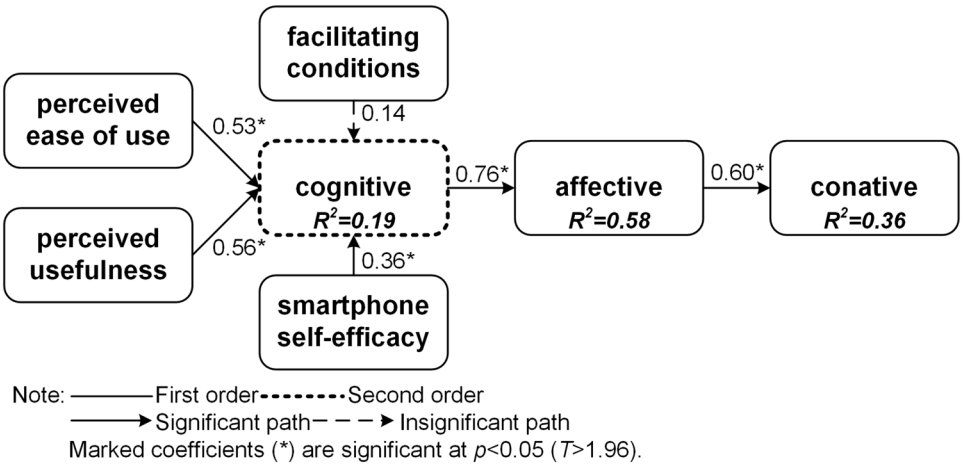

Fig. 3 The results of the structural model

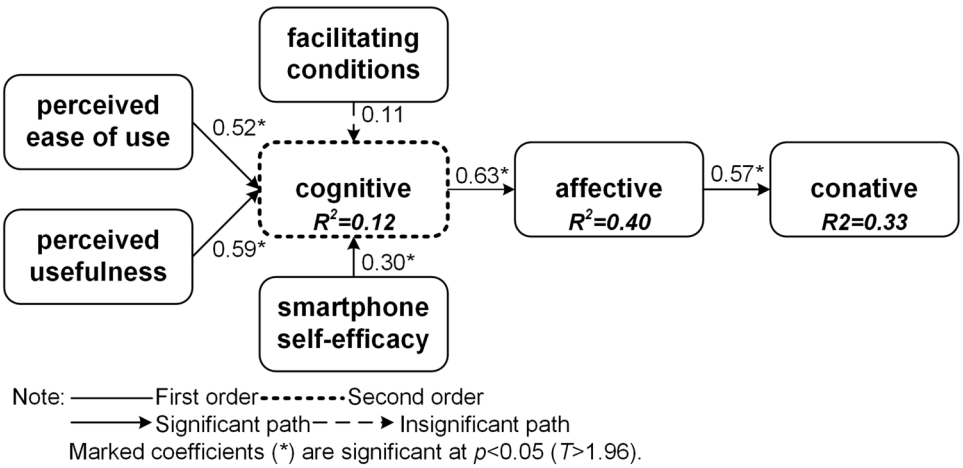

Fig. 4 Results of the structural model for subjects with a health management habit

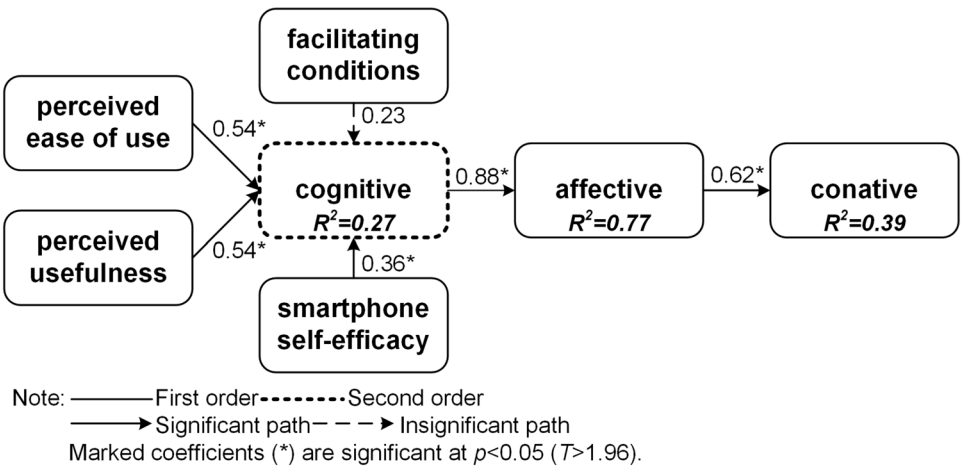

Fig. 5 The results of the structural model for subjects without a health management habit

significantly differs between the two models since its p value is larger than 0.95 at the 5% probability of error level.

5 Discussion

First of all, Fig. 3 reveals a very intriguing finding, that is, about half of the subjects had a favorable impression

Table 6 PLS-MGA results

Hypothesis	Group 1 (with the habit)		Group 2 (without the habit)		Group 1 vs. Group 2	
	Path coefficient	*p* value	Path coefficient	*p* value	Difference in path coefficient	*p* value
H1 (FC → COG)	0.11	0.35	0.23	0.17	0.12	0.74
H2 (SE → COG)	0.30	0.03	0.36	0.04	0.06	0.61
H3 (COG → AF)	0.63	0.00	0.88	0.00	0.25	0.99
H4 (AF → CON)	0.57	0.00	0.62	0.00	0.05	0.60

about the health app for its ease of use and usefulness. Moreover, they did not use the app simply out of their favorable impression about it. To be more specific, two phenomena existed in the CAC model shown in Fig. 3. The first is that cognitive response played a positive and significant role in influencing affective response, in which the former explained 58% of the variation in the latter. This implies that about half of the subjects had a positive affective response to the health app due to its ease of use and usefulness. This finding is consistent with those in most of the previous studies, i.e., users usually have a favorable impression about a given technology when they perceive its ease of use and usefulness [21–23, 25, 29]. The second phenomenon revealed in the model is that affective response exerted a significant and positive influence on conative response, though the former explained only 36% of the variation in the latter. This implies that only one-third of the subjects was willing to use the app even though most of them had a positive impression about it. To put it differently, most of the subjects did not use the app out of sentimental reasons. A plausible explanation for this is that most of the subjects made a rational evaluation before deciding whether to use the app. The reason why they made a rational evaluation rather than sentimental judgement was probably because the health app is designed for long-term use. This inference echoes Li [29], in a study pointing out that users' cognitive response is the key factor behind their long-term use of a given information system, as the system is sustainable and reliable only when it is perceived as useful and easy to use.

Figures 4 and 5 further present two findings. The first is that the subjects with no health management habit were exactly those who got a positive impression about the health app for its ease of use and usefulness. The second is that most of the subjects, whether having a health management habit or not, did not use the health app simply because they had a positive impression about it. Specifically, two phenomena existed in the CAC models shown in Figs. 4 and 5. Figure 4 shows that the cognitive response explained 40% of the variation in the affective response, while Fig. 5 illustrates that the cognitive response explained about 80% of the variation in the affective response. Table 6 further demonstrates a significant difference between Figs. 4 and 5 in the influence of cognitive response on affective response. Taking a synthetic view on Figs. 4, 5 and Table 6, we may see that most of the subjects with no health management habit got a positive impression about the health app because of its ease of use and usefulness, while only a few of the subjects in the habit were the case. Besides, the cognitive response of the subjects without a health management habit influenced their affective response to a greater extent than the case of the subjects in the habit. A plausible explanation for this is that subjects with the habit were predisposed to evaluate their affective response to the health app on the basis of their experience in health management. Lacking this kind of experience, in contrast, the subjects without a health management habit could only evaluate their affective response to the app by its ease of use and usefulness. This inference confirms the study by Wang et al. [43] which showed that experienced users tend to decide according to their own experience, while inexperienced users make decision by reference to external factors. Figures 4 and 5 commonly indicate the second phenomena, i.e., that the response affective explained about 33% of the variation in the conative response. This implies that most of the subjects, whether having a health management habit or not, did not use the health app simply out of their positive impression about it. This phenomenon confirms the results illustrated in Fig. 3, which means that the subjects' affective response was not a key factor behind their intention to use the app.

Finally, Figs. 4 and 5 also present a striking finding, that is, whether the subjects have a health management habit or not, their cognitive response was influenced not so much by facilitating conditions as by their own smartphone self-efficacy. This implies that educational tutorial or problem-solving assistance failed to help them perceive the ease of use and usefulness of the health app; instead, their confidence in operating the smartphone significantly influenced their cognitive response to the app. This finding is quite thought-provoking because it contradicts those of a majority of related works on this topic, though it confirms a small number of previous studies. On a more specific basis, many studies have proved that facilitating conditions such as educational training or problem-solving assistance are helpful for users to perceive the ease of use and usefulness of technologies [21, 39, 41, 42]. However, a small number

of studies instead discovered that facilitating conditions are not necessarily helpful in this way [32, 45]. For example, Liu and Huang [32] found that facilitating conditions exert no positive and significant influence on students' perceived ease of use of simulation technology. Manpower shortage was a probable reason, since in the design of that study there was only one teacher available for the group of students to solve the problems they faced when using the simulation technology. Yueh et al. [45] also suggested that facilitating conditions do not positively and significantly prompt users to use a Wiki. In that study, the severely limited amount of time for educational tutorial was a probable reason, which prevented the users from fully knowing how to operate a Wiki. From this research, we can reasonably infer that the limited amount of time for educational training was the primary cause of this phenomenon, since the volunteered subjects were randomly selected so that most of them could spend a very short period of time with this research, which undermined the quality of educational training they received. This limit prompted most of the subjects to use the health app on the basis of their own smartphone self-efficacy, the key factor that solely and significantly affected their cognitive response to the app.

6 Conclusions

As people's health awareness increases every day, health apps have become indispensable for middle-aged adults to enhance their health management and administer self-treatment for chronic illnesses. However, middle-aged adults' attitudes toward health app usage have received surprisingly little scholarly attention to date, which has hampered the promotion of this type of technologies, since the promoters or developers of health apps cannot achieve effective promotion or improvement without knowing middle-aged adults' attitudes toward these apps. To remedy this situation, this research employed the CAC model to investigate this very issue, thereby encouraging middle-aged adults in using health apps. Our research findings indicated that (1) most middle-aged adults with no health management habit tend to get a favorable impression about health apps because they find them useful and easy to use, while only a few middle-aged adults who already have the habit are the case; (2) most middle-aged adults, whether having a health management habit or not, do not decide to use health apps out of sentimental reasons; and (3) middle-aged adults' smartphone self-efficacy significantly influences their cognitive response to health apps. These findings greatly deepened our understanding of middle-aged adults' attitudes toward health apps.

In addition, these findings carry three major implications. First, the ease of use and usefulness of health apps will give middle-aged adults in no health management habit a favorable impression. This implies that promoters must highlight these aspects if they want to encourage these middle-aged adults in using health apps. Second, middle-aged adults' favorable impression about health apps is by no means the decisive factor at play behind their intention to use this type of apps. This implies that middle-aged adults decide to use these apps not so much for sentimental reasons as in their rational evaluation. In other words, promoters must inform middle-aged adults of the importance of health apps in a non-affective way, thereby reinforcing their willingness to use this kind of apps. For instance, promoters may present them with pieces of convincing evidence on the merits of health apps rather than simply express the benefits orally. Third, middle-aged adults' smartphone self-efficacy is the decisive factor behind their cognitive response to health apps. This implies that promoters may need to place a higher priority on those who have high smartphone self-efficacy, because they usually operate health apps all by themselves. To put it another way, these adults tend to rely on their own abilities (i.e., smartphone self-efficacy) when they try to solve the problems arising from their use of these apps. Comparing with their counterparts who have lower smartphone self-efficacy, they are more capable of solving those problems and hence have greater possibilities to comprehend the merits of health apps for their health management. Otherwise, developers have to design a new health app which grants universal access for middle-aged adults irrespective of their smartphone self-efficacy.

Despite their contribution to the development and application of health apps, these findings do have some limitations. First, this research focused simply on one health app. In our future research, we need to address the question as to whether other health apps will deliver similar results. Second, since the subjects in this research were randomly selected and involved for only a short period of time, we may wonder whether the findings of this research are generalizable if the subjects spend more time on this kind of survey. Therefore, we plan to undertake a more comprehensive and long-term study on the influence of facilitating conditions on cognitive response. Third, this research focused only on the middle-aged adults living in a specific area in southern Taiwan. The question as to whether the findings of this research are generalizable to those living in other regions remains unanswered. Accordingly, we will widen our scope of survey, enlarge our sample size, and take additional considerations on subjects' backgrounds such as age, gender, educational level, and experience in using smartphone, so as to construct a full picture of middle-aged adults' attitudes toward health app usage, and thereby strengthen and advance the arguments developed in this research.

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