Generation Z & Y preferences of user acceptance of mobile health recommender systems

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Abstract

Mobile health (mHealth) applications provide equal reach to health care services at an affordable cost. mHealth can play a major role in enhancing the quality and access of health services in developing countries, still the adoption of mHealth in these countries is very low. On the other hand, younger generations have great dependence on mobile devices and have high potential to adopt mobile applications. The aim of this study is to investigate factors that affect user acceptance of mobile health recommender system among Generations Z (between 10 and 25 years old) & Y (between 26 and 40 years old). The research adopts Technology Acceptance Model (TAM3) constructs and extends them to include constructs related to Trust and Reputation, as mHealth is prone to uncertainty and vulnerability. Based on 136 valid responses collected from a survey, structural equation modelling SEM was employed to examine the research questions. The data were analyzed using the Partial Least Squares (PLS) method. The results suggested that for generations Z & Y, Perceived Usefulness has a significant positive effect on behavioral intention to use mobile health recommender system. This direct relationship is affected by user characteristics, namely gender and experience using technology. Perceived Ease of Use and Trust in mHealth applications, significantly increase the Perceived Usefulness. The results reveal the importance of perceived reputation in building Trust in mHealth applications, and it is found that Output Quality has a positive influence on Reputation. Computer anxiety has a negative effect on Perceived Ease of Use. These findings provide a basis for improving the understanding toward factors affecting mHealth applications in developing countries. The study provides number of practical design recommendations for designers and service providers.

Introduction

Mobile Health (mHealth) is the support of mobile technologies in practice of medicine and public health services. Mobile technologies include mobile phones, tablets, PDAs, as well as wearable devices, to access health services, and to collect health data from users. The global mHealth market size witnessed a huge growth in the past few years, especially during the COVID'19 pandemic. mHealth business is expected to reach $102.4 billion in 2022 (Silicon IT Hub, 2022). Currently, there are many mHealth applications available in the market and many more are said to hit the market in the coming future. mHealth applications can be divided into five categories, as following: (1) Remote Monitoring Applications: track users' conditions in their homes, by reading blood glucose levels, oxygen level, heart rate, and blood pressure, allowing doctors to monitor the case without visiting the patient. (2) Clinical and diagnostic Applications: report lab results, and assess patients' health records, assisting doctors to check the symptoms and diagnose the illness. (3) Healthy Living Applications: track heart rates, daily diet, exercise, sleep, and suggest personalized healthy lifestyle. (4) Service Recommender Applications: on-demand healthcare application for searching and booking licensed health services. The current study focusses on Service Recommender Application. In these applications, search engine and customers' reviews can help users select a health services and book appointment.

Mobile Health can play a major role in enhancing the quality and access of health services in developing countries, On the other hand, despite the large use of mobiles in developing communities, still the adoption of mHealth in these communities is very low (Mansour, 2017). There is a severe shortage in literature investigating ways to increase the adoption of mHealth is developing countries, such as Egypt. There is a real need for empirical research to investigate how Egyptian users perceive such applications, and what are the factors affecting their use. This study is investigating factors affecting adoption of mHealth applications in Egypt. Based on the Technology Acceptance Model, this study is aiming to confirm a hypothesized significant relationship between variety of constructs, and the behavioral intention to use mHealth applications. The findings would assist designers and health service providers to meet the expectations of users and improve the applications adoption.

Literature review

The Technology Acceptance Model, TAM, developed by Davis (Davis, 1989) is the most used framework in predicting information technology adoption and acceptance (Paul, John and Pierre, 2003). There are other theories of technology acceptance namely the theory of planned behavior (TPB), value attitude behavior model (VAB), theory of reasoned action (TRA), and Unified Theory of Acceptance and Use of Technology (UTAUT) (Cao et al., 2020), among them, the TAM is the most influential model for technology adoption.

TAM model suggests number of factors that influence users' decision to use new technologies. TAM suggests that there are two factors that determine whether a computer system will be accepted by its potential users: (1) Perceived Usefulness, and (2) Perceived Ease of Use. The model suggests that Perceived Ease of Use has a causal antecedent to Perceived Usefulness, rather than being a direct cause of technology adoption behavioral intention.

Venkatesh and Bala further enhanced TAM and produced the TAM3 model (Venkatesh and Bala, 2008) that covered various determinants of perceived usefulness and perceived ease of use. They classified the determinants into four categories: (1) system characteristics, (2) individual differences, (3) social influence and (4) facilitating conditions. System characteristics covered Output quality, Result demonstrability, Objective usability and Computer self-efficacy. Individual differences covered Computer anxiety, Computer playfulness, Perceived Enjoyment, Personal innovativeness and Job relevance. Social influence covered Image and Subjective norm, whereas Facilitating conditions covered external control factors such as Access to infrastructure and technology appliances.TAM3 points to Experience as an important moderating factor. Venkatesh and Bala indicate that with increasing hands-on experience with a system, a user will have more information on how easy or difficult the system is to use. In addition, Venkatesh and Bala found that experience also moderates the effect of computer anxiety on perceived ease of use, where with increasing experience, the effect of computer anxiety on perceived ease of use became weaker. Objective usability and perceived enjoyment become stronger determinants over time because effects of general computer beliefs (e.g., computer anxiety) will diminish with increasing experience.

Though the basic TAM3 presents a rigorous explanation in predicting the user's acceptance of technology, other studies in technology acceptance suggest that additional explanatory variables are needed depending on the specific technology context (Tom Dieck & Jung, 2015). In the following we explore additional determinants to TAM3 as suggested by different research contributions.

Trust & Reputation

Cao et al. (2020) suggest that due to the high *perceived risk* in online communities, it is critical to ensure users' *trust* in mobile health services. Similarly, Alam et al. (2020) indicate the importance of *perceived reliability* in mobile health services adoption. *Trust* is a governance mechanism in response to uncertainty, vulnerability, and dependence (Bradach and Eccles, 1989). Doney and Cannon (1997) indicate that *reputation* can be defined as the extent to which buyers believe a selling organization is honest and concerned about its customers. Jarvenpaa et al. (2000) argue that buyer *trust* in an Internet store is positively influenced by the store's *perceived reputation*. Zhou (2019) examined the relationship among *privacy concern*, *trust* and motivations underlying the users' knowledge sharing intention in online health

community. It is concluded that both *information quality* and *service quality* positively affect trust in online community, as well as *privacy risk avoidance* is suggested to influence users' knowledge sharing intention in online communities. Similarly, Cao et al. (2020) indicate that doctors' *information quality* and *virtual presence service quality*, along with transfer-based experience (i.e., *trust in the offline* healthcare service) positively influence trust in mobile health services.

Output Quality

Quality is an important determinant of the long-term success of any electronic service intervention (Alter 2010). When shopping online, consumers rely on descriptions and customer reviews provided on the products that help consumer form an imagination of the product. Website information quality covers factors such as relevancy, clearness, timeliness, accuracy and consistency. Website quality is also related to user interface design features, like website ease of use, ease of navigation and interactivity, as well as technical properties of the Website such as response time and download time (McKinney et al., 2002). User perception of Website service quality can be improved through *personalized service* and privacy protection. This in turn will decrease the perceived risk and build the initial trust in online service (Cao et al., 2020).

Gender, Age, Experience as Moderating Factors

TAM3 assured the role of experience as a moderating factor in technology acceptance. This was supported by several research, for example Choi et al. (2010) suggested that prior experience has a moderating effect on technology acceptance of IP TV services in South Korea.

Although gender is considered as an important factor in technology adoption, original TAM makes no references of gender differences. Thus, gender, as a moderating factor, received less consideration in past technology adoption research compared with other factors such as age, culture and experience (Hoque, 2016). On the other hand, Alam et al. (2020) conclude that gender has a significant moderating effect on mHealth services adoption.

It is also reported modest m-health adoption in older generations. Fox & Connolly (2018) indicate that older generations reluctance stems from mistrust, high risk perceptions, and strong desire for privacy. In contrary, the younger generations have great dependence on mobile devices and have more potential to adopt mobile applications (Badillo-Torres et al., 2019). Generation Y represent those born in the decades of the 80s and 90s, are also called Millennials, and are considered the first digital natives. Whereas Generation Z are those born during the present millennium and tend to be impatient and very self-learning oriented due to their intensive use of the Internet (Campbell et al., 2015; Badillo-Torres et al., 2019). Having said that, little research is directed to study user acceptance behavior of the Millennium generations (Generation Y and Generation Z). This research is aimed to focus on preferences of those two generations in adopting mHealth applications.

Research Questions & Methodology

Research Method

The study uses structural equation modelling SEM technique, with Partial Least Squares (PLS) path modeling method, as the aim of the study is to explain and predict the theoretical constructs of user acceptance of mobile health recommender systems. In addition, the constructs have crossover effect that can be handled with cause-and-effect features of SEM. SEM is suitable for the current research as it models relationships among multiple independent and dependent constructs simultaneously instead of measuring only one layer of linkages between independent and dependent variables at a time.

The study employs a questionnaire to access research constructs using multi-item questions validated in various studies of Technology Acceptance Model TAM3. We used validated questions from TAM3 to describe perceived ease of use, perceived usefulness, output quality and computer anxiety (Venkatesh and Bala, 2008). Perceived Usefulness and Output Quality questions of TAM3 were further enriched with items from Website Quality and Online Perceived Value literature (McKinney et al., 2002) (Putri & Pujani, 2019) (Tom Dieck & Jung, 2015). Trust and reputation questions were derived from Cao et al. (2020), Jarvenpaa et al. (2000) and Zhou (2019) literature as indicated in Table1.

Table1: Source of Multi-item Questions of User Acceptance Constructs

Construct	Multi-item Questions Source
Perceived Usefulness PU	Venkatesh and Bala (2008) Tom Dieck & Jung (2015) Putri & Pujani (2019)
Perceived Ease of Use PEOU	Venkatesh and Bala (2008)
Perceived Output Quality OQ	Venkatesh and Bala (2008) McKinney et al. (2002) Tom Dieck & Jung (2015)
Perceived Trust Trust	Jarvenpaa et al. (2000) Zhou (2019) Cao et al. (2020)
Perceived Reputation Repu	Jarvenpaa et al. (2000) Zhou (2019)
Perceived Computer Anxiety CANX	Venkatesh and Bala (2008)

Demographic factors were measured using two constructs (Age and Gender), whereas Experience was measured by three constructs (mobile usage proficiency, mobile search attitude and prior use of mHealth recommender). All of the constructs, except moderating variables, were measured in a structured format on a five-point Likert-type scale, ranging from "strongly disagree" to "strongly agree." The moderating variables were assessed using categorical measures.

We excluded TAM3 constructs related to Computer Playfulness and Perceived Enjoyment, as these are not closely related to mHealth acceptance. Social norm and external control/facilitating conditions were also not included in this study as it is aimed to focus on issues specific to behavioral intention of Generation Z & Y, taking into consideration that social norm and facilitation conditions are not a pivotal to acceptance of health recommender and safety applications.

Appendix A presents the questionnaire used in this study. We developed the primary version of the questionnaire in English, and then translated it into the local language (Arabic).

Research Questions

According to TAM3 findings and literature reviewed on Perceived Trust and Perceived Reputation (as detailed in previous section) user acceptance of mHealth applications is influenced by the following constructs and hence research hypotheses are formed:

Hypothesis 1: Perceived Usefulness has a positive effect on Behavioral Intention to Use mHealth applications

Hypothesis 2: Perceived Ease of Use has a positive effect on Behavioral Intention to Use mHealth applications

Hypothesis 3: Perceived Trust has a positive effect on Behavioral Intention to Use mHealth applications

Hypothesis 4: Perceived Ease of Use has a positive effect on Perceived Usefulness

Hypothesis 5: Perceived Reputation has a positive effect on Trust in mHealth applications

Hypothesis 6: Perceived Output Quality has a positive effect on Perceived Trust

Hypothesis 7: Perceived Output Quality has a positive effect on Perceived Usefulness

Hypothesis 8: Perceived Technology Anxiety has a negative effect on Perceived Ease of Use

Hypothesis 9: Experience has a significant moderating effect on Behavioral Intention to Use mHealth applications

Hypothesis 10: Age has a significant moderating effect on Behavioral Intention to Use mHealth applications

Hypothesis 11: Gender has a significant moderating effect on Behavioral Intention to Use mHealth applications

Results & Findings

Respondent Data

To target Generation Z the questionnaire was distributed among university students in their second year, studying Business with specialty in Management Information Systems. Whereas for Generation Y the questionnaire was distributed among junior employees working in a government-related think-tank. Total of 136 valid questionnaires have been collected. Respondent characteristics are shown in Table2.

Table2: Respondent Characteristics

Control Variable	Category	Count	Percent
Gender	Male	63	46%
	Female	73	54%
Age	Generation Z Under 25	92	68%
	Generation Y 25-39	44	32%
Experience			
Mobile Proficiency	Novice	0	0%
	Intermediate	43	32%
	Professional	93	68%
Search for data on Mobile	Rarely	17	12%
	Occasionally	32	24%
	Frequently	87	64%
Prior Experience with mHealth Recommender	Yes	54	40%
	No	82	60%

Results

The data collected was analyzed with Python SEM package that fits the data to the proposed structural model and calculates the Path coefficient and the corresponding p-value. It is known that p-value less than 0.05 is an acceptable measure, as it indicates that only 5% of sample data do not fit the suggested relationship. Table 3 shows the results for the suggested Structural Model following the hypotheses outlined in previous section. It shows the hypotheses that have been supported by the sample data, and those that were rejected. Whereas Table 4 shows the auxiliary relationship between the latent variables the SEM analysis supported.

Table3: Structural Model

Dependent Variable	Independent Variable	Path Coefficient	Standard Error	p-value	Significance Level
TRUST	**REPU**	**4.022128**	**1.857963**	**0.030403**	**ACCEPTED**
Trust	OQ	-0.13202	0.091363	0.148443	Rejected
PU	**PEOU**	**1.26932**	**0.251074**	**4.29E-07**	**HIGHLY ACCEPTED**
PU	OQ	0.158346	0.11677	0.175083	Rejected
PEOU	**CANX**	**-0.63994**	**0.124392**	**2.68E-07**	**HIGHLY ACCEPTED**
BI	Trust	-0.03425	0.128407	0.789672	Rejected
BI	**PU**	**0.384609**	**0.080439**	**1.74E-06**	**HIGHLY ACCEPTED**
BI	PEOU	0.02393	0.160661	0.881598	Rejected
BI	**EXP**	**-1.14353**	**0.389345**	**0.003313**	**HIGHLY ACCEPTED**
BI	Age	0.14215	0.09182	0.121589	Rejected
BI	**GENDER**	**0.415418**	**0.086144**	**1.42E-06**	**HIGHLY ACCEPTED**

Table4: Auxiliary Relations between Latent Variables

Dependent Variable	Independent Variable	Path Coefficient	Standard Error	p-value	Significance Level
CANX	EXP	-0.09148	0.024289	0.000166	**HIGHLY ACCEPTED**
CANX	OQ	-0.31581	0.065827	1.61E-06	**HIGHLY ACCEPTED**
Repu	OQ	0.101567	0.046165	0.027802	**ACCEPTED**
PU	Trust	0.058009	0.018922	0.002171	**HIGHLY ACCEPTED**

Based on the SEM analysis (Table3 & Table4) we conclude the acceptance of several hypotheses made in this research, but also point out rejection of some hypotheses, and we provide possible reasons for rejection that would improve understanding of acceptance of mHealth application, as follows:

Hypothesis 1 **HIGHLY ACCEPTED**: Perceived Usefulness has a positive effect on Behavioral Intention to Use mHealth applications

Hypothesis 2 **REJECTED**: Perceived Ease of Use has a positive effect on Behavioral Intention to Use mHealth applications

This could be justified as 60% of respondents of the current study's sample did not use an m-Health recommender before but have heard about such experience from relatives and friends. On the other hand, this result confirms TAM3 suggestions concerning Perceived Ease of Use, having less effect on Behavioral Intention than Perceived Usefulness.

Hypothesis 3 **REJECTED**: Perceived Trust has a positive effect on Behavioral Intention to Use mHealth applications

Having said that, it is found that Perceived Trust has a noticeable direct positive effect on Perceived Usefulness (Table4), rather than directly affecting Behavioral Intention.

Hypothesis 4 **HIGHLY ACCEPTED**: Perceived Ease of Use has a positive effect on Perceived Usefulness

Hypothesis 5 **ACCEPTED**: Perceived Reputation has a positive effect on Trust in mHealth applications

Hypothesis 6 **REJECTED**: Perceived Output Quality has a positive effect on Perceived Trust

Output Quality has a positive effect on Perceived Reputation (Table4), rather than direct effect on Perceived Trust.

Hypothesis 7 **REJECTED**: Perceived Output Quality has a positive effect on Perceived Usefulness

Taking into consideration that the sample contains 60% of respondents who did not use an m-Health recommender before, so quality measures were evaluated through experiences from others, and with cautious attitude.

Hypothesis 8 **HIGHLY ACCEPTED**: Perceived Technology Anxiety has a negative effect on Perceived Ease of Use

Hypothesis 9 **ACCEPTED**: Experience has a significant moderating effect on Behavioral Intention to Use mHealth applications

Experience was found to have a negative effect on Behavioral intention, this could be justified that user with prior exposure to mobile applications and online services, can identify some weaknesses and hence are reluctant to use the online service again. This needs to be further tested on a larger sample.

Hypothesis 10 **REJECTED**: Age has a significant moderating effect on Behavioral Intention to Use mHealth applications

According to sample data there is no difference found between Generation Z & Y regarding the behavioral intention to use mHealth applications.

Hypothesis 11 **HIGHLY ACCEPTED**: Gender has a significant moderating effect on Behavioral Intention to Use mHealth applications

Gender has been pointed as significant control variable in user acceptance of online services. The current study found that females have higher behavioral intention to use mHealth applications than males.

Discussion

Based on the Technology Acceptance Model, this study is aiming to confirm a hypothesized significant relationship between variety of constructs, and the behavioral intention to use mHealth applications. A questionnaire was conducted with 136 of representative sample and data was analyzed using SEM. The analysis of the structural model indicates a high degree of significance for the accepted relationships with p-value much less than 0.01 in several cases and the outcome of the analysis is shown in Figure1.

Confirming with previous research, the result of the current study suggests that Perceived Usefulness has a significant positive effect on behavioral intention to use mobile health recommender system (Venkatesh and Bala, 2008). This direct relationship is affected by user characteristics, namely gender and experience using technology. Females showed higher intention to use mHealth applications, this agrees

with previous work confirming the effect of gender in adoption of new technologies (Alam et al., 2020). Experience was found to have a negative effect on Behavioral intention, this could be justified that experienced users can identify some weaknesses in the current applications, and hence are reluctant to use them. While this finding confirms previous work indicating that with increasing hands-on experience with a system, a user will have more information on how easy or difficult the system is to use (Choi et al. ,2010). Still, such findings need to be further tested on a larger sample.

The current research confirms the important role of Trust in new technology adoption (Cao et al., 2020). According to the findings of the current research, Perceived Usefulness can be significantly increased by increasing Trust and Perceived Ease of Use, where Reputation and Output Quality have a significant effect on building Trust in mHealth applications. This specific finding agrees with previous work of Jarvenpaa et.al., 2000, highlighting the important effect of online services' Reputation & Quality.

Computer anxiety has a significant negative effect on Perceived ease of Use and is affected by both Experience and Output quality in a negative way. This confirms with previous research on TAM3 (Venkatesh and Bala, 2008). They indicated that Experience and Output Quality moderate the effect of computer anxiety, where with increasing experience and Output Quality, the effect of computer anxiety on perceived ease of use became weaker.

These findings provide a basis for improving the understanding toward factors affecting mHealth **applications in developing countries.**

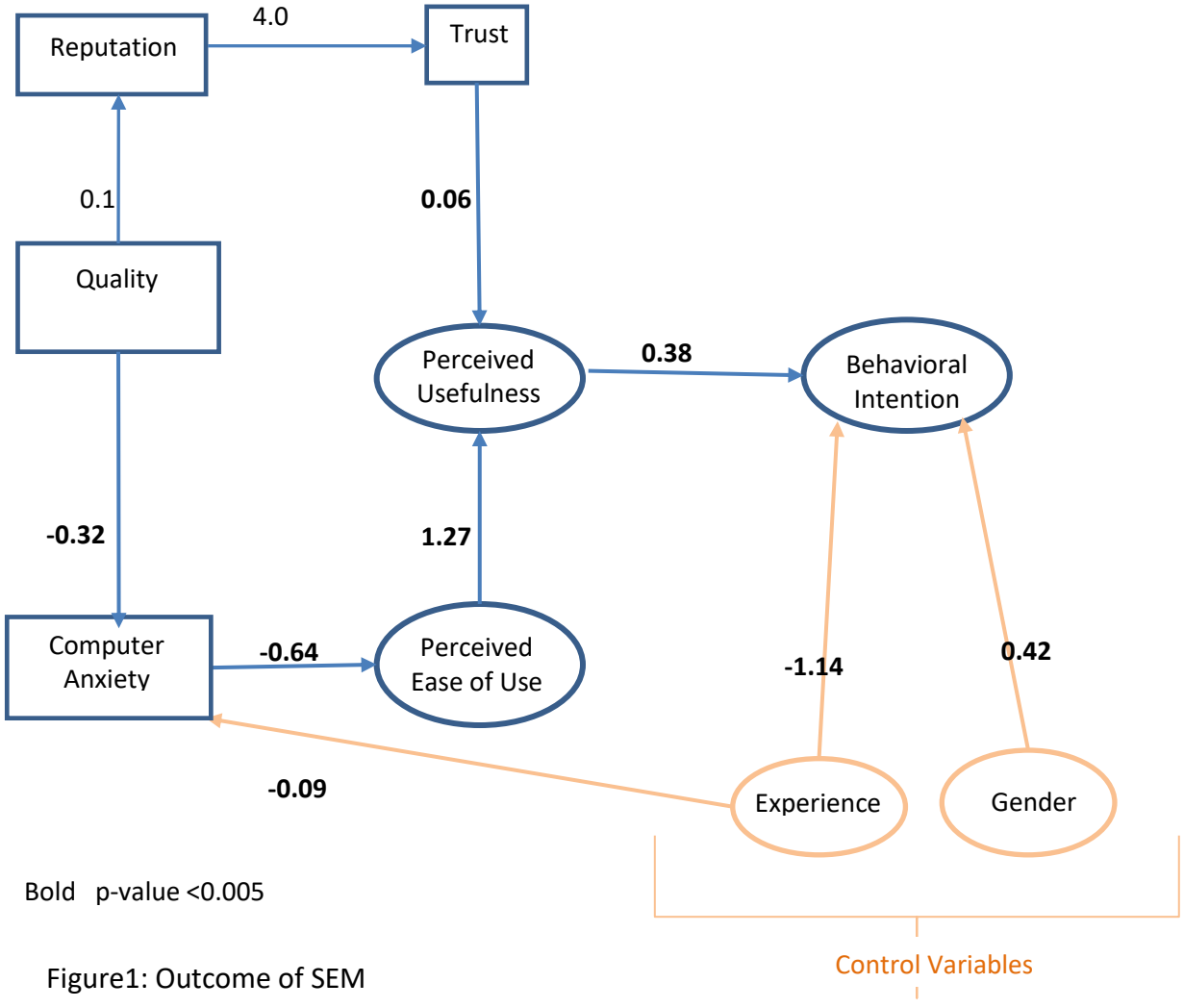

Figure1: Outcome of SEM

Conclusion and Implications

mHealth applications can enhance the quality and access of health services in developing countries, still the adoption of mHealth applications in developing communities is very low. On the other hand, younger generations have great dependence on mobile devices and have high potential to adopt mobile applications. Results of this study suggest factors that affect user acceptance of mobile health recommender system among Generations Z (between 10 and 25 years old) & Y (between 26 and 40 years old). Such factors include Perceived Usefulness which is suggested to have a direct significant positive effect on mHealth adoption, Trust and Perceived Ease of Use, both having a significant effect in increasing Perceived Usefulness, and Perceived Reputation and Output Quality having a significant effect in building Trust.

Findings of the current research can highlight some of practical design recommendations for mHealth designers. Building Trust could be achieved through the "about us" section placed in a noticeable part of the application. Trust can also be built through the recognition of the application using advertising and by highlighting positive users' reviews and quality of the service. mHealth applications might be able to increase their Perceived Reputation by quoting policies for users' satisfaction and refunds.

Limitations and direction for future research

Firstly, the research findings are solely based on the results of a survey. Although the sample size is relatively large, a triangulation of data collection methods is needed, to capture more authentic perception of mHealth users. Future work is aiming to conduct semi-structured interviews to complement the data collected in this research. Such qualitative data might strengthen the research model suggested in the current research, more factors affecting behavioral intention to use mHealth applications, might be revealed. Secondly, all the survey participants reported a high to intermediate level of technology familiarity, and they were all located in Cairo, with high technology awareness and intellectual skills. Future work would consider users with diverse characteristics and in rural areas in Egypt. In addition, Generation Z represented in the sample data are two times of Generation Y respondents, future work needs to include more of Generation Y.

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Appendices

Appendix A: Questionnaire used in the Study

Please Tick the Appropriate Category

1 Gender	Gender	O Male		O Female	
2 Age	Age	O Under 25	O 25-39	O 40-60	O Over 60
3 ExpMobileProf	How would you rate yourself as a user of the Mobile apps	O Novice	O Intermediate		O Professional
4 ExpSearch	How often do you search for data on Mobile Apps	O Never	O Rarely	O Occasionally	O Frequently
5 ExpPrior	Did you ever used a Health Recommender Mobile App, such as Vezeeta?	O Yes or No			

Please Tick the Appropriate Category, even if you never used a Health Recommender Mobile App before.

		strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
		1	2	3	4	5
1 PUAlternative	The app is a good alternative to word of mouth	O	O	O	O	O
2 PUSpeeds	Using the App speeds up the process of booking doctors	O	O	O	O	O
3 PUEnriches	The App enriches my information on the doctor	O	O	O	O	O
4 PUSkillful	Using the App helps me find a skilful doctor	O	O	O	O	O
5 PEOUEasy	I find the App easy to use.	O	O	O	O	O
6 PEOUDoWhat	It is easy to get the App to do what I want to do.	O	O	O	O	O
7 PEOUNoHelp	Interacting with the App does not require external help	O	O	O	O	O

8 RepuKnown	This App is well known	O	O	O	O	O
9 RepuGood	This App has a good reputation in the market	O	O	O	O	O
10 RepuRecommend	Others recommended using the App	O	O	O	O	O
11 TrustTrust	I trust this App	O	O	O	O	O
12 TrustRating	I trust the ratings and reviews of the doctors on the App	O	O	O	O	O
13 TrustPrivacy	I would provide personal information to this App	O	O	O	O	O
14 BI	I am very likely to consider using this App in the future	O	O	O	O	O
15 CANXScare	Technology do scare me.	O	O	O	O	O
16 CANXNevous	Working with a mobile app makes me nervous.	O	O	O	O	O
17 CANXUncomfot	Mobile apps make me feel uncomfortable.	O	O	O	O	O
18 OQInfomation	The quality of information given on the doctor is high	O	O	O	O	O
19 OQRating	The ratings and reviews given on the doctor are reliable	O	O	O	O	O
22 OQPersonalize	The App provides a personalized experience	O	O	O	O	O