

Health Apps' Functionalities, Effectiveness, and Evaluation

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Abstract. Positive user evaluation reflects success for a mobile application (app). When a health app fulfills their intended objective, it leads to higher usage and garners better evaluation. Although designing an app with a clear functionality is the key to success, but most apps are built with complex functionalities with confusing objectives that may not help a user's end objective of managing their health. In this regard, this study explores how functionality and intended health effectiveness of an app influence evaluation. Tracking a set of 188 health apps for 14 weeks, we find that functionality and appeal positively impact the evaluation of the apps. On the other hand, when the apps offer advanced and complex functionalities that are not mature and not fully integrated, the appeal will fade resulting in negative evaluations. Managerial and research contributions of the findings are discussed.

Keywords: Health apps · Apps functionalities · Mobile health · mHealth · Digital health

1 Introduction

Health information seeking has grown at a phenomenal rate. Health apps are programmed applications that run on smartphones and tablets to provide healthcare services. Health apps are intended to improve a patient's well-being. There are many types of health apps. Some apps are designed to help the patient manage his or her health, while others help patients and users to live a healthier lifestyle by giving them advice on nutrition and exercise, with others offer the ability for the patient to communicate with healthcare professionals regarding prescription refills and appointments [1, 2]. In addition, many apps are integrated with electronic medical records allowing health care providers to monitor patients and record their progress [3]. It is reported that there are 43,689 mobile healthcare apps available to users on the iTunes platform, with almost equal numbers in Android platform [4]. It is predicted that the number of users downloading health-related apps will reach to 1.7 billion by 2017 [5], with a global revenue potential of \$21.5 billion by 2018 from mobile app based health businesses [6].

Research on the challenges of the health app usage and adoption suggest that apps should be designed properly for better appeal and usage, with appropriate design of their functionalities. The overall goal of a mobile health app is to improve the health and lifestyle of its users [7]. Mobile technology can be a powerful vehicle for providing individual level care to patients [8] if they provide effective functionalities. In this context, apps vary widely in the functionalities. Some apps offer instructive functionalities such as weight management, monitoring daily activities, patient reminders for pills and appointments, enabling patients to self-manage medical conditions, and locating nearby pharmacies and hospitals. Newer health apps offer more advanced functionalities such as monitoring vitals, communication with healthcare professionals and caregivers, ability to integrate with personal electronic health records and various other functions. However, with the objective to attract wider patient groups, often developers cram the apps with too many functionalities. While the intention of cramming too many functionalities may be to achieve a variety of tasks and objectives for the apps, but increasing functionalities may introduce complexity. The complexity and poor design may reduce overall appeal and lead to a negative impression and negatively impact subsequent usage intention [9]. Indeed, although health apps are perceived to be enablers toward personalized and patient centered care, yet, the realistic impact of apps on health is still low [10]. Given the potential benefits of health apps for both providers and patients, Kumar et al. [11] raise the need for more research in the area of health apps and the need for more collaboration between scholars from different disciplines like medicine, public health, and information systems areas.

We propose that the influence of some functionalities on the appeal and evaluation of a health app is amplified by the app effectiveness. In addition, the health effectiveness of an app moderates the effect of functionalities on appeal in such way that the appeal of the app decreases when the app offers advanced functionalities that are not fully developed. Furthermore, we propose that the influence of functionalities of an app on evaluation is also mediated by the appeal. In such, more appealing apps are rated higher by users. We tracked 188 mobile health apps in the Google digital market for 14 weeks. Text mining was used to code variables, and econometric techniques for panel data was used to analyze the data. This study contributes to the information systems and mobile health literature in providing a better understating of how functionalities impact the appeal and evaluation of the app.

2 Background and Prior Research

Phillips et al. [7] define mobile health as the usage of mobile technology to deliver and enhance healthcare experience to users. Related information systems and health information technology research have shown that health apps have the ability to deliver healthcare in an efficient way [11]. Health apps empower patients to manage their health, adopt a better lifestyle, and adhere better to recommended regimen [12]. Also, apps can enable patient self-monitoring [13] and provide healthcare professionals with additional intervention [14, 15] and treatment options [11, 12, 16–18].

Users can download health apps from the digital marketplace like itunes.apple.com for iOS devices, play.google.com for Android devices, and Microsoft.com store for

Microsoft devices [19]. The digital app markets provide users with a platform that allows them to review apps and rate them after they download and use the apps. The posted review and rating will influence other users' perception towards an app and may even impact the decision to download the app or not [20]. Recently, apps digital marketplaces allowed app developers to reply to reviews and comments. Such dynamics result in significant amount of unstructured data that provide researchers with a rich substance to explore and investigate.

To summarize, there has been an overload in the number of available health apps. Although there are many apps, developers and providers continue to encounter low usage and retention [21]. To increase the usage and the value of the apps, developers and providers tend to equip apps with more functionalities. Therefore, they need to better understand how adding more functionalities may impact users. To our knowledge, information systems and health IT researchers have not yet investigated how health apps functionalities may change user's evaluation. This study tries to address the existing gap in the literature of mobile health apps.

3 Theoretical Background and Conceptual Framework

In this research, we anchor to the prior research of assimilation and contrast effects on judgment and evaluation. The assimilation and contrast theory builds a foundation of an individual's evaluative judgment and attitude change. The theory argues that the addition of new information impacts an individual's initial opinion or attitude, the person will compare the new information to existing information and prior experience [22–24]. The theory explains how evaluation is based on a mental process that compares a given target to existing information, ideas, or experiences; this judgment is an accumulation of the assimilation and the contrast effects. The two processes are not mutually exclusive; while they may happen in separate of each other, they can also overlap depending on context and the situation. Based on this theory an individual may use a prior knowledge to evaluate a new experience. If the new target is not discrepant from the individuals existing expectations, the experience will be assimilated and falls in the area of acceptance. On the other hand, if the opposite is true then the new target will produce a contrast effect and cause user's rejection [23, 25, 26].

The assimilation in apps occurs when the target shares common features and attributes with existing or the previous ones. As opposed to that, the contrast happens when the experience falls outside the user knowledge or experience. The incorporation of the new experience that falls outside the user's expectation can be uncomfortable to the individual [23, 27]. Generally speaking, the assimilation and contrast effects are silent processes, and it is hard to identify their direction, but they are often reflected in the reviews, ratings, and attitudes towards products or services [28]. Assimilation effect is positive in nature where the contrast effect is negative [27]. Broadly, it is apparent that app developers need to stimulate more assimilation effect than contrast effect in their apps. Such will help in increasing the user's positive attitude and gain good evaluation from users.

We suggest three sets of relationships that will have an effect on the individual's overall evaluation of a health app. First, we propose that advanced and instructive

functionalities will have a direct influence on the appeal and the evaluation of the app. The appeal in our study is the ability of the app to attract, please, interest, engage and enjoy users. Evaluation is reflected by the average rating an app gets every week. Second, we propose that the health app effectiveness, reflected by the positive impact noticed by the user due to using app, will moderate the impact of functionalities on the appeal and the evaluation of the app. Third, the appeal is a mediating factor between the role of functionalities and effectiveness on evaluation.

Based on the assimilation and contrast effects and our three suggested relationships, we argue that the foundation of a user's evaluation will be primarily drawn from the health app functionalities. For the health apps in this study, we operationalized a classification of health apps into advanced and instructive apps. The instructive functionalities are reflected through the features of providing information or instruction on the prevention of diseases, healthy living, self-diagnosis, finding a physician or facility, and post diagnosis education. The advanced functionalities are reflected through the features of providing reminders, alerts, connecting with healthcare professionals, teleconferencing, filling prescriptions, and compliance and adherence [4]. A number of functionalities on health effectiveness will be assimilated that will, in turn, enhance the user's evaluation and judgment. With more effectiveness, multi-functional apps will be able to attract more patients to realize the benefits of the app, and subsequently get higher evaluations. On the other hand, developing apps with advanced functionalities that are not mature or fully developed will result in a contrast effect that negatively impacts user's evaluation. In addition, appeal manages to establish a relationship between the app and the user. When the app is appealing, the user will evaluate the app positively and will be more tolerant towards glitches and bugs. We conduct an exploratory analysis of these effects using secondary data from the Android app store.

4 Method

4.1 Data and Variables

To test the proposed relationships, we focused on health apps in the Android app store. We collected data for a span of 14 weeks from October 2014 to January 2015. The first week is the focal reference week for the health apps in this study. We found more than 2,203 health and medical applications in the focal week of 13th October 2014 to 20th October 2014. We could not consider 49 apps for our analysis because they did not have any reviews in the marketplace in the focal week. After we had examined the data more closely, we found 73 apps in languages different than English, had unreadable names, or duplicated in the market. Also, we excluded 1,344 that were not related to patient's information, treatment, diagnosis, and or disease management. We also excluded 471 apps that were not directed to patients, rather directed towards providers, healthcare professionals, and medical students. We were left with 188 apps. Because this study spans for 14 weeks, we tracked these 188 apps for the 14 weeks to have an unbalanced (minimal) panel data set of 2,243 observations.

In Table 1, we provide a description of the variables we use in this study. To measure appeal and health effectiveness we used two different methods. In the first method, we examined the consistency between the polarity of review sentiment and the number of stars that a review is received, while in the second method, we used machine-learning techniques to predict the consistency of the review. Table 2 provides the descriptive statistics and correlations amongst key variables used in this study.

Table 1. Description of variables

Variable	Description and operationalization
Evaluation	Average weekly rating of the app in the app store
Functionalities	This variable is the total count of the four instructive functionalities and two advanced functionalities. The four major instructive functionalities of the apps: display of information, providing instructions, search and explore functions, and providing education. The instructive functionalities are reflected through the features of providing information or instruction on the prevention of diseases, healthy living, self-diagnosis, searching a physician or facility, and education on different procedures or conditions. The two advanced functionalities of the apps: connecting to back-end applications with the features and aligning to workflow and operational requirements. The advanced functionalities are reflected through the features of providing reminders, alerts, connecting or following up with doctors or providers, or with video or teleconferencing provisions, filling prescriptions, or compliance and adherence
Appeal	The ability of the app to attract, please, interest, engage and enjoy users in a way that will stimulate a relationship between the user and the app. This variable is coded by mining the text reviews of each app in each week
Health effectiveness	The positive impact felt or noticed by the user for using a health application. This variable is coded by mining the text reviews of each app in each week

Table 2. Descriptive statistics and pairwise correlations amongst key variables

Variable	Apps	Mean	Std. dev.	Min	Max	1	2	3	4	5	6	7	9
Evaluation	188	3.91	0.61	0	5	1							
Appeal	188	0.33	0.17	0	1	0.26	1						
Functionality	188	1.30	0.61	0	5	0.09	0.08	1					
Effectiveness	188	0.34	0.24	0	1	0.49	0.47	0.05	1				
Advanced	188	0.26	0.44	0	1	-0.01	-0.02	0.20	0.15	1			
Age	188	1.20	0.56	0.1	3.5	0.11	0.10	0.16	0.09	0.06	1		
Price	188	0.96	0.81	0	10	0.19	0.07	0.06	0.10	0.10	0.20	1	
Download	188	850	85	1	3.561	0.36	0.21	0.20	0.16	0.11	0.12	0.05	1

4.2 Estimation Models

We have used panel data for our analysis. To determine if we should perform a fixed effects or random effects analysis we ran Hausman test. The result of the test was

significant, hence we used a fixed effect model. In addition, the change in patient evaluations is continuous which makes a fixed effect model a good fit for our analysis.

$$Evaluation_i = \beta X_{it} + \alpha + u_{it} + \varepsilon_{it}$$

where, $Evaluation_i$ is the dependent variable, X_i is a set of explanatory variables, β is a vector of parameters, t is the time in weeks, u is the between-entity error and ε are within entity error associated with each observation.

5 Results

We found that with more effectiveness, multi-functional apps will be able to better engage patients to use and form good relationship with the app. Also, with more appeal, multi-functional apps will be able to attract more patients to realize the benefits of the app, and subsequently get higher evaluations. In addition, we find support for the

Table 3. Results of Estimation Models

Variables	Fixed effect models			
	(1)	(2)	(3)	(4)
	Direct effect model	Direct effect model	Interaction model	Interaction model
	Appeal	Evaluation	Appeal	Evaluation
Effectiveness \times functionalities			0.103*** (0.0121)	0.227*** (0.053)
Effectiveness \times advanced			-0.110*** (0.013)	0.102*** (0.024)
Appeal		3.134*** (0.039)		3.100*** (0.039)
Health effectiveness	0.029*** (0.006)	0.022* (0.012)	0.031*** (0.009)	0.030* (0.017)
Functionalities	0.012* (0.015)	0.087*** (0.025)	0.011* (0.003)	0.053** (0.009)
Advanced	-0.023* (0.009)	-0.010* (0.016)	-0.194* (0.020)	-0.159* (0.038)
Constant	0.522*** (0.004)	2.251*** (0.022)	0.476*** (0.006)	2.229*** (0.022)
R-squared	0.310	0.347	0.341	0.381
F stat	15.85***	16.36***	16.48***	16.78***

(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

(2) Standard errors in parentheses

(3) All Models have 188 number of apps, with 2,243 observations

(3) Models control for number of apps by same developer, developers' average ratings and reviews in the market, total rating of the developer, price of the app, when the app was last updated, when the app was introduced in the app store, number of downloads of the app, when the publisher released their first app in the app market

negative effect of advanced functionalities on the app appeal. The interaction term (Effectiveness \times Advanced) is negative and significant (refer to column 3 in Table 3, $\beta = -0.110$, $p < 0.01$). The positive impact of effective functionalities on apps evaluation is supported as the coefficient is positive and significant (refer to column 4 in Table 3, $\beta = 0.102$, $p < 0.01$). Finally, appeal manages to establish a relationship between the app and the user. The user will evaluate the app positively and provide developers with better feedback to improve it. Users will also be more tolerant towards glitches and bugs in apps that they find appealing.

We tested for multicollinearity by computing variance inflation factors (VIFs) for all estimation models. The highest VIF was 2 in the direct-effect models, confirming that multicollinearity is not a serious concern. To reduce potential high multicollinearity issues due to the number of interaction terms in the models, all continuous variables were mean-centered by subtracting the corresponding variable mean from each value [29]. The VIF of any individual variable in any of the interaction effect models was less than 7. Furthermore, mean VIFs in all the models were less than 5. Thus, we find that multicollinearity is not a serious concern in the estimation.

6 Discussion

The first thing we can draw from our findings is that adding more effective functionalities to health apps help increase the average rating. Secondly, adding advanced functionalities in the health app may sacrifice some of its simplicity an appeal that will negatively impact the overall rating of the app. A third finding is that the appeal of the health app will positively impact its average rating.

We draw some managerial implications from this study. First, the apps functionality plays a valuable role in user's evaluation. Hence, developers should pay attention toward what type of functionalities they provide in their applications. This study contributes to the literature of mobile health applications, by identifying how technological and functional factors are associated with digital application success. Finally, tracking evaluation regularly is critical for a health application's success.

Regarding our research contributions, to our knowledge, this study will be the first one to explore the effects of factors like functionality, appeal, and effectiveness on how users rate health apps in the digital marketplace. These contributions will enrich the existing information systems literature and research associated with mobile health apps. Future studies can look if health apps were recommended or prescribed by providers and how that will impact consumer's evaluation. In our study, we only collected data for apps that came from the Android store; future studies may include apps from other markets as well.

In conclusion, as mobile health apps become ubiquitous, Health apps functionalities and appeal will have a stronger relationship with users' initial and long-term decision to use the app. Our study shows that developers should pay attention not only to health app's functionalities but also how appealing the app is. Developers tend to add more functionalities to their apps to keep up with competition sometimes at the expense of simplicity and appeal. Developers that contradict what users find appealing may trigger a bad first impression and damage user's expectations. As functionality is

important to establish a long-term relationship between the user and the health app, the appeal is significant in leaving a good impression to start using the app and engage users more.

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