Assessment of Activity Trackers: Toward an Acceptance Model

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Abstract
In this project we seek to understand the factors that influence user acceptance of Activity Trackers, through a model that quantifies how users come to adhere to the use of Activity Trackers. The proposed research model and hypotheses were validated and tested with data collected from a cross-sectional survey conducted using a self-selected convenience sample. Constructs from half dozen of established models were gathered into a suppositional model, based on their hypothetical applicable relevance for the Activity Trackers use. The results were analyzed using a variety of statistical techniques including Structural Equation analysis. The final result can be a first step for researchers aiming to complement their own processes of study, ideation or design of Activity by taking into account factors such as Usefulness, Ease of Use, Health Consciousness, Hedonic Motivation, Image, Habit, etc.

Author Keywords
User acceptance; Ubiquitous Systems; Personal Informatics; Personal Data Tracking; Wearable Computers; Sports/Exercise; Survey.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

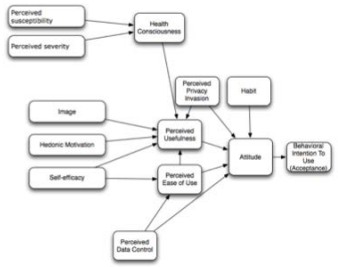

Figure 1: Proposed Model.

Scales -

All of the scales were adapted from prior research.

The scales for the Technology Acceptance Model (TAM) constructs (i.e., Perceived Usefulness and Perceived Ease-of-Use, Intention to Use, and Attitude) came from Venkatesh and Davis [20].

The scales for the UTAUT2 constructs (i.e., Hedonic Motivation, and Habit) came from Venkatesh et al. [22]. The scales for the Perception of System Attributes – Behavioral Intention Model constructs (i.e., Perceived Privacy Invasion, and Perceived Data Control) came from Moran [15].

Introduction

Activity Trackers are becoming increasingly important in health, socialization, and recreation, and thus an ever more important topic in Human Computer Interaction (HCI). Known this, it is important to enlighten what drives Activity Trackers use and acceptance, and how Activity Trackers influence human behavior. While the research in HCI has followed a more qualitative vision of Activity Trackers use with this paper we want to provide an overall quantitative picture of Activity Tracker's core use, which may lead to its improvement by, for example, incrementing design iterations to identify weaknesses that need to be addressed.

An influential paradigm to follow in this research path can be the Technology Acceptance Model (TAM) by Fred Davis [6], which postulates that user acceptance can be described by two ideas: Perceived Usefulness (PU), and Perceived Ease of Use (PEoU). TAM was originally developed on extrinsic motivation only. Nevertheless intrinsic motivation was included later [7] with the construct Perceived Enjoyment (PE). However, this addition attached little importance, since the majority of TAM research centers exclusively on utilitarian systems [10]. Another paradigm is Everett Rogers' Diffusion of Innovations [18] that tackles the proliferation of abstract concepts and ideas, technological information, and factual practices in a social structure. Despite the commercial success of Activity Trackers a recent survey [13] exposed that 34% of users stopped using them over six to twelve months after acquisition. Ruben Gouveia et al. [9] tackled this problem and proposed three directions for design: "designing for different levels of 'readiness', designing for multilayered and playful goal setting, and designing for sustained engagement". However, we foresee the need for additional research that can understand the long-term use of Activity Trackers.

We edified upon existing work to establish an extrapolative model that has its focus exclusively on Activity Trackers users. We want to know which share of Activity Trackers' use our model explains. This model tries to provide an extensive view of these devices, by for example, not being exclusively based on users that search for Health Information. The proposed model can be used to broaden the iterative design process by showing shortcomings that need to be tackled in order to enhance user acceptance. In the following section, we portray the models whereupon we based ours. Then we describe the methodology and the validation process of the model. Finally we discuss the results, and conclude.

Related Work

The rationale of the hypotheses considered in this work is loosely coupled with the context of several theories: Technology Acceptance Model (TAM), Innovation Diffusion Theory, Social Cognitive Theory, Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), Perception of System Attributes – Behavioral Intention Model, Health Belief Model (HBM), and Health Information Technology Acceptance Model (HITAM).

TAM is based on Martin Fishbein and Icek Ajzen's Theory of Reasoned Action, a theory from social psychology that illustrates the behavior of a human being based on their intentions, [8]. TAM in particular focuses on computer control by introducing two constructs: Perceived Usefulness (PU) and Perceived Ease-of-Use (PEoU) that determine Intention to Use

The scales for the Health Belief Model constructs (i.e., Perceived Susceptibility, Perceived Severity, and Health Threat) came from Angela Bryan et al. [2] and Mei-Fang Chen. [3].

The scales for the Health Information Technology Acceptance Model constructs (i.e., Health Consciousness) came from Kim and Park [12].

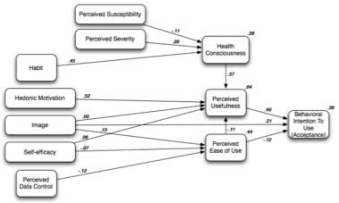

Figure 2: Final Path Diagram.

(IU) via Attitude [6, 20]. Moore and Benbasat interpreted Innovation Diffusion Theory from sociology from a technology point of view. Even though they defined a few constructs similar to PU and PEoU, they also looked at Image [14]. Albert Bandura created one of the most prevailing theories of human behavior, the Social Cognitive Theory [1], where beyond Outcome Expectations (Performance, and Personal), Affect and Anxiety, he added Self-Efficacy (SE) [4]. The above mentioned researchers have come out with several theoretical models, rooted in psychology, sociology and information systems. Faced with a choice amongst a plethora of models, Venkatesh et al. saw the need to formulate the UTAUT a unified view of user acceptance, from a review and integration of eight models [21]. Recently, Venkatesh et al. expanded UTAUT to UTAUT2 by bringing Hedonic Motivation, Habit, and Price Value in the determination of acceptance [22].

Activity Trackers are becoming pervasive in our daily lives, in both utilitarian and hedonic aspects. This made us look into Stuart Moran's Perception of System Attributes – Behavioral Intention Model from which we acknowledge the constructs Perceived Privacy Invasion, and Perceived Data Control [15].

The evolution of the Health Belief Model (HBM) [19] over time made us look only into: Perceived Susceptibility of Disease, and Perceived Severity of Disease. Finally, the HITAM [12] has a construct similar to one in HBM that is Health Consciousness [17]. Later, Kim complemented their first study by abstracting the constructs that make up the user experiences of self-trackers for activity, sleep, and diet [11]. To our knowledge this is a unique study that uses a TAM related work to model self-trackers for activity. However, her sample was limited to 18 Korean female college students, who used the device for 3 months, and also, Kim used a qualitative data analysis methodology, focusing on health related factors. There was no discussion on how to apply the findings in practice.

Method

Our model hypotheses are based on the established hypotheses discussed in the models described in the previous section Figure 1 shows the proposed model.

The items in the scales were considered using a seven-point Likert scale, 1 being "Strongly Disagree" and 7 "Strongly Agree." In order to evaluate our hypotheses, we built a survey, which included 50 questions rephrased from prior research to focus on Activity Trackers, for example "My interaction with an Activity Tracker is clear and understandable". Our target population were current users of Activity Trackers, who were recruited on social media, and on a micro work site called Prolific [5]. The micro workers received a compensation of approximately 1.5 US Dollars. There were 360 returned responses worldwide, being 112 from social media, and 248 from the micro work site. From the total number of participants, there were 113 who responded "No" to the question "Do you own an Activity Tracker?" These were eliminated before the data analysis, being 25 from social media, and 88 from the micro work site. Consequently, 247 responses were accepted for further analysis, of which 144 were male (58.3 percent) and 103 were female (41.7 percent). The respondents had average age of 33 (standard deviation: 10.6), and had the devices on average for 16 months (i.e. 488 days, standard deviation: 485, median 365). The overall response acceptance rate was 68.8

percent. From a total of 20 countries, the most represented were the United States with 118 respondents (47.8 percent), the United Kingdom with 69 (27.9 percent), and Portugal with 22 (8.9 percent).

Analysis

We analyzed the proposed model using maximum likelihood parameter estimation. Cronbach alphas for each measure indicated that construct reliability was higher than 0.7. The Kurtosis analysis found normality issues, with values higher than 2, in several items: one item of the construct Perceived Usefulness, one item of the construct Perceived Ease of Use, three items of the construct Attitude, and in all items of the construct Behavioral Intention. However, these constructs passed on the Exploratory Factor Analysis that trimmed the Perceived Privacy Invasion construct. Regarding the Factor Loadings for the solution using Maximum Likelihood analysis with Promax Rotation, Perceived Usefulness, and Attitude loaded as one factor. Item 1 of the construct Heath Consciousness was not loading in any factor and was discarded. Item 1 of the construct Habit, and item 1 of the construct Perceived Severity to Chronic Diseases had factor loadings around 0.46. This last item was also cross loading on Perceived Susceptibility to Chronic Diseases. Nevertheless we decided to maintain these for the sake of the model. The total variance explained was 71.9 percent. The correlations coefficients for the measured variables vary from 0.005 to 0.620.

As we collected the data through a unique online survey, Common Methods Bias was tested during the Confirmatory Factor Analysis, and we concluded that it was not a serious concern. The convergent and discriminant validity of the scales with the Average Variance Extracted (AVE) that is the average quantity of variance in variables which a construct is able to explain, always exceeded 0.50, and Critical Ratios exceeded 0.80. The Maximum Shared Variance (MSV) and the Averaged Shared Variance (ASV) are alos reported. The finalized model exhibited the fit to the data with a Chi-square of 67.573, 23 degrees of freedom, $P < .001$, goodness of fit index of .957, root mean square error of approximation of .089. The model accounts for 36% of the variance in behavioral intention, 28% of the variance in Health Consciousness, 43% of the variance in Perceived Ease of Use, and 63% of the variance in Perceived Usefulness.

Discussion and Conclusion

We proposed an acceptance model that could explain the use of Activity Trackers and assessed it through an online survey. We submitted the constructs of this model to statistic analysis and obtained the resulting final model. The final model, show in Figure 2, has the same level of prevision as the original TAM [6]. The described study is consistence with previous research as it supports the hypotheses that Perceived Usefulness and Perceived Ease of Use are stronger determinants of Behavioral Intention to use Activity Trackers. The Health Information nature of an Activity Tracker is not as strong condition as PU and PEoU to the validity of its use and acceptance. Nevertheless, Health Consciousness is a significantly prevalent value in favor of the Behavioral Intention to use Activity Trackers.

The deeper repercussion for further research is that Health Consciousness is backing up the important role of system usefulness. This shows that users' motivation to use Activity Trackers can be initiated by their need to know and degree of interest in this Health related

information. It also advocates that development in Health acceptance should be made by focusing on the nature of system use in addition to the inclusion of additional determinants. Perceived Susceptibility shows that instead of having a prophylactic attitude, for some users it may be their existing illness that might motivate them to seek the information about their activity.

This study supports that Hedonic Motivation aids Perceived Usefulness in giving utilitarian value to Activity Trackers. This implies that a significant amount of users are also notably interested in the contextual aspects rather than only in technical aspects of the information, suggesting that not all users are goal-oriented. Also, Perceived Usefulness straightforwardly contributes to potential intentions to use the Activity Tracker by enhancing the hedonic use. One repercussion of this conclusion, in parallel with the fact that Perceived Usefulness loaded with Attitude, is that while Perceived Usefulness is a significant system development variable in general, it is remarkably important for Activity Trackers.

Another point from the study is the straightforward link between Image and the direct intention to use an Activity Tracker. This removed emphasis on the initial assumption that Perceived Usefulness or Perceived Ease of Use mediates Image. Interestingly enough, given that Image implies a certain amount of prestige that is obtained by simply using the device, or by simply showing it off. This finding need to be further studied to see if it prevails for long-term users. Finally, it is worth to mention that the Perceived Privacy Invasion relations were not supported, which suggests that Activity Trackers can further share data to increase acceptance and use.

One limitation of this study is that the sample is biased concerning users. Those incipient users who perhaps perceive Activity Trackers as difficult to use or/and less useful and rejected its use are not target respondents. It is plausible that a user's motivation for using an Activity Tracker has a distinctive model from a user's motivation not to use an Activity Tracker. Another limitation of this study lays in the statistical loadings of some factors. This research implies that Image can play a pivotal role to increase acceptance of Activity Trackers. It also suggests that Hedonic Motivation play an important role. Consequently, if users reject Activity Trackers, designers may need to add Image and Hedonic related features to achieve more acceptance.

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