Perceived Usefulness and Behavioral Intention to Use Consumer-Oriented Web-Based Health Tools: A Meta-Analysis

Completed Research Paper

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ABSTRACT

This meta-analysis reports on the predictive power of a portion of the Technology Acceptance Model (TAM), when used to evaluate web-based tools geared towards consumers of healthcare. Findings show that perceived usefulness is a strong predictor of behavioral intention in consumers who use web-based tools for health purposes. Findings also show that users in the contexts of both mental health and wellness exhibit homogeneity, suggesting that these populations may be distinct in their perceptions and use of web-based health tools.

Keywords

Web-based health tools, meta-analysis, consumer-oriented ehealth

INTRODUCTION

The application of technology to healthcare processes provides an opportunity for revolutionary change, in which substantial improvements in quality, patient safety, cost savings, equity and satisfaction may be realized (Eysenbach, 2001; Pagliari, Sloan, Gregor, Sullivan, Detmer, Kahan, Oortwijn, and MacGillivray, 2005). A key benefit that has been realized from this development is *the ability to deliver healthcare to consumers through the world-wide web.* Consumer-oriented web-based health tools, for the purpose of this research, are defined as websites aimed at healthcare consumers, including patients. These tools include applications, information, or other systems for the purpose of tracking symptoms (Or, Karsh, Severtson, Burke, Brown, and Brennan, 2011) or health information seeking (Osborn, Mayberry, Mulvaney, and Hess, 2011).

Although these tools can increase accessibility to health services to healthcare consumers, the development of these tools can potentially be quite costly, and it may be important to justify the expenditure by ensuring that the user perceives the technology as useful to the consumer (Davis, Bagozzi, and Warshaw, 1989; Venkatesh and Davis, 2000). *Perceived usefulness* pertains to the belief that technology is helpful in the performance of a given task (Davis, 1989; Davis, Bagozzi, et al., 1989). Many theoretical frameworks have been developed to meet the need of evaluating information systems, yet a large number of them are rooted in the Technology Acceptance Model (TAM) (Davis, Bagozzi, et al., 1989). TAM posits that perceived usefulness is determinant to the intention to use a technology, which is subsequently determinant of actual use.

Applications and adaptations of this model remain popular in healthcare, although its value in this context is questioned. Bagozzi (2007) suggests that, despite having parsimony as its central strength, the model is in fact too simple, and therefore not likely generalizable across a wide variety of contexts because of this. Indeed, new "core" models have been proposed along the years, attempting to overcome this weakness, yet still be generalizable (Venkatesh and Bala, 2008). Considering that technology has been applied to a multitude of unique contexts in healthcare, knowledge of the predictive power of perceived usefulness on behavioral intention, both within and among contexts, becomes valuable to researchers. This is due to the fact that researchers must include relevant constructs in their models, yet must produce models that are parsimonious.

This meta-analysis seeks to address the following objectives. First, the predictive power of perceived usefulness on behavioral intention will be reported, in a population of health consumers, in studying web based health tools. It has been noted that consumer-oriented web-based health tools can entail a diverse variety of artifacts, in different contexts, for different purposes, audiences and intended use duration. For this reason, this second question will seek to report differences in the predictive power of perceived usefulness on behavioral intention among different subgroups of studies, to detect any heterogeneity that may be present. This paper is structured as follows. The second section will contain an overview of the evidence and issues associated with the use of tools designed for the needs of healthcare consumers, including the hypotheses tested in this research. The fourth section outlines the methods used in this meta-analysis. The fifth section presents results and findings of the study, and the paper concludes with a discussion of the limitations.

BACKGROUND

Clinical processes have been slow to adapt technology, due to risk to the patient inherent in disrupting clinical processes (Ash, Berg, and Coiera, 2004), security and privacy issues (Järvinen, 2009), and resistance to change by clinical staff (Leyland, Hunter, and Dietrich, 2009). Despite these forces, technologies for healthcare consumers have been gradually implemented for many reasons, including symptom reporting to physicians (Johansen, Berntsen, Schuster, Henriksen, and Horsch, 2012), receiving test results (Halamka, Mandl, and Tang, 2008), patient-physician communication (Bergmo, Kummervold, Gammon, and Dahl, 2005), wellness (Dohan and Tan, 2011), chronic disease self-management tools (Or, Karsh, et al., 2011) and homecare applications (Cranen, Drossaert, Brinkman, Braakman-Jansen, Ijzerman, and Vollenbroek-Hutten, 2012). The desire for patients to use personal health records to enhance their care in various ways is documented (Cruickshank, Packman, and Paxman, 2012), and the power of giving healthcare consumers the technology to assist in managing their own health is recognized by governments (FDA, 2011). In other words, the interest in consumer-oriented technologies for health purposes is expressed, and their viability to do so successfully is argued.

In developing these technologies for healthcare consumers, it is important for developers to ensure that use of the application provides the maximum benefit for the user. To achieve this, the user must *want to use* the technology in question, lest it be abandoned or underutilized by the user (Archer, Fevrier-Thomas, Lokker, McKibbon, and Straus, 2011), resulting in no benefit and a waste of resources in building the technology. The appeal of evaluating technologies using TAM-based models is in its parsimony, as well as its ability to predict use in other contexts, such as eCommerce (Kim, Kim, and Shin, 2009) and eLearning (Lam, Lee, Chan, and McNaught, 2011). As new opportunities arise in applying technology to healthcare, the demand for useful models to explain and evaluate their use will follow suit. The demand for theoretical models explaining the use of technology by healthcare consumers is apparent when the area literature is examined. There are many versions of TAM that have been “extended” for use in Internet utilization (Shih, 2004), adoption of electronic health records by healthcare professionals (Archer and Cocosila, 2010), and for the adoption of technology to assist in home care (Holden and Karsh, 2010) to name a few. Pertaining specifically to healthcare consumers, many varied adaptations of the TAM model exist, each attempting to explain one facet or another of consumer acceptance of theses web-based health tools, in a variety of contexts, illnesses and perspectives (Or and Karsh, 2009). As such, this meta-analysis will address the following hypothesis:

Hypothesis 1: Perceived usefulness has a significant impact on behavioral intention to use consumer-oriented web-based health tools.

The number of tools will be numerous, reflecting the variety of patient needs to be addressed in a multitude of settings, characterize by condition, intended mode of use, and other qualities. Therefore, these constructs may perform differently depending on these unique settings of use. As such, this meta-analysis will seek to address this second hypothesis:

Hypothesis 2: The setting of use will have a moderating effect on the relationship between perceived usefulness and behavioral intention to use consumer-oriented web-based health tools.

METHODS

Eligibility Criteria

Articles must reach several criteria in order to be included in this analysis. First, articles must test the relationship between perceived usefulness (antecedent) and behavioral intention (determinant). Equivalent measures were included, specifically those of UTAUT (Venkatesh, Morris, Davis, and Davis, 2003) and ISO (ISO, 1998), whose “performance expectancy” and “effectiveness” constructs are widely considered linearly equitable to perceived usefulness. Second, this article examines the performance of these variables in the context of only web-based tools. Although smart device applications are gaining in popularity, the web remains a tool that is accessible to a much larger audience, more freedom of choice with respect to development platforms, and easier to upgrade, given the centrality of the code repository. Third, this article restricts the focus to use of technology by patients, rather than any healthcare staff, such as doctors or nurses. As much attention has been given to physicians and other healthcare workers in this respect (Archer and Cocosila, 2010; Yau, Williams, and Brown, 2011), this research may not necessarily apply to a person who is managing their own disease, compared with those who are working with them, within the context of work in organizations. Lastly, the search was restricted to articles from 2002 to 2012.

Information Sources

The following databases were searched for articles that qualified for this study: Google Scholar; PubMed; ISI Web of Knowledge; ACM Digital Library; Business Source Complete; CINAHL; MDConsult; AISeL; and the Cochrane Library. Further, several journals that are likely outputs for this type of research were included in this search. These journals included: Journal of the American Medical Informatics Association (JAMIA); International Journal of Medical Informatics (IJMI); Journal of Medical Internet Research (JMIR); Telemedicine and e-Health; International Journal of Healthcare Information Systems and Informatics (IJHISI); Health Informatics Journal (HIJ); Journal of Medical Systems (JMS); and Methods of Information in Medicine (MIM). Reference list of review articles were searched. Lastly, key researchers in the field were contacted for any feedback or assistance in this search.

Search

Error! Reference source not found. (**Error! Reference source not found.**) displays the search terms used to search for these papers. Every viable combination of search terms from each of the three columns were used. Also included were several articles recommended by several authors who were contacted. As well, bibliographies from various reviews and articles were inspected for relevant citations.

One of	One of	One of
ISO 9241	Patient	Web-based
UTAUT	Healthcare Consumer	Internet
“technology acceptance model”	Wellness	Personal Health Record
“perceived usefulness”	Disease	Health Information Portal
	Personal Health	

Table 1: Search terms used in this meta-analysis.

Study Selection

A PhD and a PhD Candidate selected and evaluated studies for inclusion. Any conflicts related to the inclusion of a study were resolved through discussion. 3413 citations were identified by the search effort. 62 articles were discarded because they were not written in English. 865 citations were duplicates. An article was considered a duplicate if either two search terms yielded the same citation, or if two distinct citations published results from the same dataset (i.e. if a journal article used the same dataset as a doctoral thesis). 2008 titles were excluded based on irrelevant title, 346 studies were excluded based on irrelevant abstract and 92 were excluded upon inspection of the article content. Irrelevant articles included qualitative research, studies with healthcare professionals as the central population, non-health related studies, use of models that were incongruent of the purpose of this study, or studies that otherwise did not meet the criteria. 19 of these results were some type of review (meta-analysis, systematic reviews, etc), and therefore could not be included. The authors of 4 articles were contacted in search of missing data and clarification on their articles, and all but one had to be excluded due to non-response. The remaining 15 articles were assessed for quality, according to an adapted version of the method used by Haynes, Taylor, Snow, and Sackett (1979), described in Table 2 (below). Only studies that scored 12 or higher were retained. One citation reported results on three studies, and another on two. At the end of this process 14 studies were deemed applicable for the purpose of this analysis. **Error! Reference source not found.** (below) depicts a flow diagram of the process involved in evaluating these studies.

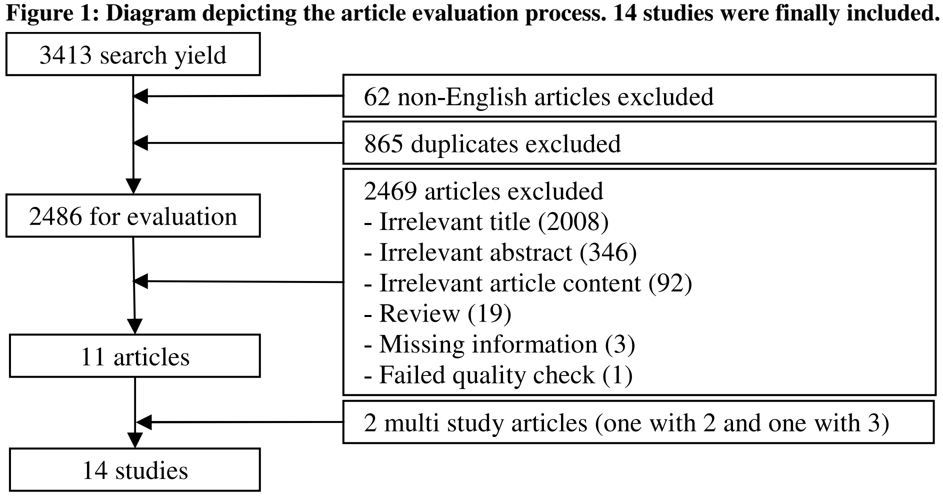
Description of Studies

Table 3 (below) contains a summary of the 14 studies retained in the meta-analysis. Of these, five studies were published in 2011, three studies were published in 2010, two studies were published in 2009, and one study each in 2008, 2007, 2006 and 2003. 12 of the studies were journal articles, 1 is a doctoral dissertation, and 1 is a conference paper. Of the journals, 3 studies were published in the Journal of Medical Internet Research. 2 studies each were published in the International Journal of Medical Informatics, Journal of the American Medical Informatics Association, and e-Service Journal. 1 study each was published in the European Journal of Information Systems, International Journal of Pharmaceutical and Healthcare Marketing, and Electronic Journal of Applied Psychology. The conference paper appeared in the 2003 America’s Conference of Information Systems. The thesis is from Maastricht University. Although equivalent measures were considered, all papers included constructs based on the TAM constructs (Davis, 1989; Davis, Bagozzi, et al., 1989).

Characteristic	Evaluation Criteria	Pts
Study Design	1. Randomized trial 2. Non-randomized trial with control group 3. Descriptive/cohort study	3 2 1
Selection and Specification of Sample	1. Random selection with description of 4 to 5 demographic variables 2. Random sampling without sufficient description of the demographic variables 3. Convenience sampling with sufficient background information 4. Bonus point for description of number of excluded patients and reasons for exclusion	3 2 1 +1
Specification of Health Concern	1. Illness or health concern specified with reproducible inclusion/exclusion criteria. 2. Diagnostic criteria only were provided 3. Diagnosis only 4. Bonus point if all prior criteria were met and co-morbidities were described.	3 2 1 +1
Reproducability of Study	1. Description permits the reader to replicate the study 2. Results provided a standard for computing effect	1 3
Outcomes Specification and Measurement	1. Outcome measure is described and valid instrument use was clearly provided 2. Outcomes were not measured using valid and reliable instruments 3. Results did not match the described outcomes to be measured in the study	3 2 -1

Table 2: Study inclusion quality criteria, adapted from Haynes, Taylor, Snow, and Sackett (1979).

Figure 1: Diagram depicting the article evaluation process. 14 studies were finally included.



Years	2011 (5); 2010 (3); 2009 (2); 2008 (1); 2007 (1); 2006 (1); 2003 (1)
Country	Australia (1); Netherlands (4); United States (6); Hong Kong (1); Taiwan (1); Singapore (1)
Source	Journal (12); Dissertation (1); Conference Proceedings (1)
Source	Journal of Medical Internet Research (3); Journal of the American Medical Informatics Association (2). e-Service Journal (2); International Journal of Medical Informatics (2); European Journal of Information Systems (1); International Journal of Pharmaceutical and Healthcare Marketing (1); Electronic Journal of Applied Psychology (1); America's Conference for Information Systems (1); Maastrict University (1)
Intervention	Personal Health Record (2); Self-Management (2); Information (6); Communication (2); Multi (2)
Period	Description Only (4); One Use (6); > 1 month (4);
Population	General public (5); Patients (3); Disease Self-Managers (2); Chronically Ill (3); Caregivers (1)
Concern	Specific Disease (3); Wellness (3); Mental Health (3); General Health (5)

Table 3: Summary of studies from retained articles.

Calculations

This analysis involves the calculation of three figures: the effect size (ES), Q, and the confidence interval (CI). Five steps were used to calculate the effect size, as per Hunter and Schmidt (2004). First, each effect size - Pearson's r - was corrected for unreliability by multiplying it by the square root of the product of the Cronbach's alpha (Cronbach, 1951) for both the independent and dependent variable. Second, each ES is standardized into a z-score. Third, the weight for each study is calculated by first subtracting 3 from the number of cases, and then adjusted by both alphas. Fourth, the overall weighted mean effect size is calculated for the entire dataset by dividing the sum of the product of the adjusted weight and effect size z-score by the sum of the adjusted weight. Fifth, the overall effect size is transformed back into r.

As well, the calculation of Q is performed to assess homogeneity of the population represented by multiple studies. In other words, it will allow us to assume that two or more studies are making estimates on the same population. Q is utilized as a χ^2 (chi-square), along with the degrees of freedom (number of studies – 1). It is compared against the critical chi-square. To calculate Q, the squared sum of the product of the weight and the effect size over the sum of the weight is subtracted from the sum of the product of the weight and the effect size squared.

The CI will be calculated for the sample of studies, as well as each of the groups of studies, grouped by setting of use. This will result in the ability to estimate the interval in which the population mean exists, with 95% accuracy. A confidence interval that does not include zero suggests significant results.

RESULTS

Error! Reference source not found. (**Error! Reference source not found.**) contains the results[1]. The average ES over the studies was 0.65, ranging from 0.23 to 0.88. 12 (85.7%) of the studies has a large ES (> 0.5), 1 (8.5%) has a medium ES (> 0.25 and < 0.5) and 1 (8.5%) study has a low ES (< 0.25). Two of the papers didn't submit exact Cronbach's alpha for either the independent or dependent variables, so 0.7 will be assumed for these values.

Study Number	Reference	n	IV	DV	r
1	(Crutzen, Cyr, and De Vries, 2011)	343	0.91	0.87	0.63
2	(Crutzen, Cyr, et al., 2011)	343	0.95	0.91	0.72
3	(Crutzen, Cyr, et al., 2011)	343	0.95	0.89	0.75
4	(Jereskes, 2010)	167	0.80	0.94	0.72
5	(Klein, 2007)	294	0.84	0.92	0.48
6	(Klein, 2007)	143	0.87	0.91	0.21
7	(Klein, 2006)	294	0.84	0.92	0.26
8	(Whetstone and Goldsmith, 2009)	542	0.84	0.94	0.55
9	(Baulch, Chester, and Brennan, 2010)	143	0.7*	0.7*	0.62
10	(Lai, Larson, Rockoff, and Bakken, 2008)	32	0.7*	0.7*	0.61
11	(Liang, Xue, and Chase, 2011)	330	0.85	0.93	0.56
12	(Lishan, Chiuan, Choolani, and Chuan, 2009)	1071	0.91	0.86	0.54
13	(Ma and Liu, 2003)	175	0.94	0.89	0.44
14	(Or, Karsh, et al., 2011)	146	0.95	0.97	0.77

[1] Details of these calculations are available on request.

Table 3: Statistics from retained studies. * An alpha of 0.7 is assumed due to missing information.

Hypothesis 1: Perceived Usefulness and Behavioral Intention

Statistics that describe the correlation between perceived usefulness and behavioral intention are contained in **Error! Reference source not found.** (**Error! Reference source not found.**). The effect size for the entire sample is 0.6566. This effect size is quite large, suggesting a strong correlation between the two variables. Q is calculated for the sample, and compared against the critical chi-square for its corresponding degrees of freedom. Q for the entire sample is 2098.5477. This result is significant, which suggests a heterogeneous population among all of the studies, as the critical chi-square is 22.36 ($p < 0.05$, df = 13). The standard error for the sample is 0.055, for a 95% confidence interval between 0.55 and 0.76. This interval does not include zero, which suggests that the effect is significant.

ES	Size	Q	Homogenous	CI	Significant
0.66	Large (> 0.4)	2098.55	No	$0.55 < \rho < 0.76$	Yes

Table 4: Effect Size, Q and Confidence Interval statistics for group containing all studies.

Research Question 2: Setting of Use as a Moderator

The studies were assigned several coded variables, which were tested as moderators of the relationship between perceived usefulness and behavioral intention. Specifically, the intended setting of use of each of the studies was the basis of the code. This coding scheme has been validated by two researchers (one senior PhD, and one other PhD student). Codes include *mental health*, *wellness*, *general health* and *specific disease*.

The results of this partitioning are shown in Table 5 (below). Again, all confidence intervals are calculated at 95%. All four groups have large effect sizes (greater than 0.56). Two of the groups have insignificant Q values, which suggest that these groups of studies can be used to make inferences on a homogenous population. Each confidence interval does not include zero, an indicator of the presence of a significant effect.

Setting of Use	n	df	Critical $\chi 2$	ES	Size	Q	Homogenous	CI	Significant
Specific Disease	3	2	5.991	0.65	Large (> 0.4)	36.14	No	$0.42 < \rho < 0.88$	Yes
Wellness	3	2	5.991	0.82	Large (> 0.4)	0.55	Yes	$0.80 < \rho < 0.83$	Yes
Mental Health	3	2	5.991	0.74	Large (> 0.4)	5.06	Yes	$0.66 < \rho < 0.84$	Yes
General Health	5	4	9.488	0.56	Large (> 0.4)	50.62	No	$0.40 < \rho < 0.72$	Yes

Table 5: Statistics for studies grouped by setting of use, including Effect Size, Q and Confidence Interval.

DISCUSSION AND CONCLUSION

The primary goal in this analysis was to investigate the relationship between perceived usefulness and behavioral intention to use consumer-oriented web-based health tools. Specifically, two goals were sought. First, the effect size of the correlation between perceived usefulness and behavioral intention for all studies is reported. Second, the moderating effect of the setting of use is assessed. With respect to the first goal, the effect size was found to be quite large and significant, although the population is not homogenous. From this we can conclude that there is indeed a strong correlation between perceived usefulness and behavioral intention to use consumer-oriented web-based health tools. Although this is not a contentious finding, the heterogeneity of the population suggests that not all healthcare consumers are alike. In considering the population, setting of use seemed to identify some homogenous groups. This suggests that some groups of healthcare consumers, people seeking to manage wellness and mental health issues in particular, each possess distinct characteristics that apply to their use of these web-based health tools.

Several limitations affected this study. First, this meta-analysis may not have contained a complete collection of relevant studies. It did not include unpublished studies, and although several key researchers in the field were contacted regarding this, it was not fruitful. Further, only one of the authors contacted to clarify details in their article was helpful. Second, outliers may have impacted the results of this analysis. One study in particular stands out from the rest, with 1750 cases. The decision to keep this possible outlier in the sample was made, although the detection and removal of outliers warrants further consideration, amidst conflicting recommendations on how to handle outliers (Durlak, 1995; Hunter and Schmidt, 2004).

The results of this analysis lead to two distinct directions for future research. First, the existence of homogenous populations across several studies suggest that there may be opportunity to develop theory explain the use of consumer-oriented healthcare technology that focuses on distinct settings of use, including the ones proposed here. Second, as there are other constructs commonly utilized in the same models as behavioral intention and perceived usefulness, such as perceived ease of use, further meta-analyses of these studies may further reveal distinct homogenous populations of healthcare consumers, as well as in the broader nomological network in this and other contexts.

This article excluded any analysis involving the perceived ease of use construct. This is due to the large amount of varied adaptations of the TAM model. It is not certain that all of these models include perceived ease of use, therefore a separate analysis involving this construct is necessary.

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