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ABSTRACT

A short video clip has been produced and used to educate the participants of the study about functionality and different features of an online self-management support system for chronic illnesses (the system). After watching the video, participants were asked questions to test their perception of the system. The participants were patients with at least one serious chronic illness and have no prior experience to such system. The UTAUT2 a pre-validated model in technology adoption has been used to test the participants' perceptions, and PLS method was used for data analysis. The results have shown that using video to introduce and educate patients is as effective as in-person education.

Keywords — video, perception, e-health, self-management, chronic disease

1. INTRODUCTION

The Canadian healthcare system is mostly based on delivering acute and symptom-driven care, with less attention being paid to the prevention and treatment of chronic diseases [1]. In the case of diabetes [2], for example, the daily care needed to deal with the disease is largely in the hands of the patient. Therefore, developing with the patient's care provider a collaborative self-management plan becomes not just promising but essential. The self-management plan must allow patients to set goals that may involve changing their lifestyles, and to make frequent daily decisions that do not undermine their values, while also promoting effective treatment/management of their conditions [3]. To achieve this goal, decision support [4] and education and training are keys to patient self-management, since this promotes better understanding of diseases and hence adherence to treatment regimens [5], [6].

The overall goal of self-management is to improve a patient's health status and behaviour and, at the same time, to reduce and minimize the inappropriate utilization of healthcare system resources [7], [8]. Self-management can be seen to play a major role in both preventive and chronic care, and is a significant way of promoting patient quality of life, with simultaneous cost reductions for the healthcare system [8], [9].

In this study an online chronic disease self-management support system was developed that included sustainability elements such as recreational elements (e.g. games, entertaining videos, etc.), online social networks, and patient reward systems combined with support elements such as continuing education & training, family and community support, decision support, and self-monitoring. All were designed to provide feedback to patients to aid self-management of chronic illnesses. These elements could be significant factors in influencing the perceptions of users and their interest in the adoption of such a system. The system comprises a website that provides several functionalities for both patients and their care-providers. For ease of wording, the word "system" is used here to mean "Comprehensive Chronic Disease Self-Management Support System". The core of the system is based on the Chronic Care Model or CCM [10]. CCM is a heuristic model that can be used to help understand the complex nature of chronic illnesses in multiple settings. It comprises three realms including the community, the healthcare system, and the provider organization [10].

The provider organization realm, which is the target of this study, consists of four essential elements [11]:

1) Self-management support: This prepares the patients to play a collaborative and active role in their own care processes, by helping them to understand the importance of their role,
2) Delivery system design: ensures follow-up and continuity in changes to meet patient needs by composition and proper functioning of appointment systems, practice teams, and their approaches,
3) Decision support: ensures that caregivers and patients have ready access to preventive knowledge and clinical information, and
4) Clinical information: ensures that care providers can readily access patient health status information [12].

The final product (the system) incorporated all of these elements. It was designed to have a high potential for consumer (patient) adoption based on its capabilities and ease of use. However, just like any other newly developed system, potential users must be made aware of the different features and functionalities of the product.

It has been reported [13] that product learning aids can enhance consumer experience of the decision-making performance of a new product. In this study, potential consumers (patients) were in the pre-usage stage of product (system) adoption, where a narrated online video clip was created with the objective of providing an initial introduction to the features of the system and its various functionalities. Studies have shown [14],[15], [16], [17] that, using video clips for introducing products to consumers is very effective in the sense of aiding long term memory and recall of important features, in comparison with text and image-based presentations [13].

Based on these studies, a video clip that introduced the various capabilities of the system was produced, with a focus on support and sustainability elements. The video clip was then used to study the perceptions of potential system users of its usefulness in managing their chronic illnesses.

The main focus of this study is observing perceptions of users considering system adoption, after watching a video clip about the capabilities of the system. Although it has been established that Behavioural Intention (BI) is a predictor of actual use and performance expectancy, effort expectancy and hedonic motivation are also known to affect BI [18]. The UTAUT2 model was chosen for this study since it has been tested and proven to be a robust predictor of information system adoption as well as usage continuance behavior [18]. It would therefore serve to reflect the Behavioural Intention of users in this study.

However, UTAUT2 has other constructs such as Price Value and Facilitating Conditions, Social Influence and Habit. Since we are merely showing a video to the consumers (patients), elements like Price Value and Facilitating Conditions are not affected. Neither would Social Influence and Habit be affected since we only chose participants who have no prior experience with such a system. Therefore, the model was simplified to contextualize and tailor it towards the key purpose of this research [19] by eliminating Social Influence, Facilitating Conditions, Price Value and Habit constructs from the basic UTAUT2 model. Figure 1 shows the simplified model, and Table 1 explains what those constructs in the model are.

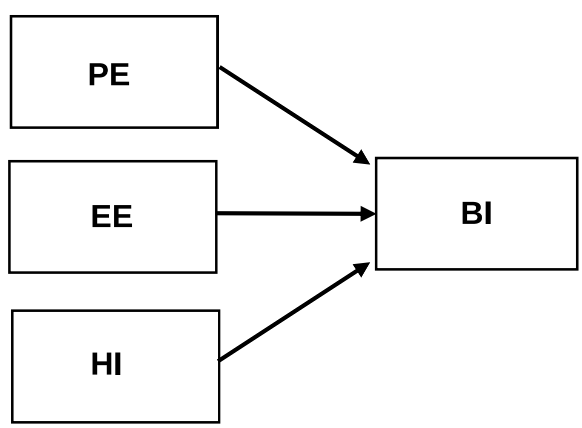

Figure 1. Simplified UTAUT2 Model

Table 1. Construct Definition

Abbreviation	Construct	Definition
PE	Performance Expectancy	The degree to which a patient believes that using the proposed CHSMSS will help him or her to attain gains in health status. Adapted with minor changes from [18].
EE	Effort Expectancy	The degree of ease or effortlessness associated with the use of the proposed CHSMSS. Adapted with minor changes from [18].
HM	Hedonic Motivation	The perceived fun, pleasure or interest derived from using the proposed CHSMSS. Adapted with minor changes from [18].
BI	Behavioral Intention	The perceived likelihood or subjective probability that patients will engage in using the proposed CHSMSS. Adapted with minor changes from [18].

2. INTRODUCTORY VIDEO CLIP

This study aimed to target individuals with any type of serious chronic disease. Therefore, an introductory video clip about the various capabilities of the system, with a focus on support and sustainability elements, was produced and used to introduce the health self-management system to participants. The intent was to study their perceptions of the system, and to note their decisions on how useful it might be to them in self-managing their chronic illnesses.
There were several reasons that a video clip was chosen to educate the participants about system capabilities, compared to other types of education and training methods, including:

1) Feasibility: Training on the actual system, using text and image based material to guide the participants through the system would have been much more time consuming; a video clip can be as effective and capable of delivering fairly the same amount of information and guidance in less time. In terms of effectiveness of the video clip comparing to text and image based presentation, research has shown that narrated videos are considered to be effective in reducing perceived ambiguity of the introduced task [20].
2) Effectiveness: In terms of effectiveness of the video clip comparing to text and image-based presentations, research has shown that narrated videos are considered to be effective in reducing perceived ambiguities in using the system [20].
3) Organization of Information: The researcher has more flexibility in the sense of organizing the information and using a variety of information delivery tools (e.g. pictures, texts, audio, etc.).
4) Better Learning Experience: Using multimedia content (i.e. video clips) instead of still images, or text-based material is believed to provide a much better learning experience in a richer format [21].
5) Identical Learning Experience for all Users: An identical learning experience for all participants in the sample improves the quality of the study's representativeness of the user population.
6) Other Studies: Other studies have recommended a video clip instead of live training, [14], [22], [17], [23]. They suggest that a video clip can be used to "create realistic facades of

what the system consists of", and they (video clip and live training) have been shown to be equivalent for the audience, in that specific sense [23].

2.1 Video Clip Content

The video clip was 9 minutes and 31 seconds long and almost evenly divided into three main sections: 1) explanation of the system or concepts (what), 2) benefits of the system for the user (why) and 3) demonstration of the features and functionalities of the system (how). These are consistent with other studies pursuing the same goals, e.g. [24], etc. The content material that was used to produce the video clip includes narrated text, related pictures to demonstrate concepts, and related animations which help to shape and explain attitudes, beliefs and intentions towards the information system.

In the first and second section of the video, through narrated text, related pictures and animation, the patient becomes familiarized with what the system is and why the patient might adopt the system. In the third section, the patient learns about different features and functionalities of the system and how to actually use them. The video was kept as short, simple and informative as possible so it was easy to understand and follow. The video clip deliberately targeted a wide range of patient demographics.

2.2 Video Clip Development Process

The video clip was produced and refined based on a variety of sources including doctoral dissertations, published research papers, expert opinions, and also a comprehensive research on videos that were created for the same purpose. The development of the video clip has three stages: 1) scenario & script development, 2) audio & voice over recording, 3) screen video recording, and finally 4) final video production. Each stage is explained here:

a) ***Stage 1*****:** *Scenario & script development*

In the first stage, a scenario that potentially covers all aspects of the system was developed. In the scenario, the "what the system is", "why should it be used" and "how can someone use it" were explained. Then the detailed script of the scenario was prepared and sent to the PhD supervisor for consultation and refinement. It took twelve (12) versions for the script to be finalized.

b) ***Stage 2*****:** *Audio and voiceover recording*

In the second stage, the audio (voiceover) of the video clip was recorded using a volunteer student[1]'s voice. Audacity[2], a free open source software, was used to record the audio for our video clip. Further, five (5) audio recording sessions were recorded before finalizing the audio.

c) ***Stage 3*****:** *Screen video recording*

In this stage, CamStudio[3], another free open source software, was used to capture and record the screen, while playing the written scenario in the system, in order to show the appearance as well as functionalities of the system to the audience.

d) ***Stage 4*****:** *Full video production*

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[1] A fulltime student at McMaster University consented to help us in this project.
[2] http://audacity.sourceforge.net/
[3] http://camstudio.org/

In this stage, Microsoft PowerPoint was used in order to tie everything together and produce the full video including the voiceover (audio), plain text, pictures, and the recorded video of the system.

2.3 Video Clip Pilot

After the video clip was made to the satisfaction of the authors, and in order to make sure that the content of the video was a good and reliable tool that could aid data collection, it was uploaded on YouTube and its link was sent to a number of experts for their consultation on different aspects of the video (e.g. text, voiceover, pictures, video, etc.).

The experts included three information systems faculty members at the Degroote School of Business, with extensive research experience in eHealth, technology adoption and information systems. After that, the video was also shown to sixteen (16) PhD students in different fields of business such as marketing, information systems and management science, and one eHealth MSc student at the DeGroote School of Business, and their feedback was collected. The reason the graduate student feedback was used was that each of them had looked at the system from their own point of expertise and also at that point most of the required feedback were about the look and feel of the system. Subsequently, the video clip was revised, based on the feedback received from all of these experts.

2.4 Technical Considerations

Following are the technical matters that needed to be taken into consideration:

a) About 29 versions of the video clip were made until it evolved to an optimal level. The initial version of the video clip was 9 minutes and 13 seconds long which was considered to be too long according to the received feedback. The final version was 6 minutes and 4 seconds long.
b) The video presented a focus on “any type of chronic disease”.
c) YouTube was used as a vessel for video clip watching and testing for all versions.
d) All the video playback control buttons were disabled to ensure participants did not skip any part of the video while watching it.
e) The video dimensions were set to automatically fit the screen size of the viewer (i.e., the maximum possible size for each viewer).
f) The quality and specifications of the video were tested on several different types of computers and hand-held devices, with various screen sizes, screen resolutions, operating systems, and web browsers.

3. DATA COLLECTION & RESULTS

The focus of this research was on the "pre-usage" stage, so study participants would have had no prior exposure to the proposed system. In addition, since there are few other online disease self-management support systems available commercially, would be unlikely to have any prior experience with similar systems.

3.1 Survey

An Internet panel cross-sectional survey method that used a commercial firm[4] was employed to collect data and test the hypotheses postulated in UTAUT2 model [18]. Administering a survey after participants had watched the video in order to test the proposed research model was appropriate, since surveys are accepted as one of the most effective tools in information systems research [25]. Moreover, using surveys, according to Webster and Trevino [26], is a typical approach to validate adoption models. In the following, an Internet panel survey was the focus of the study. The survey will be available to anyone who is interested, upon request.
In addition to the survey, participants were asked two open-ended questions:

- *Open-Ended Question 1:* participants were asked whether they were interested in using the system and if their answer was "No", they were asked to explain why.
- *Open-Ended Question* 2: participants were asked to provide suggestions for improving the system.
-

3.2 Sample Size

For the purpose of this research, a sample of 204 patients was selected, including males and females. Each claimed to suffer from a serious chronic disease (e.g. heart failure, rheumatoid arthritis, diabetes, etc. We have also screened potential participants in our study using three mandatory questions at the beginning of the questionnaire:

- I am 18 years of age or older ☐ Yes / ☐ No
- I have been diagnosed by a physician to have a serious chronic illness ☐ Yes / ☐ No
- Chronic illnesses can rarely be cured ☐ Yes / ☐ No

A "No" answer to any of these questions would result in a message to participants that they could not continue participating in the study since they were not eligible. Finally, upon completion of the survey, each participant received fair market compensation based on their membership agreement with the company. Due to company policy, no compensation was provided for participants who did not finish the questionnaire.

PLS-SEM (partial least squares – structural equation modelling) was used to analyze the data. PLS was chosen due to its strong capabilities in model evaluation, reporting and minimum data requirements [27]. The minimum sample size required to validate the proposed model using PLS was ten times the highest number of predictors, i.e., ten times the larger of the following two numbers [28]:

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[4] ResearchNow (http://www.researchnow.com/)

1) Number of predictors in the measurement block (i.e., variable) with the highest number of predictors.
2) The largest number of paths leading to a single dependent variable.

Based on the number of predictors and the largest number of paths leading to a single variable, in the simplified model of Figure 1, a sample size of 90 or higher is suitable. However, having about 200 data points ensures better validity and reliability of the study. Further, according to rules for sample size [29], a sample size of about 200 is suitable for most types of statistical analysis such as measuring group differences (e.g., t-test, ANOVA), relationships (e.g., correlations, regression), and Chi-Square.

3.3 Demographics

For the demographics of participants, consistent with guidelines on information systems research presentation of results [28], the characteristics of the study participants, included Location, Age, Gender, Level of Education and Internet Experience and Smartphone Use were acquired through demographic questions. From the 204 participants, 6 of them were considered to be outliers and therefore excluded from the analysis. From the rest (198) almost half of the participants (102) were from the USA, the other half (96) from Canada. The response rate of the participants was about 37% for USA and 27% for Canada. The following tables 2 and 3 show the results.

Table 2. Gender of Participants

Gender	Frequency	Percentage (%)
Male	104	52.53
Female	94	47.47
Total:	198	100

Table 3. Age of the Participants

Age	Frequency	Percentage (%)
18 – 29	0	0
30 - 49	14	7.07
50 - 69	151	76.26
70+	33	16.66
Total:	198	100

Considering that the incidence of serious chronic illness tends to increase with age, these results seem to be appropriate for the populations surveyed. Further, participants in the study were asked to specify their level of education. Table 4 shows the results for all participants (Canada and US).

Table 4. Education Level of the Participants

Education Level	Frequency	Percentage (%)
Did not complete high school	3	1.51
High school diploma	21	10.6
Some college	51	25.75
Bachelor's degree	77	38.88
Master's degree or higher	46	23.23
Total:	198	100

According to the results in table 4, a high percentage of the participants would be able to understand simple health related material. Since all participants used the Internet to access the survey, it could be inferred that most are Internet literate as well (some would be assisted by care partners). Based on these statistics, it could be inferred that those who answered the questionnaires understood the questions before answering and therefore their answers reflect their beliefs accurately. Moreover, all participants in the study were asked to specify whether they had Internet access and confirmed that they have access to the Internet. They were asked to specify how much they use the Internet on a weekly basis. They were also asked whether they use a smartphone or tablet. Tables 5 and 6 show the results for all participants (Canada and US). The weekly Internet use question was included for screening purposes.

Table 5. Participant Weekly Internet Usage

Education Level	Frequency	Percentage (%)
I don't use the Internet at all	0	0
Up to one hour	2	1.01
From 1 to 3 hours	25	12.62
More than 3 hours	171	86.36
Total:	198	100

Table 6. Participant Smartphone Access

Smartphone Use?	Frequency	Percentage (%)
Yes	139	70.2
No	59	29.8
Total:	198	100

According to the results in tables 5 and 6, almost 86% of participants use the Internet more than 3 hours a week and all of them use the Internet at least once a week. This indicates that they could enter data at least once a week, if they choose to do so (a requirement of the online health self-management system if they actually were to sign up to use it). Also, more than 70% of the participants have access to and use smartphones which means they would have easier access to the proposed system depending on their data plan and their intent to use the proposed system.

3.4 Common Method Bias

Common Methods Bias (CMB) is a technique that instead of focusing on the variance of hypothesized relationships among items and their related latent variables, refers to the common method variance (CMV) related to the measurement method [30].

However, a systematic and comprehensive analysis of the past IS research provides strong arguments that CMV makes no significant difference in IS-specific context research. Its findings reveal that contrary to the concerns of some skeptics, CMV-adjusted structural relationships are not statistically differentiable from uncorrected estimates [31]. Therefore, CMV and CMB were intentionally ignored in this research.

4. RESULTS

For analyzing the results of the study, the fundamental outcome in the SEM model is Behavioral Intention (BI). To check the model results, the following were determined:

- *R-squared (R^2):* R^2 is the proportion of variance explained by the antecedents of a dependent variable [32]. It is a measure of the success for predicting the dependent variable from its independent antecedents [33]. It must be high enough to have significant explanatory power [34].

- *PLS Path Estimates (β)*: The bootstrapping technique was used to determine the significance of the coefficients, based on the precision and stability of the PLS results [33]. In bootstrapping, usually about 500 resamples with replacement are taken from the original sample to obtain 500 estimates for each parameter in the PLS model. After that, t-tests are calculated for each estimated parameter in the PLS model from these 500 estimates in order to determine the statistical significance of the parameters [33]. Figure 2 demonstrates the results of the analysis.

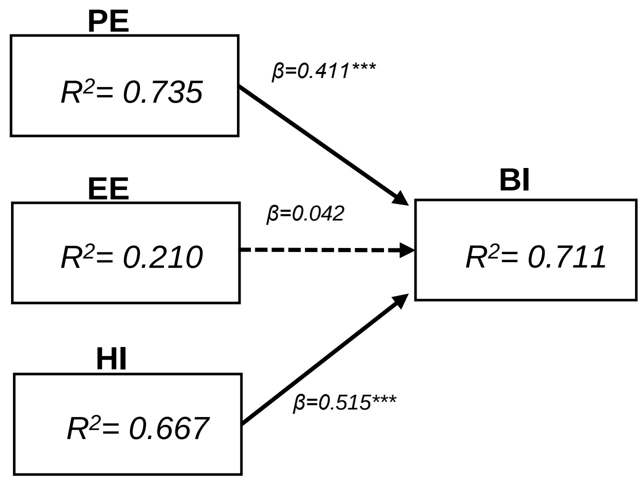

Figure 2. PLS Results[5] of the Proposed Model

Furthermore, effect size, cross-validated redundancy and the goodness of fit of the model were calculated:

- *Effect Size (f^2):* The effect size shows the magnitude of effect that an independent variable has over its related dependent variable. The values of effect size are viewed in four categories: between [0, 0.02), [0.02, 0.15), [0.15, 0.35), and equal to or above 0.35 The first of these categories is seen as non-significant and rest are an indication of small, medium and large effect sizes respectively [33]. Table 7 shows the results. The effect size is calculated from the R^2 result for the dependent variable as follows:

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

Table 7. f^2 (effect size) of the Variables

Variables	BI
PE	0.242
EE	non-sig.
HM	0.284

- *Cross-validated Redundancy (Q^2):* This is a measure of predictive relevance of the model, or how well the model can predict the behavior of variables [33]. A value of $Q^2<0$ is an indication of no predictive relevance and $Q^2>0$ shows predictive relevance [33]. According to Table 8, except for (EE) which has a medium predictive relevance, a large predictive relevance for all other endogenous variables is demonstrated by the model results.

Table 8. Q^2 for the Model Variables

[5] *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$ ------: non-significant path

Endogenous Variables	(Q^2)
PE (Performance Expectancy)	0.718
EE (Effort Expectancy)	0.189
HM (Hedonic Motivation)	0.598
BI (Behavioral Intention)	0. 697

- *Goodness of Fit (GoF):* Goodness of fit indicates the level of prediction performance of the PLS model on both structural and measurement levels [35]. The baseline values of 0.1(low fit), 0.25 (medium fit), and 0.36 (high fit) can be used to assess the overall fit of the model [36], [37]. The formula to calculate the GOF is:

$$GOF = \sqrt{\overline{Communality} * \overline{R^2}} = \sqrt{(0.9497) * (0.5807)} = 0.7426$$

This is a clear indication of a high fit.

4.1 Analysis of the Individual Characteristics of Participants on the Model

Based on the analysis of the collected participants' data, it seemed that except Age, no other variable had a meaningful relationship with the constructs of the model. Tables 9 and 10 shows the results.

Table 9. Impact of Individual Characteristics on the Model Constructs

Variables	Age		Gender		Education		Int. Use		Smartphone	
Stat.	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
PE	-0.035	0.636	-0.006	0.126	0.001	0.030	-0.029	0.647	-0.013	0.282
EE	**-0.261**	**3.036**	-0.074	0.889	0.134	1.509	0.059	0.846	-0.104	1.135
HM	-0.017	0.317	0.009	0.189	-0.034	0.714	-0.027	0.605	-0.024	0.485
BI	0.018	0.391	0.035	0.684	-0.022	0.440	0.010	0.219	0.057	1.112

Table 10. Individual Characteristic Effects on R^2 of the Model Constructs

Variables	PE	EE	HM	BI
Age	0.004	**0.102**	0.004	0.000
Gender	0.000	0.007	0.000	0.004
Educational Background	0.000	0.025	0.004	0.004
Hours of Internet Use	0.004	0.004	0.004	0.000
Smartphone Access	0.000	0.014	0.004	0.012

4.2 Open-ended Questions Results

There were two open-ended questions in the survey, in order to collect insights on the mind-set of participants regarding adoption and use of the proposed system. Table 11 shows the results of the first open-ended question.

Table 11. Results from the First Open-ended Question

Type of Concern	Number of Answers	Percentage of Responses
Too much effort	49	~ 49 %
Lack of need	22	~ 22 %
Security & Privacy	20	~ 20 %
Other concerns	10	~ 10 %

Most of the participants said that they did not have any suggestions. A number provided positive feedback such as "good work…", "it's awesome…", "well designed system", "easy to understand", etc. while some others just said "No" or "N/A" . Suggestions that are worth considering are categorized and highlights are provided in Table 12.

Table 12. Highlights of Participant Suggestions for System Improvement

Suggestions
➢ Making it more automated to eliminate data entry, so less effort and time would be needed
➢ Support for more specific conditions
➢ Linking the system to the systems of official healthcare providers
➢ Adding a professional fitness trainer
➢ Patients should be able to see what others with similar condition are doing, rather than just what they choose to post online
➢ Education for the care partner too

5. DISCUSSION

A previous comprehensive study in the field of technology or information systems acceptance examined nine different related theories including UTAUT (an older version of UTAUT2), using PLS (Partial Least Squares) analysis and compared the results [38]. For an R^2 of BI in the pre-use stage in all these theories, the study reported a range of 0.30 to 0.52 [38]. Another study [18] examined the R^2 of BI in the pre-use stage based on the UTAUT2 model and reported a result of 0.74. As shown in figure 2, the R-squared of the Behavioral Intention in this study shows that the UTAUT2 model accounted for more than 71% of the variability ($R^2 = 0.711$), which is very promising. This indicates that the video was a very good method of introducing the system to patients, since the model explained a large fraction of their behavioral intention.
Further, except for EE ($Q^2 = 0.189$) which shows a medium predictive relevance, the rest of the variables in the model have a high predictive relevance as shown in table 8. Further, model's GOF (Goodness of Fit) of about 0.74 is also very high, meaning that model performs well in predicting the intention of the potential users to adopt and use the system.

According to a variety of different studies in this context e.g. [23], [39], [40], [18], etc. there should be a strong connection between performance expectancy and behavioral intention of users (PE $\rightarrow$ BI) and also between effort expectancy of the system and behavioral intentions (EE $\rightarrow$ BI) as well as hedonic motivation and behavioral intention (HM $\rightarrow$ BI). However, while there was a significant relation between PE$\rightarrow$ BI (β=0.411, f^2=0.242) and HM$\rightarrow$ BI (β=0.515, f^2=0.283), there was no significant relationship between EE $\rightarrow$ BI, which was a bit surprising at first.

However, a careful look at the participant demographics shows that almost 90% of participants have a college diploma or a higher level of education. It may be that participants had the ability and education to easily understand the system and the benefits it provides. Having said this, an examination of responses for the first open-ended question shows that about half of the respondents felt that using such a system requires too much effort (i.e. daily interaction with the system, commitment to data entry, etc.).

Nonetheless, even those participants who did not want to use the system (due to the amount of effort needed), had a positive perspective towards the potential benefits it provides for users. In other words, the benefits of using the system appear to outweigh the effort needed from users. The latter result may account for the finding that EE doesn't have a significant effect on the Behavioral Intentions of potential users.

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