

CONTINUANCE USAGE INTENTION MODEL OF PHYSICAL ACTIVITY
TRACKING TECHNOLOGY

NITTEE WANICHAVORAPONG

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Faculty of Engineering
Universiti Teknologi Malaysia

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DEDICATION

Specially dedicated to My father and mother

I would not have accomplished this thesis without the great support from both of my parents. The more I think of them the more I have encouragement to move forwards with all my full willpower to this study goals.

~ Nitte ~

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ABSTRACT

In eHealth, physical activity (PA) tracking technology exists that can assist people in monitoring their PAs. However, long-term use is the cornerstone of information technology (IT) product and service success; otherwise, it is a failure. Then, persistence becomes a factor of concern and it fades away over time. There is limited knowledge of information system (IS) continuance in this domain called PA tracking devices and apps (PATDA). Prior IS continuance research has no suitable models that can explain continuance intention (CI) of PATDA. The aim of this study is to build a model that predicts users to continue using PATDAs. This study also demonstrated the use of expectation-confirmation model (ECM), Network externalities (NE), and Value-based factors to understand CI of PATDA. Through data collection, a survey method was carried out among PATDA Singaporean users. The proposed model has been tested for reliability and validity using a Structural Equation Modelling (SEM) method. The results exhibited that all the ECM constructs had statistically significant impacts on CI. However, Social Value (SS) had rather an insignificant correlation with CI. Referent Network Size (RNS) also received an insignificant association with Usefulness. Besides, the analysis showed many of the constructs clustered in the group that yielded high performance and importance, including Satisfaction, Utilitarian, Confirmation, Hedonic, Complementarity, and Usefulness. Referent Network Size arrived in the middle between Social Value, which is rated as insufficient on performance and importance and the outstanding group. The research model can be functioning as a guideline to increase the understanding regarding the CI of a PATDA. By applying the evaluation result of identified factors, stakeholders can embrace a range of benefits from PA tracking technology in connection with research, product features, and usage.

ABSTRAK

Dalam eKesihatan, terdapat teknologi pengesanan aktiviti fizikal (PA) yang boleh membantu pengguna memantau PA mereka. Dengan beberapa produk dan perkhidmatan teknologi maklumat (IT), penggunaan jangka panjang adalah asas kepada kejayaan; jika sebaliknya, ia merupakan satu kegagalan. Oleh itu, kegigihan menjadi kebimbangan dengan penggunaan yang berterusan. Walau bagaimanapun, terdapat pengetahuan terhad mengenai sistem maklumat (IS) yang berterusan dalam domain ini yang disebut peranti dan aplikasi pengesanan PA (PATDA). Penyelidikan berterusan IS sebelum ini tiada mempunyai model yang sesuai yang boleh menerangkan niat berterusan (CI) PATDA. Tujuan kajian ini adalah untuk membina sebuah model yang mendorong pengguna untuk terus menggunakan PATDA. Kajian ini menggunakan model pengesanan-jangkaan (ECM), Rangkaian luaran (NE), dan faktor berasaskan Nilai untuk memahami CI PATDA. Melalui pengumpulan data, kaedah kaji selidik telah dijalankan di kalangan pengguna PATDA di Singapura. Model yang dicadangkan telah diuji kebolehpercayaan dan kesahihan menggunakan kaedah Permodelan Persamaan Struktur (SEM). Hasil kajian menunjukkan bahawa kesemua kontrak ECM mempunyai kesan signifikan secara statistik terhadap CI. Walau bagaimanapun, nilai sosial (SS) tidak menunjukkan hubungan yang signifikan dengan CI. Saiz Rangkaian Rujukan (RNS) juga menunjukkan persamaan yang tidak signifikan dengan Kegunaan. Selain itu, analisis menunjukkan banyak kontrak yang dikumpulkan dalam kumpulan yang mempunyai prestasi tinggi dan berkepentingan seperti Kepuasan, Praktikal, Pengesanan, Kesukaan, Pelengkap dan Kegunaan. RNS dinilai rendah di kedua-dua skala prestasi dan kepentingan. Model yang dicadangkan dapat berfungsi sebagai panduan untuk meningkatkan pemahaman tentang CI dari PATDA. Dengan menggunakan keputusan penilaian faktor-faktor yang dikenal pasti, pihak berkepentingan boleh meningkatkan lagi pelbagai faedah dari teknologi pengesanan PA berkaitan dengan penyelidikan, ciri produk dan penggunaan.

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LIST OF ABBREVIATIONS

ACP	-	Average Congruency Percentage
AMOS	-	Analysis of A Moment Structures, a statistic CB-SEM application
AVE	-	Average Variance Extracted
BBC	-	British Broadcasting Corporation
BS	-	Bone-strengthening
CA	-	Cronbach's alpha
CB	-	Covariance-based
CFA	-	Confirmatory Factor Analysis
CI	-	Continuance intention
CR	-	Composite Reliability
CVI	-	Content Validity Index
DV	-	Dependent variable
ECT	-	Expectation Confirmation Theory
ECM	-	Expectation and confirmation Model
EFA	-	Exploratory factor analysis
HE	-	Hedonic
HPB	-	Health Promotion Board
HTMT	-	Heterotrait-Monotrait ratio
IoT	-	Internet of Thing
IPMA	-	The importance-performance map analysis
IS	-	Information system
IT	-	Information Technology
IV	-	Independent variable
LTPA	-	Leisure-time physical activity
MET	-	Metabolic Equivalent of Task
MI	-	Multiple Mutation
MS	-	Muscle-strengthening
MVPA	-	Moderate-vigorous intensity physical activity
NE	-	Network Externalities

PA	-	Physical activity
PATDA	-	Physical activity tracking device and application
PATT	-	Physical activity tracking technology
PBC	-	Perceived Behavioral Control
PC	-	Perceived complementarity
PEOU	-	Perceived ease of use
PLS	-	Partial Least Squares
PU	-	Perceived usefulness
PV	-	Perceived Value
RNS	-	Referent network size
SCT	-	Social Cognitive theory
SDT	-	Self-determination Theory
SEM	-	Structural equation modeling
SIT	-	Social Interaction Ties
SLR	-	Systematic Literature Review
SM	-	Social media
SNSs	-	Social Networking Sites
SS	-	Social value
TAM	-	Technology Acceptance Model
TPB	-	Theory of Planned Behavior
TRA	-	Theory of Reason Action
TTM	-	Transtheoretical Model
UGC	-	User Generated-Contents
UT	-	Utilitarian
UTAUT	-	The Unified Theory of Acceptance and Use of Technology
VB	-	Variance based
VIF	-	Variance Inflation Factors
WAT	-	Wearable activity trackers
WFT	-	Wearable fitness technologies
WHO	-	World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Sedentary lifestyle activities such as watching television, working with computers or playing games may, consequently, lead to unwanted chronic diseases (Biswas et al., 2015). The reduction of screen time has been studied as the effect of lessening the inactive issue, in fact; these scholars tried to detect the relationship between cause and effect (Mark & Janssen, 2008; Olds et al., 2006). In addition, inactivity is harmful to an individual as it introduces obesity and diseases, thus reduces the quality of life. Researchers came up with one of the solutions that physical activity (PA) can be performed together with lifestyles, and quoted walking is free (Sullivan & Lachman, 2017). Recently, there has been a shift in the focus of health prevention programs. As such, any individual who has a severe health issue would need a real discipline and commitment to alter the inactive lifestyle. To elucidate this, the promotion of especially moderate-vigorous physical activity (MVPA) intensity (e.g. brisk walking, jogging, cycling, dancing, sprinting, and swimming) must be done in an efficient way to diminish the difficulty and to enhance the quality of life.

The evolution of activity tracking technology starting from electric typewriters, which are used to record people's activities manually (BBC, 2017). Later, web platforms whereas individuals monitor their PA by entering data into the systems, mounting with social media site (Web 2.0) then individuals can upload photos, videos, and other multimedia types with the ability to share their activities, ideas and thoughts to other friends or people on the same network community. In the digital age, the arrival of eHealth delivers an alternative practice to a typical method by combining information and communication technology (ICT) including

computers, cellphones, tablets, mobile devices, social media (SM), and the Internet with healthcare to increase the quality of health practices (Baker et al., 2014; Oh et al., 2005). It is valid, there is a concern that research in eHealth would not keep up with the speed of technological development. Then, fitness and PA tracking technology that can assist people in monitoring and archiving PAs, including a wearable device, a smartphone app, and a web-based app are gaining popularity and enjoying the flourishing market. Wearables (Garmin, Samsun gear, Apple watch, and Fitbit), and apps (Runtastic, Strava, Runkeeper, and Endomondo) are the examples of Quantified Self. The latest technology, including smartphone apps (Middelweerd et al., 2014) wearable devices (Canhoto & Arp, 2017) and smart devices (Lazar et al., 2015) that aid people with automated tasks, for instance, logging data and uploading to servers for further usages.

PA tracking technology plays the important role in assisting and improving their health behaviors for examples tracking, monitoring, visualizing, and archiving PA. Even though the immense benefits from PA tracking technology many others failed to constantly use it in the long-term rather they try and intermittently use the technology. The continuance intention (CI) of information technology (IT) goods and services has intrigued researchers for decades in tackling the issue of long-term use (Bhattacharjee, 2001; Kim et al., 2007; Jin et al., 2007). Despite the increasing popularity of PA tracking technology, it is being challenged with the high rate of abandoning (Lazar et al., 2015). Therefore, the improvement in this situation can be accomplished from research focusing on the CI of physical activity tracking devices and applications (PATDA). Certainly, stakeholders, including health professionals, producers, and researchers can refer the study results to broaden their perspectives about the CI of PATDA.

1.2 Problem Background

Previous research studies addressed the continuance use of eHealth, for example, mHealth services (Akter et al., 2013), Mobile Wellness Application (MWA) (Yusof & Iahad, 2013), and smart-connected sports products (Song et al.,

2017). Currently, there is still lacking research on the continuance usage of PATDA. Finding the real solution to identify the influential factors pertaining to the CI of a PATDA must be accomplished. A research study focused on PA phone application and behavior change tools admitted making long-term engagement of users is challenging (Karapanos, 2015). In relation to CI, many of the variables were extracted and derived from multiple sources (Touzani et al., 2017, Zhou et al., 2016, and Nabavi et al., 2016) including theories, frameworks, and models, which are for their specific purposes and contexts. Thus, there should be a research study that focuses on the CI of PATDA in order that this will contribute to the more understanding, and stakeholders can benefit from the study. Therefore, it is best to identify the variables that help to increase the knowledge of the CI of PATDA. The meaning is that research studies have to connect together what factors influence people to continue using PA tracking technology in order to plan and locate more resources in the right direction.

Persistence becomes a primary concern with continuing to use of Physical activity tracking technology (PATT) as self-monitoring is likely to fade away over time when people ending up with similar amounts of activity each day then PATT turns to an unnecessary thing (Karapanos, 2015). Clawson et al., (2015) contributed their study to the reason behind the abandon of the devices on a classified website. Many users left behind their devices sometime after six months and half of them reported no longer use the devices. In spite of the growing popular usage of PA tracking devices and adoption, there exists that an increasing concern with the technology would not capture long-term use. As such, the evidence can be found on craigslist.com posted by the previous owners (Lazar et al., 2015, Shih et al., 2015) using for a short time because this technology may not answer their needs or the usage is only to achieve their set goals and then abandoned them. Substantially, a huge number of users were not succeeding in prolonged use and half of those owners stop using PA trackers. Besides, 75% deserted their PA trackers within six months (Ledger & McCaffrey, 2014). A variety of downloadable applications available for easy use do not guarantee long-term use (Yusof & Iahad, 2013) in a mobile wellness context which specializes in obesity monitoring. For the reason, this research study will look for the solution to increase the prolonged utilization of PATDA.

There is the evidence from that the absence of a model that will be used to understand and predict the CI for PATDA from the systematic literature review, there appears to be the necessity of having an appropriate model. Based on a study conducted by Nabavi et al., (2016), the most-used model in IS continuance is ECM (Bhattacharjee, 2001) where it has been used in a variety of IS contexts such as mobile phone subscription, mobile banking, online banking, online shopping, and e-learning. It seems there is a limitation of the model in covering and understanding other aspects, for example, network externalities and value-based factors. By assigning factors from these aspects, the knowledge of can be acquired thus it increases the understanding of these parts.

The understanding between technology and users' behaviors will bolster the way people use it to make a PATDA meaningful and suitable for an individual. In addition, ECM emerged in 2001 when there is non-existence of a newly eHealth concept and after two decades, ECM needs to be equipped with additional constructs to handle many innovations and changes in terms of technology, business and users' requirements. Apparently, the extension of NE would be favorable to increase and broaden the understanding of the CI. NE (Katz & Shapiro, 1985) and prior research studies have reported NE has a positive influence on both enjoyment and usefulness (Gao & Bai, 2014; Zhou et al., 2015). Touzania et al., (2017) implies that value-based factors have the degree of contribution to increase the continuance usage level. Li et al., (2013) analyzed the CI of a social network game and reported these value-based factors having the degree of influence to the CI. The combination of these models and factors which formed a conceptual model can be used to predict and understand the CI of PATDA and this expands the body of knowledge. The model is proposed to fill up the missing piece of the previous IS continuance model (Bhattacharjee, 2011) by integrating NE and value factors to cover more on other perspectives.

IS continuance research was identified from previous studies as implementation, incorporation, and routinization (Zmud, 1982; Kwon & Zmud 1987; Cooper & Zmud 1990). In addition, the high cost of achieving new users is five times or 80% more than retaining the old users, which promotes the attention for research (Bhattacharjee, 2001). The initial use and acceptance of IT products or

services triggered much of interest for research in IS success, on the other hand, the continuous long-term use poses a bigger challenge. This is the preferred solution rather than the first adoption due to IS continuance actually leads to project success (Bhattacharjee, 2001; Akter et al., 2013). In other words, an IS project can be classified as successful; it needs to show a significant number of IT product or service users have moved from the initial adoption by using IT technology a continuous and long-term basis. There exists that the evidence pointed out the determinants of the dependent variable in adoption and continuance consisted of different factors (Limayem et al., 2007). Consciously, it sounds more difficult in practice than in the reality to gain success in the sustainable long-term use of IT products and services (Limayem et al., 2007).

From the review of a similar context, it appears research studies asserted that users faced with difficulty in embracing the technology for long-term use; however, the situation would be in reverse as they switched back to their old habits (Yusof & Iahad, (2012). There exists that a bunch of technical problems causes a halt in long-term use. Research in this area is still immature, and a number of studies highlighted on the reliability and validity of measures (Lunney et al 2016). Users do not like to wear a PA tracking device as they feel uneasy, or they may not consent to use it as a stylish accessory (Mekky, 2014). Certainly, there is the absence of a proper solution to the continuance usage in PA tracking technology. This implicitly indicates that they will exit and desert the technology in later stages. Akter et al., (2013) affirmed that promoting mHealth services cannot just maximize and expand the accessibility or make low costs. Next, it happens to some individuals who IT tension results in isolation and in turn make them disconnected in the context of connected objects (Touzani et al., 2017). The limited knowledge of the post-adoption behaviors and repetitive use behaviors developed a level of concern to IS continuance research, as well as the emotional state of users from a variety of modern technologies.

Singapore has an effective healthcare system, along with the expenditure on healthcare is S\$7.6 billion, which is equal to 3.8% of the GDP in 2005 (Wong & Lee, 2008). On the other hand, Straitstimes, (2016) reported Singaporean workers appeared to be lacking PA, which is affected by stress as reported by a survey conducted by Willis Towers Watson, an advisory company. They were subjected to

stress (56%), lack of PA (52%), lack of sleep (32%), and obesity (24%). In addition, this indicates that lacking PA has a strong correlation with stress and obesity among them. In response, Singapore's government invested heavily in the wellness of their people as seen in the promotion of health promotion board (HPB), a Singapore government unit has come up with a step challenge program and many events.

1.3 Problem statement and research questions

One of the main interests is that eHealth research would lag behind the fast pace of ICT development (Baker et al., 2014). There is still a concern that the technology may not make longstanding use that has been addressed. In addition, studies focused on the adoption of PA tracking technology and mHealth are in surplus however, prior research addressed no concern with the CI of a PATDA (e.g. Al-Debei et al., 2013; Zhou, 2013; Song et al., 2017; Cho et al., 2014; Canhoto & Arp, 2017; Lunney et al., 2016). In order to reduce the time and effort of inputs in full production and avoiding pitfalls, the measures of importance and performance have to be empirically measured. Obviously, these are the identified gaps that need to be filled to improve the situation and to build up the knowledge in this specific area for the purposes of use in research and other solutions.

This study started with a research question is "How to understand users' behaviors regarding the continuance usage intention of physical activity tracking devices or apps (PATDA)?" In order to tackle this, the research question is fragmented into 3 smaller questions. They are described below:

1. What are the factors that influence the continuance usage intention of a PATDA?
2. What is the appropriate model that explains the continuance usage intention of a PATDA?
3. How to evaluate the proposed model of the continuance usage intention of a PATDA?

1.4 Research objectives

The objectives of this study, which are corresponding to the sub research questions are as follows:

1. To identify the important factors that influence a user's intention to continue using a PATDA.
2. To propose a model of continuance use intention of a PATDA.
3. To evaluate and assess the model for the continuance use of a PATDA.

1.5 Research Scope

According to the research questions and objectives, the directional intention of the study focus is the users' CI. This study focuses on only for PA tracking for health preventive reasons. Besides, this study has no intention to resolve technical and engineering issues, for instance, testing algorithms to improve accuracy and establishing a new method to measure reliability and validity.

This study would target potential PATDA users in Singapore's environment, including the ages between 21 and 60. This is the working-age range, thus their mental and physical are shaped by the determination to maintain health. These are the ranges that Gao et al., (2015) reported that they were two groups of people in the US who use this type of technology are the young people and older people. The respondents are Singaporean who have experience using a PATDA. The intention of this research study is to understand and predict CI from other dimensions.

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