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System and Information Qualities in Mobile Fitness Apps and Their Effects on User Behavior and Performance

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ABSTRACT

Grounded in goal setting theory and other IS models, this study introduces a robust model, that examines the determinants of MFA goal setting and goal tracking use, and their impact on user behavior and achievement. The empirical results show that system quality and information quality are two key determinants of MFA goal setting and goal tracking use, which significantly influence a user's goal achievement and behavioral change in terms of physical activities.

KEYWORDS

Goal setting theory; mobile fitness applications; goal tracking; PLSc; information quality; system quality

Introduction

Smartphones have completely or partially replaced pay- phones, Global Positioning System (GPS) devices, scanners, alarm clocks, cameras, voice recorders, music players, calculators, maps, televisions, and many other devices. Since Steve Job's vision (Eadicicco & Leswing, 2020) about the Apple Store in 1983, using mobile applications (apps) in smart devices to communicate, entertain, open businesses, or track health performance has created the "new normal" for these activities. After nearly two decades of bringing the Internet to our pocket, smartphones have become irreplaceable tools for an increased number of people world- wide. For example, the number of active apps in the Apple App Store increased from 49,538 in July 2008 to 3,420,161 in July 2020, rising 6,804% (Statista, 2020b).

The recent COVID-19 pandemic has amplified our reliance on smartphones. As of March 2020, when many countries were on partial or complete lockdown due to COVID-19, smartphone usage increased by 70% world- wide, 40% in the United States, 86% in China, and 72% in Italy (Statista, 2020a). Installation of specific apps, such as health and fitness apps, increased by 67% in a brief time from late March to early April of 2020, com- pared to the same period of 2019. One possible explanation is that people spent more time at home and may have wanted to enhance their immune systems via in- house physical activities. In a recent study, about 70% of respondents would be less likely to go to the gym during April of 2020 because of the pandemic (Statista, 2020c). However, this increase was also amplified by the emerging use of mobile health and fitness apps before the pandemic began. An increased number of health and fitness apps were introduced in digital stores such as the Apple, Microsoft, and Google Play stores. In the Google Play store, the total number of Android health and fitness apps increased from 17,756 in 2014 to 103,231 in 2020, an increase of 481% (Appbrain, 2020; Middelweerd et al., 2014). The digital health industry's global funding was $14.6 billion in 2018, which is about two times greater than in 2015 (Statista, 2020d).

Mobile Fitness Applications (MFAs) are used to set daily exercise goals, track work-out hours, count the steps or calories burned, provide feedback or credits for each achievement, or share achievements with other users. Previously published studies in the Information Systems (IS) literature have extensively investigated the adoption of MFAs (e.g., Dhiman et al., 2019; Lim & Noh, 2017; Murnane et al., 2015, September). Using a digital laboratory experiment, Lim and Noh (2017) showed exercise self-efficacy and out- come expectation of exercises as the two main driving factors of MFA use. Dhiman et al. (2019) used the extended theory of acceptance and use of technology (Venkatesh et al., 2012) to determine driving factors of intention to use MFAs such as performance expectancy, social influence, price value, personal innovativeness, and habit. Other studies (e.g., Barkley et al., 2020; Bort-Roig et al., 2014; Fanning et al., 2012; Huang & Ren, 2020) have examined the impact of MFA use on physical activity behavior. For example, Fanning et al. (2012)

and Bort-Roig et al. (2014) showed the influence of data reliability of MFAs on users' behavioral change. Higgins (2016) identified the potential influence of using MFAs on improving patient health. Barkley et al. (2020), studying the relationships between fitness app use and physical activity behaviors, found that individuals who self-selected to use MFAs were more physically active than those who did not use MFAs. Conceptualizing the expectation–confirmation model and the investment model, Chiu et al. (2021) found that users' satisfaction and investment size positively affects their commitment to using fitness and health apps, which lead to their continuance intention. A study by Katheeri (2020) found that trustworthiness, competition, learnability, and feelings of enjoyment are major factors that impact the usability of mobile health apps.

While goal setting and goal tracking are two main functions of MFAs, an extensive literature review shows that the driving factors of using goal setting and goal tracking functions provided by MFAs and the direct impact of these functions on users' achievement or behavioral changes have remained unknown. Goal set- ting and goal tracking functions are also used in other apps, such as productivity apps (Stawarz et al., 2015), learning languages apps (Nushi & Eqbali, 2017), and personal financial management apps (Bitrián et al., 2021). Therefore, it is important to investigate the roles of goal setting and goal tracking functions in behavior change interventions on mobile apps. This study aims to address the research gap on factors that influence the use of goal setting and goal tracking on mobile apps and its impact on user behavior change. Specifically, this study addresses the following research questions:

> Question 1: How do system quality and information quality influence goal setting and goal tracking use on mobile applications?
> Question 2: How do the use of goal setting and goal tracking on mobile applications influence users' behavioral change?
> Question 3: How do the use of goal setting and goal tracking on mobile applications influence goal achievement?

Grounded in goal setting theory (Locke, 1996; Locke & Latham, 2006), the IS success model (DeLone & McLean, 1992), Wixom and Todd's (2005) model, and other published models in the IS literature, this study proposed an integrated model, which shows the determinants of the most important functions of MFAs, including goal setting and goal tracking, and their impact on behavioral change and goal achievement. The proposed model was empirically tested using survey data. The model is expected to contribute to IS research by highlighting the impact of goal setting and goal tracking use as system functions on the performance of individuals. The model can also be adapted to other contexts such as nutrient and diet apps (Tang et al., 2015), self-study apps such as studying new languages (Bursali & Öz, 2018), online advanced coursework learners (Handoko et al.,

2019), and personal financial management apps (Bitrián et al., 2021). The rest of the paper proceeds with a brief preview of goal setting theory, goal setting in the context of MFAs, and goal acceptance model. Then, we discuss the hypotheses development, describe the research methodology, and present data analysis and results. We conclude the paper with discussions on theoretical and practical contributions of our findings."

Literature review

Goal setting theory and physical activity

A goal is defined as the desired result or an aim of actions, typically within a limited time (Locke, 1996). A goal stands for the discrepancy between one's current condition and the need to achieve future value outcomes (Locke & Latham, 2006). Locke and Latham (2002) demonstrated that setting goals could enhance performance quality. Their goal setting theory describes how different types of goals affect individual performance and how setting goals can lead to positive behavior. This theory was based on 400 laboratory and field studies over 35 years, demonstrating that a goal affects performance through four mechanisms (Locke & Latham, 2002). First, a goal's directive function indicates that a person will cognitively spend his/her energy on goal-relevant actions and refrain from goal-irrelevant ones. Second, a goal's energizing function expresses the positive correlation between goal difficulty and its corresponding level of task performance. For example, a specific or high standard goal enables a correspondingly high level of task performance, while a vague goal leads to an irrelevant level of performance and negatively unexpected results. The third mechanism shows the effect of goals on persistence. A tight or intense goal may lead to more effort in a brief period, while loose or less intense deadlines lead goal makers to work more slowly and last for a longer time. LaPorte and Nath (1976) confirmed that a difficult goal helps maintain effort when time is not limited. The fourth mechanism reveals the indirect effect of a goal on actions. Depending on the background knowledge and skills, people, when encountering a specific goal, may have different actions such as apply/modify already acquired skills, innovate new strategies, or learn new skills to achieve the goal.

In the literature of industrial psychology, goal setting has been strongly considered a motivational tool to improve job performance. However, the benefits of goal setting on sports performance had not been clearly supported until the introduction of Kyllo and Landers's (1995) study, which is considered the first to empirically confirm the positive influence of goal setting on sports performance. Follow-up studies (e.g., Burton et al., 2010; Burton & Weiss, 2008) also addressed the importance of goal setting on sport/exercise performance in different contexts or human subjects such as student-athletes or

U.S. Olympic athletes. Later, Weinberg (2013) proposed major stages of goal setting and a seven-step goal setting guideline to improve sport/exercise performance effectively. Besides the benefit on sport/exercise performance, the combination of goal setting and physical activity is possibly an effective behavioral change strategy, which has been demonstrated by previously published studies (Kyllo & Landers, 1995; Shilts et al., 2004; Whitt-Glover & Kumanyika, 2010). For example, Shilts et al. (2004) showed the role of goal setting in the health intervention domain, in which goal setting was used as a motivational tool to encourage behavior change in physical activity and healthy diet.

Goal setting in the context of MFAs

In the MFA industry, persuasive technologies, which are key factors to encourage IS adoption, are defined as interactive tools that motivate and influence users' actions and behavior. Human behavioral studies, psychology, and behavioral economics have been used by technology designers to create proper persuasive technologies for digital technologies such as smartphones and social media. In Consolvo et al.'s (2006) study, small groups of participants shared their step counts and progress toward daily goals using a mobile phone application prototype. The study found four major requirements of persuasive technologies to encourage physical activity, such as rewarding users with credits for designed activities, allowing users to track behavior status, enabling social support from other users, and understanding the practical issues of each user's lifestyle. The first two criteria possibly stand for the role of goal and goal tracking, respectively. Consolvo et al. (2009)'s study tracked the MFA use of 28 participants in three months and examined their reactions to various types of goal-setting considerations such as who should set the goal and the timeframe in which an individual should achieve the goal. The results indicated that users would rather to set the goal themselves or with the help of fitness experts than to follow the goals set by medical experts, national guidelines, or social network groups. For the goal timeframe, users preferred their goals being set for a calendar week to the ones set by a rolling seven- day window or fixed calendar week.

Some MFAs have recently been pre-installed on mobile devices such as Apple Health on the iPhone or Samsung Health on Samsung Galaxy phones. Many MFAs provide goal setting and goal tracking functions to set one or multiple goals, track steps, measure traveled distance, and monitor different types of exercises. For example, to set daily goals, users can use Google Fit, an application for fitness tracking to measure work-out hours, daily steps, and calories burned. MFAs also provide helpful feedback or proper credits to encourage users to achieve their goals. After each achievement, users can share their success on social media sites.

In the IS literature, many studies (e.g., Bort-Roig et al., 2014; Fanning et al., 2012; Huang & Ren, 2020; Khakurel et al., 2018) identified wearable devices, smart- phone applications, or MFAs as

tools to track and positively influence physical activity behavior. Fanning et al.'s (2012) and Bort-Roig et al.'s (2014) meta-analysis studies demonstrated the reliability of the physical activities data captured by the smartphone and supported the potential influence of smartphones on behavioral change. However, both studies addressed the need for more rigorous research on this topic with larger sample sizes or different research designs. Several studies have focused on finding the determinants of MFAs' use and their benefits (Dhiman et al., 2019; Lim & Noh, 2017; Murnane et al., 2015, September). Also, Murnane et al. (2015) identified reasons why users uninstall MFAs, such as phone system incompatibility or lack of tracking and notification features. However, no study has investigated the determinants of the actual use of MFA goal setting, goal tracking, and their benefits.

Conn et al. (2011) showed that behavioral interventions, including goal setting, goal reviewing, self-monitoring, or performance measurement, are more effective to increase greater physical activities and effectiveness among healthy adults than cognitive interventions, including health education, decision making, problem- solving, or providing information. These behavioral interventions are matched with the most frequently used behavior change techniques used in most popular health and fitness apps, including performance feed- back, prompt self-monitoring, specific goal setting, social support, and contingent rewards (Middelweerd et al., 2014; Munson & Consolvo, 2012; Normand, 2008). Samdal et al. (2017) discussed the short- and long-term effect of goal setting and self-monitoring on behavioral change in overweight and obese adults, based on 42 previously published studies. Higgins (2016) sup- ported the use of MFAs to improve patient health and fitness and suggested that insurance companies could encourage customers to use MFAs to lower premium costs. Higgins (2016) also called for more research to objectively investigate the effectiveness of MFAs on patients' behavioral changes and improved well-being. The extensive literature shows that although goal setting and goal tracking are essential functions of MFAs, the causal relationships between goal setting and goal achievement, and goal tracking and behavioral change have not been studied in the context of MFAs. This study fills that void in the literature. It also proposes a new framework for finding the determinants of goal setting and goal tracking use to determine their impact on goal achievement and behavioral changes. The key determinants of the use of goal setting and goal tracking are conceptualized from essential factors of previously published models in the IS adoption literature.

Goal acceptance model

An extensive literature review of IS adoption theories such as the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1969), the Technology Acceptance Model (TAM; Davis, 1985), the IS Success Model (DeLone & McLean, 1992), the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2012), and Wixom and Todd (2005) shows that new models were

often extended by integrating or using essential factors of previously published models. For example, conceptualizing the theories in TRA and TAM, DeLone and McLean (D&M) proposed a framework of causal interrelationships among IS success factors, including system quality, service quality, information quality, system use, level of satisfaction, and system benefits (DeLone & McLean, 1992; Petter et al., 2013).

The system quality construct captures the technical success of IS, while information quality stands for the semantic success of an IS system. In addition, the IS success model addresses the relationship among actual use, user satisfaction, and system benefits, capturing the individual or organizational impacts of an IS system. The IS success model postulates that higher IS quality, which is captured by system quality, information quality, and service quality, leads to higher use and user satisfaction, which in turn leads to increased impacts on individual or organizational productivity. Adapted from D&M's IS success model, which is one of the most used in IS research (Petter et al., 2013), this study pro- posed a model showing system usage as a mediating variable of the relationship between IS quality and the impact of system usage on individuals or organizations (see Figure 1). The proposed model also conceptualizes the IS quality in Wixom and Todd's (2005) and Petter et al.'s (2013) studies, which identify the major components of system quality and information quality. System quality can be accessed by several factors, including reliability, flexibility, integration, timeliness, and accessibility (Petter et al., 2013; Wixom & Todd, 2005). Information quality, which refers to the extent a user perceives the quality of output that an MFA system produces, can be accessed by measurements of completeness, accuracy, currency, and format (Petter et al., 2013; Wixom & Todd, 2005).

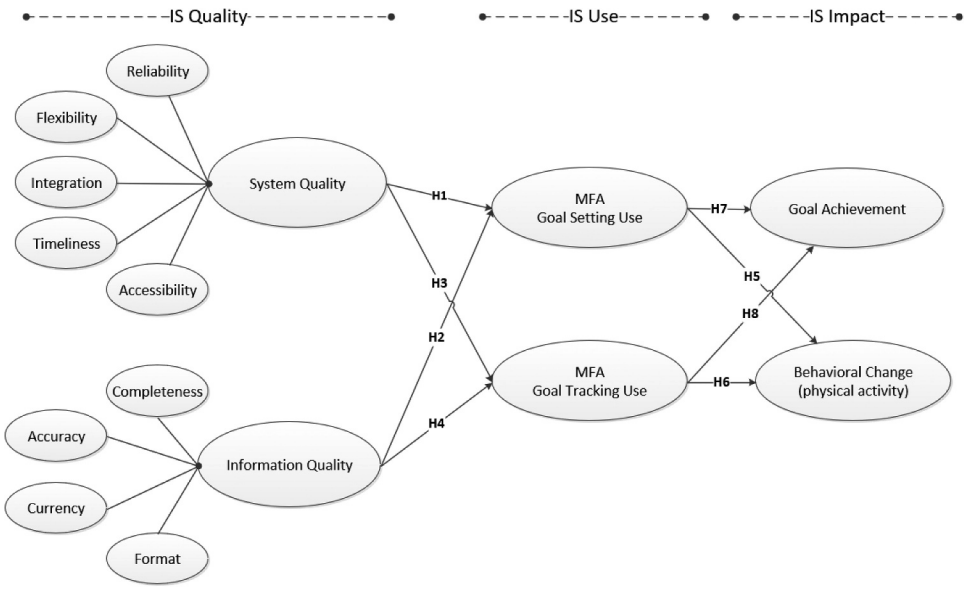

Figure 1. Goal acceptance model.

Previous researchers have shown that systems usage constructs have been conceptualized in four different domains: IS success, IS acceptance, IS for decision-making, and IS implementation (Burton-Jones & Straub, 2006; Devaraj & Kohli, 2003; Doll & Torkzadeh, 1998). Burton-Jones and Straub (2006) conceptualized system usage based on its structure, which combines three elements: the user, system, and task. Each element's roles and measurements are relatively tied to other constructs in newly proposed models and depend on different research contexts. In this study, goal setting and goal tracking were considered as two major system usage constructs. In addition, system usage is often referred to as the utilization of an IS at three different levels, including individuals, groups, or organizations (Chan, 2000; Straub et al., 1995). In the research context of MFAs, the model is designed to analyze the impact on individual users. In other words, the proposed model helps explain how information system quality affects goal setting and goal tracking use, as well as, their impacts on individual performances.

Hypotheses development

Goal setting and goal tracking using MFA

As mentioned in the literature review, the proposed model includes the two key factors of IS quality: system quality and information quality. System quality refers to the extent users perceive the quality of the technical aspects of an MFA system, which includes software and data components (Petter et al., 2013). System quality can be accessed by various factors, such as reliability, flexibility, integration, timeliness, accessibility, functionality, credibility, monitoring, scalability, and speed. Information quality refers to the extent users perceive the quality of outputs that an MFA system produces. Information quality can be assessed by measurements of completeness, accuracy, currency, format, precision, logging, and verification. However, including or excluding proper factors to measure system quality and information quality depends on the research context and the type of IS system. (Forsgren et al., 2016; Petter et al., 2013).

According to the IS success model (DeLone & McLean, 1992), system quality directly affects user intention to use the system and the actual system use of goal setting and goal tracking. System quality represents IS excellence, a level of the system which properly offers its major functions, and IS value, a degree to which the software is easy to use, learn, and maintain (Gorla et al., 2010). In this study, goal setting use is defined as the extent to which users set their physical activity aims using MFAs. Middelweerd et al. (2014) showed that frequently used goal settings in the most popular MFAs are performance goals and specific goal setting, such as assigned daily steps or exercise schedules. Some MFAs require users to provide their goals along with users' demographic information, such as age, gender, and health-related issues, to

generate better recommendations for appropriate physical activity goals (Elavsky et al., 2017). When an MFA system provides goal setting functions and its system is reliable, easy to integrate data from different sources, or flexible to meet different fitness needs, users are more likely to use physical activity goals provided in the MFAs. Therefore, the higher the system quality, the more likely MFA users will utilize physical activity goal setting functions.

H1: MFA system quality positively influences goal set- ting use.

MFA systems also collect real-time information to help users set up goals or develop more specific and realistic goals (Menaspà, 2015). For example, MFAs may suggest higher goals or more intense schedules for users who are younger, healthier, or have more free time in their daily activities. The apps, integrated with artificial intelligence, may also analyze user activity habits to predict how soon users will achieve their goals and provide suggested training schedules to achieve them (Flores et al., 2021; Jossa- Bastidas et al., 2021). If this suggested information is provided accurately, reasonable for users' ability, and presented clearly in an easy-to-read format such as short notifications, MFA users may be more likely to use the goal setting function. Thus, the higher the information quality, the more likely MFA users will utilize physical activity goal setting functions.

H2: MFA information quality positively influences goal setting use

Goal setting is more beneficial when provided with a feedback system to remind the user about upcoming schedules or show achieved progress (Locke, 1996). Regularly collected data and updated feedback are considered major functions of a goal tracking system. Statistics showed that goal tracking was among the most important reasons people use MFAs in the U.S. (EMarketer, 2014; Wang & Collins, 2021). Many MFAs provide options for recording, tracking, and viewing physical activity-related data. For example, Google Fit users can effortlessly track walking distance, step counts, or types of activities, such as walking, running, and biking (Menaspà, 2015). Users can also manually add data for the activities that cannot be tracked by MFA systems. Hence, when the goal tracking functions of MFA systems work efficiently, reliably, functionality and flexibility, users will be more likely to use the system for goal tracking.

H3: MFA system quality positively influences goal tracking use.

Gaining important and useful information is among the most important reason for using IS systems (Kim et al., 2011). A user would continue to check their progress when the system is able to provide complete and accurate information because the higher information quality an IS system provides, the better decision quality the IS user can make (Raghunathan, 1999). Allowing MFA to self-track user activities imposes certain risks for users, such as privacy leaks or inappropriate use of data (Busch et al., 2021). Nicolaou and McKnight (2006) showed the imporSchulznce of information quality in IS system use by enhancing users' trusting belief and mitigating perceived risks. Lee and Cho (2017) also found the

impact of credibility, accuracy, and comprehensibility of system information on diet/fitness apps use. Thus, when the goal tracking function of an MFA system provides accurate information and allows flexible adjustments for data input, users will be more likely to use the system for goal tracking.

H4: MFA information quality positively influences goal tracking use.

Behavioral change (physical activity)

Several studies (Consolvo et al., 2009; Latif et al., 2011; Munson & Consolvo, 2012; Shilts et al., 2004) suggested that using goal setting to encourage changes in physical activity behavior is an effective strategy. Annesi (2002) found that a group with goal setting protocols, used as an exercise maintenance tool, had significantly lower drop-out and higher exercise attendance rates than those without goal setting protocols. Goal setting, when combined with a feedback group, helps participants achieve greater improvement in exercise self-efficacy, exercise performance, and exercise load (Bandura & Cervone, 1983; Stenstrom, 1994). Shilts et al.'s (2004) study found a significant impact of goal setting on positive behavior change by promoting healthy dietary and frequent physical activities in adult participants. Fritz et al. (2014) showed that wearable activity-tracking devices possibly motivate participants to make positive physical changes, such as walking more, taking the stairs, or beginning a running program. They also found that numerical feedback could also encourage users to increase their activities, achieve better results, and quickly reach their goals. For example, people possibly stop doing exercise when they feel tired. However, knowing how many steps they made and recognizing that they need a few more steps to reach the goal, they will be more likely to try some more steps instead of giving up. The literature suggested that when users use MFAs to set physical activity goals and track their goals, they will achieve positive behavioral change, especially in their physical activity.

H5/6: MFA goal setting/tracking use positively influences behavioral change (physical activity).

Goal achievement

In this research context, goal achievement is defined as the extent to which a user accomplishes their physical activity goals when using MFAs. Locke and Latham (1990) showed that goal setting may positively affect individual performance. Some may assume that when people set more challenging goals, they will have greater achievement. However, the goal setting theory (Locke & Latham, 1990) demonstrated that the assumption will be held only if, but not limited to, high levels of commitment, and goal makers have a relevant knowledge and ability to reach closer to the goal. A specific and explicit goal could also help reduce the variance of individual performance (Locke, 1996).

Goal setting protocols help participants maintain their commitment because they are shown to significantly reduce the drop-out rate or increase exercise attendance (Annesi, 2002). Most people know that obesity may lead to many health-related issues. While physical activity may improve overall health or reduce weight, maintaining fitness activities and consistency every day requires a lot of effort and proper strategies.

Consolvo et al. (2006) tested a prototype app that helped participants track and share their step count with friends. Besides showing the technology design requirements to encourage goal achievement, the study reports the importance of goal tracking devices to help people keep consistency and encourage training activities, leading to goal achievement. Also, these participants expressed that the information from tracking devices helped them find a pattern of their success and failure, and from there, they could develop a more successful strategy. By actively knowing their current step counts throughout the day, goal tracking users actively find time to do more physical activity to meet their daily goals. Based on this empirical evidence, this study assumes that both goal setting and goal tracking provided in MFAs are spontaneously key factors of goal achievement. Similar to a proverb, "a goal without a plan is just a wish," said by Antoine de Saint Exupéry, a French writer, and Larry Elder, a U.S. radio and television host (Pearson, 2014), a goal without goal tracking, in this research context, is similar to going to an unknown area without a map. If the goal is to walk 20,000 steps a day, users need to know how many steps they walked so far on that day. If the number of step counts was below the target, they would increase their activities on another day or try a new strategy to gradually achieve the goal.

H7/8: MFA goal setting/tracking use positively influences goal achievement.

Methodology

Instrument development

The user satisfaction model, proposed by Forsgren et al. (2016), showed that using second-order constructs for system quality and information quality is more statistically and conceptually appropriate than measuring these constructs by questionnaire items. To match with the context of MFAs, information quality is measured by a second order formative construct with four dimensions, including completeness, accuracy, currency, and format. In comparison, system quality is measured by five dimensions: reliability, flexibility, integration, timeliness, and accessibility. These first-order constructs, used to measure information quality and system quality, are reflective con- structs. The survey instrument was designed to measure these nine constructs, adopted from Wixom and Todd's (2005) study, and were modified to fit the research context of this project.

New measurement items for goal setting, goal tracking, behavior change, and goal

achievement were developed for the purpose of this study. To assess face validity, each of the proposed items was measured against its construct definition to remove any ambiguous items. To examine construct validity, a card-sorting exercise is used, in which several people familiar with the IS field, such as Ph.D. candidates and IS professors, were asked to sort the randomly mixed items into constructs categories (Moore & Benbasat, 1991). The results of the cardsorting exercise help modify and refine the list of questionnaire items. The first draft of the survey was evaluated by 23 Ph.D. candidates. After pilot testing, the measurement items were further modified and prepared to be used as the final survey questionnaire listed in Table 7. All the survey items were shown in Table 1 and measured with 5-points Likert-type scales.

Data collection

We created the survey for data collection via Qualtrics, an online survey software, and used Amazon's Mechanical Turk (MTurk), a web-based crowdsourcing market, to distribute the survey. The survey was distributed before the COVID-19 pandemic. MTurk allows individual employers to specify the number of responses, ratings of respondents, and the location of responses to solicit responders' views on specific topics (Steelman et al., 2014). Data collected via MTurk are more statistically appropriate for empirical studies that require a diverse sample (Jia et al., 2017). Many published papers (e.g., Daly & Nataraajan, 2015; Jia et al., 2017; Steelman et al., 2014) validated the reliability and the quality of web-based crowdsourcing used for academic research. For example, U.S.-based MTurk workers are comparable to general online panels and more likely to follow instructions than undergraduate students (Hauser & Schwarz, 2016). The study collected 400 completed responses from MTurk. The respondents were U.S.-based MTurk participants who completed more than 500 tasks with an approval rate higher than 95%. After cleaning the data by removing insufficient completion time or non-MFA users, the final dataset includes 256 usable responses.

Table 2 shows the demographic characteristics, the frequency of MFA use, and the length of usage. The sample includes 36% male and 64% female respondents. The gender proportion of this sample is consistent with the previously published statistics. For example, a survey conducted in the U.S. in 2017 showed that 24% of female respondents use MFAs regularly, while only 15% of male respondents do so (Statista, 2020). Another survey by Gallup (McCarthy, 2019) confirmed that women are more likely to wear tracker devices or use MFAs than men and that the data show the proportion of gender users as about 60% female and 40% male in 2019. Our data also show that using MFAs is common in different age groups from 18 to above 50. However, more than 60% of users are from 18 to 35. More than half of the respondents have used MFAs for more than one year, while 27% of respondents used MFAs for more than two years.

Data analyses and results

The proposed model is tested by using consistent Partial Least Square Structural Equation (PLSc – SEM). The PLSc method was first introduced by Dijkstra and Henseler (2015) to address the concerns that PLS-SEM results were not consistent or did not provide the good- ness of fit indices (Ronkko & Evermann, 2013; Ronkko et al., 2016). Prybutok et al. (2020) compared the use of PLS-SEM, PLSc, and covariance-based SEM in the con- text of an eHealth model, and showed that PLSc pro- vides fit indices and outperforms PLS-SEM in respect of path coefficient estimates and supported the use of PLSc in future research. In addition, the use of PLSc is appropriate because the proposed model is an integrative extension of existing theories and the PLS method is primarily designed for theory building rather that confirmation (Hair et al., 2010; Lowry & Gaskin, 2014). Finally, PLS-SEM is proper for models combining both formative and reflective constructs (Gefen et al., 2011; Hair et al., 2010). The PLSc results are achieved by using SmartPLS 3.0. The statistical significance of path eco efficiency is tested by using consistent PLS bootstrapping.

Model assessment

Two approaches to identify the common method bias were used to examine and enhance the statistical rigor of the proposed model (Gefen et al., 2011). The first approach is Harman's (1976) single-factor test, in which all the items of the latent constructs are loaded on a single factor. The results of Harman's method showed that the total variance explained by a single factor is 41% which indicates no presence of common method bias, since it is less than the threshold of 50%. Using a full collinearity test, the second approach (Kock, 2015; Kock & Lynn, 2012) generates the variance inflation factor (VIF) of all latent constructs in the research model. The results show that VIF values of all the independent and dependent constructs are below the conservative threshold of 3.3, showing no presence of common method bias.

According to the model assessment proposed by Anderson and Gerbing's (1988) study, the study assesses the reliability and validity of the latent indicators. In the proposed model, the reflective con- structs include completeness, accuracy, currency, format, reliability, flexibility, integration, timeliness, accessibility, MFA goal setting use, MFA goal tracking use, goal achievement, and fitness behavior, while second-order formative constructs include information quality and system quality. First, psychometric properties of the measurement scales for the reflective constructs were assessed by discriminant validity, convergent validity, and construct reliability, presented in Tables 3–5.

Table 1. Survey Questions.

Construct	Items	Sources
Completeness	My mobile fitness application provides me with a complete set of my fitness information.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application produces comprehensive information about my fitness activity.	
	My mobile fitness application provides me with all the fitness information I need.	
Format	The information provided by my mobile fitness application is well formatted.	Adapted from Wixom and Todd's (2005) study
	The information provided by my mobile fitness application is well laid out.	
	The information provided by my mobile fitness application is clearly presented on the screen.	
Accuracy	My mobile fitness application produces correct information about my fitness activity.	Adapted from Wixom and Todd's (2005) study
	The information provided by my mobile fitness application is accurate.	
Currency	My mobile fitness application provides me with the most recent information about my fitness activity.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application produces the most current information about my fitness activity.	
	The information from my mobile fitness application is always up to date.	
Reliability	My mobile fitness application operates reliably.	
	My mobile fitness application performs reliably.	Adapted from Wixom and Todd's (2005) study
	The operation of my mobile fitness application is dependable.	
Accessibility	My mobile fitness application allows information to be readily accessible to me.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application makes information very accessible.	
	My mobile fitness application makes information easy to access.	
Flexibility	My mobile fitness application can be adapted to meet a variety of fitness needs.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application can flexibly adjust to new fitness demands or conditions.	
	My mobile fitness application is versatile in addressing my needs as they arise.	
Integration	My mobile fitness application effectively integrates data from different resources.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application pulls together information that used to come from different systems.	
	My mobile fitness application effectively combines data from different applications.	
Timeliness	My mobile fitness application provides information in a timely fashion.	Adapted from Wixom and Todd's (2005) study
	My mobile fitness application returns answers to my requests quickly.	
Goal Setting	I use my mobile fitness application to set my exercise goals.	Developed by authors
	I record my fitness objective using the mobile fitness application.	
	I use the goal setting function in my mobile fitness application.	
	I use my mobile fitness application to set my fitness goals.	
Goal Tracking	I use my mobile fitness application to track my progress towards achieving my fitness goals.	Developed by authors
	I track my progress towards meeting my exercise goals using my mobile fitness application.	
	I track my pace towards my fitness goals using my mobile fitness application.	
	I keep track of my physical activity progress using my mobile fitness application.	

(*Continued*)

Table 1. (Continued).

Construct	Items	Sources
Behavioral change	Since I started using my mobile fitness application, I exercise more regularly.	Developed by authors
	Since I started using my mobile fitness application, I start setting more achievable fitness goals.	
	Since I started using my mobile fitness application, I improve my fitness activity.	
	Since I started using my mobile fitness application, I am more engaged in physical activity.	
	Since I started using my mobile fitness application, I start setting more challenging fitness goals.	
Goal Achievement	I achieve the goals I set on my mobile fitness application.	Developed by authors
	I rarely reach the objectives I set on my mobile fitness application.	
	I usually reach the objectives I set on my mobile fitness application.	
	I attain the fitness goals I set using on my mobile fitness application.	

Table 2. Demographic characteristics.

Variable	Sample	Percentage (%)
Gender		
Male	91	35.55%
Female	165	64.45%
Age		
18–25	30	11.72%
25–30	72	28.13%
30–35	55	21.48%
35–40	29	11.33%
40–45	32	12.50%
45–50	10	3.91%
Above 50	28	10.94%
Academic level		
Undergraduate	103	40.23%
Graduate	62	24.22%
Other	91	35.55%
Frequency of use		
2–3 Times a day	83	32.42%
Once a day	74	28.91%
2–3 Times a week	68	26.56%
Once a week	15	5.86%
2–3 Times a month	12	4.69%
Once a month	4	1.56%
Experience		
Less than a month	19	7.42%
6 Months to a year	97	37.89%
1 to 2 years	72	28.13%
2 to 3 years	38	14.84%
More than 3 years	30	11.72%

Table 3. Construct reliability, VIF, and AVE.

Construct	Mean[a]	SD [a]	VIF	Cronbach's Alpha	Composite Reliability	AVE
Accessibility	4.23	0.62	1.74	0.86	0.91	0.78
BC	3.91	0.58	1.70	0.92	0.94	0.76
Accuracy	3.94	0.71	2.44	0.78	0.90	0.82
Completeness	3.74	0.79	2.20	0.82	0.89	0.74
Currency	4.00	0.67	2.83	0.85	0.91	0.78
Flexibility	3.72	0.80	2.43	0.86	0.91	0.78
Format	4.00	0.62	1.28	0.84	0.91	0.76
Goal Achievement	3.77	0.75	1.69	0.89	0.93	0.76
Goal Setting	3.93	0.86	2.06	0.90	0.93	0.78
Goal Tracking	4.16	0.73	2.12	0.88	0.92	0.74
Integration	3.47	0.93	1.87	0.90	0.94	0.83
Reliability	4.00	0.70	3.01	0.87	0.92	0.79
Timeliness	3.80	0.75	1.06	0.77	0.90	0.81

[a]Mean and standard deviation (SD) are calculated using the average of construct items.

Table 4. Factor loading.

Constructs	Item	1	2	3	4	5	6	7	8	9	10	11	12	13
(1) Behavioral Change	**BC1**	0.88												
	BC2	0.87												
	BC3	0.86												
	BC4	0.90												
	BC5	0.86												
(2) Goal Achievement	GA1		0.88											
	GA2		0.77											
	GA3		0.91											
	GA4		0.91											
(3) Goal Setting	GS1			0.85										
	GS2			0.86										
	GS3			0.90										
	GS4			0.92										
(4) Goal Tracking	GT1				0.86									
	GT2				0.90									
	GT3				0.87									
	GT4				0.82									
(5) Accuracy	Accu1					0.91								
	Accu2					0.90								
(6) Completeness	Com1						0.90							
	Com2						0.88							
	Com3						0.80							
(7) Currency	Cu1							0.89						
	Cu2							0.91						
	Cu3							0.84						
(8) Format	F1								0.90					
	F2								0.88					
	F3								0.84					
(9) Accessibility	A1									0.87				
	A2									0.91				
	A3									0.86				
(10) Flexibility	Flex1										0.87			
	Flex2										0.90			
	Flex3										0.88			
(11) Integration	Inte1											0.90		
	Inte2											0.93		
	Inte3											0.91		
(12) Reliability	Reli1												0.90	
	Reli2												0.89	
	Reli3												0.89	
(13) Timeliness	Time1													0.91
	Time2													0.89

Table 5. Correlations.

Construct	1	2	3	4	5	6	7	8	9	10	11	12	13
(1) Accessibility	**0.88**												
(2) BC	0.46	**0.87**											
(3) Accuracy	0.62	0.44	**0.91**										
(4) Completeness	0.46	0.47	0.52	**0.86**									
(5) Currency	0.70	0.51	0.67	0.58	**0.88**								
(6) Flexibility	0.52	0.47	0.48	0.64	0.50	**0.88**							
(7) Format	0.65	0.39	0.56	0.51	0.67	0.49	**0.87**						
(8) Goal Achievement	0.48	0.61	0.45	0.40	0.50	0.43	0.43	**0.87**					
(9) Goal Setting	0.43	0.64	0.42	0.47	0.50	0.44	0.38	0.46	**0.88**				
(10) Goal Tracking	0.56	0.53	0.40	0.40	0.54	0.43	0.46	0.54	0.70	**0.86**			
(11) Integration	0.34	0.33	0.31	0.53	0.36	0.64	0.35	0.31	0.39	0.36	**0.91**		
(12) Reliability	0.69	0.48	0.68	0.46	0.71	0.53	0.62	0.49	0.48	0.53	0.35	**0.89**	
(13) Timeliness	0.55	0.40	0.49	0.36	0.54	0.48	0.54	0.39	0.37	0.42	0.39	0.57	**0.90**

*Diagonal elements are square root of AVEs and off-diagonal elements are correlations.

Table 6. Summary of results.

Path	Standardized estimate	T-statistics	*P*-values
GS -> BC	0.52	7.21	<.001
GS -> GA	0.16	2.03	.04
GT -> BC	0.16	2.00	.04
GT -> GA	0.43	5.78	<.001
IQ -> GS	0.26	2.14	.03
IQ -> GT	0.20	2.03	.04
SQ -> GS	0.33	2.92	<.0

SQ -> GT	0.43	4.79	01 <.0 01

SQ: System Quality; IQ: Information Quality; GS: Goal Setting; GT: Goal Tracking; BC: Behavioral Change; GA: Goal Achievement.

Table 7. Path Coefficients of Subsamples - User Age

	Age 18-35			Age 35 and older		
Path	PC	t-value	*p*-value	PC	t-value	*p*-value
SQ -> GS	0.49	4.39	0	0.1	0.57	**.57**
IQ -> GS	0.23	1.97	.05	0.28	1.5	**.13**
SQ -> GT	0.49	4.76	0	0.34	2.07	.04
IQ -> GT	0.21	1.97	.05	0.16	0.96	**.34**
GS -> BC	0.51	6.6	0	0.54	3.56	0
GT -> BC	0.21	2.56	.01	0.09	0.31	**.76**
GS -> GA	0.24	2.53	.01	0	0.03	**.98**
GT -> GA	0.46	5.66	0	0.41	3.48	0

*PC: Path Coefficient; SQ: System Quality; IQ: Information Quality; GS: Goal Setting; GT: Goal Tracking; BC: Behavioral Change; GA: Goal Achievement.

Table 8. Path coefficients of subsamples – user experience.

	0–2 years			> 2 years		
Path	PC*	t-value	*P*-value	PC*	t-value	*p*-value
GS -> BC	0.44	4.50	.00	0.72	6.04	.00
GS -> GA	0.09	1.06	**.29**	0.34	2.23	.03
GT -> BC	0.23	2.10	.04	0.02	0.09	**.93**
GT -> GA	0.53	6.96	.00	0.18	1.02	**.31**
IQ -> GS	0.46	3.68	.00	−0.16	0.88	**.38**
IQ -> GT	0.28	2.59	.01	−0.02	0.16	**.87**
SQ -> GS	0.17	1.30	**.19**	0.72	4.24	.00
SQ -> GT	0.43	4.19	.00	0.43	2.25	.02
GS -> BC	0.44	4.50	.00	0.72	6.04	.00

*PC: Path Coefficient; SQ: System Quality; IQ: Information Quality; GS: Goal Setting; GT: Goal Tracking; BC: Behavioral Change; GA: Goal Achievement.

Discriminant validity, showing how a construct is different from other constructs (Hair et al., 2010), is confirmed because the average variance extracted (AVE) of each reflective construct is higher than the maximum correlations between the construct and all other reflective constructs (Hair et al., 2010). Convergent validity assesses the extent to which the observed survey items measure the correct underlying theoretical construct. Factor loadings and AVEs were used to assess convergent validity. The factor loadings of all items measuring the same construct are higher than 0.7 and the cross-loadings are lower than the threshold of 0.4 (Hair et al., 2016). Moreover, all AVEs of the constructs are much greater than the value of 0.5, suggesting a satisfied convergent validity (Hair et al., 2010). Construct reliability, measuring the internal consistency, is valid because all values of composite reliability (CR) are greater than 0.8 (Werts et al., 1974) and all values of Cronbach's Alpha (CA) are greater than 0.7 (Cronbach, 1951).

The validity of the second-order formative constructs is assessed via two criteria, suggested by Petter et al.'s (2007) study. First, unlike reflective indicators, formative indicators are not interchangeable because they capture unique aspects of the underlying construct. Therefore, high correlations among formative indicators are undesirable (Jarvis et al., 2003). The multicollinearity test shows that all related items' VIF values are less than the threshold of 3.3 (Petter et al., 2007). The second criterion examines the paths between the first-order indicators and the second-order constructs. As shown in Table 6, all the paths between the first-order indicators and the second- order constructs are statistically significant. Thus, the two-criteria test confirms the reliability and validity of the two second-order formative constructs: system quality and information quality (Petter et al., 2007).

Structural equation model results

The PLSc results, in Table 6, support hypotheses 1, 2, 3, and 4. The results show that information quality had significantly positive relationships with goal setting and goal tracking ($p < .05$, $\beta = 0.26$ and 0.20, respectively). System quality had significantly positive relationships with goal setting and goal tracking ($p < .001$, $\beta = 0.33$ and 0.43). Hypotheses 5 and 6 are also supported, showing MFA goal setting and goal tracking use positively influence behavioral change in physical activity ($p < .001$ and < 0.05, $\beta = 0.52$ and 0.16). The path coefficients of 0.16 (p- value < 0.05) and 0.43 (p-value < .001) support the positive impact of MFA goal setting and goal tracking use on goal achievement. Hypotheses 7 and 8 are statistically supported. The relatively high variance explained coefficients R^2 of MFA goal setting use, MFA goal tracking use, goal achievement, and behavioral change (physical activity) are 32%, 35%, 30%, and 42%. The Standardized Root Mean Square Residual (SRMR) is 0.0342, less than Bentler and Bonett's (1980) threshold of 0.08 and the Normed Fit Index (NFI) of 0.9151, is higher than Lohmoller's (1989) threshold of 0.9, showing good model fit.

In the first post hoc analysis, the proposed model was tested by comparing the path coefficients between two different age groups. Group 1 includes Generation Z (born from 1997 to current) and millennials (born from 1981 to 1996; Dimock, 2019), and

Group 2 includes respondents who were born before 1981. At the time of data collection, the age range of Group 1 is from 18 and 35, while the age range of Group 2 is 35 and older. All hypotheses are still supported for Group 1, while only three hypotheses 3, 5, and 8 are supported for Group 2. In a second post hoc analysis, the role of user experience is examined to investigate the different impact of MFA goal setting and goal tracking functions on novice and expert users. Novices are considered respondents who have used MFAs for less than 2 years, while Experts are respondents who has used MFAs for more than 2 years. We chose the 2-year cutoff point because it is straightforward that the one who uses the MFA apps for more than two years is more likely to have more experience than the one who uses less. Also, several studies (Benner, 1984; Burger et al., 2010; Hargreaves & Lane, 2001) mentioned a timeline of more than two years to become competent and expert in their research context. Courtney et al. (2008) applied Benner's (1984) study on novice to expert (1984) to support their classification of information technology from novice to expert in nursing practice. Thus, we also used the same measure to categorize users as the novices and experts. The results show that, for the group of Novice users, all hypotheses are supported, except hypothesis 7 (path between MFA goal setting use and goal achievement) and hypothesis 1 (path between System Quality and MFA goal setting use), while, for the group of Expert users, all hypotheses are supported, except hypothesis 6 (MFA goal tracking use and behavioral change), hypothesis 8 (MFA goal tracking use and goal achievement), and hypotheses 2 and 4 (path from information quality to MFA goal setting and goal tracking use). The data are displayed in Tables 7 and 8, and the results will be discussed in the next section.

Discussion

Theoretical contribution

The study contributes to the IS literature by providing the success model of MFAs, identifying the determinants of MFA uses via two functions of success: goal setting and goal tracking, and explaining the interrelationships among constructs in the proposed model. Consistent with the D&M IS success model (DeLone & McLean,

1992), the results show that IS quality has a positive and strong impact on both MFA goal setting and goal tracking use. In other words, success at the technical level (IS quality) leads to success at the behavioral level (IS use) and, later, improves user performance (IS impact). Consistent with the goal setting theory (Locke & Latham, 2002), the combination of goal setting and goal tracking has a positive association with goal achievement and behavioral change. In this research context, when MFA users increase their use (goal setting and goal tracking), it is more likely that they enhance their ability to attain their fitness objective (goal achievement and behavioral change). This finding is consistent with the literature (Consolvo et al., 2009; Latif et al., 2011; Shilts et al., 2004) showing that goal setting is a major factor to encouraging physical behavior changes by setting more challenging goals or doing exercise more frequently.

The proposed model can also be applied to other types of persuasive technologies that influence user behavior in different contexts. In organizational research literature, Latham and Yukl (1975) showed that setting specific goals help to improve employee performance. Thus, besides its positive impact on individual performance, the goal setting technique could possibly be used to enhance the performance of groups, teams, or organizations (Porter & Latham, 2013). In organizational settings, goals should be challenging but attainable in order for organizations to be successful (Locke & Latham, 2019). During the COVID-19 pandemic, about 44% of workers were able to work from home worldwide (World Economic Forum, 2020). Working from home may have negative impacts on employee productivity (Farooq & Sultana, 2021). Rudnicka et al. (2020) showed that people who work from home during the COVID-19 pandemic face the challenge of balancing between work and personal life. Future research can examine how productivity- enhancing apps, which include goal setting and goal tracking functions, can be used to track work productivity for those working from home. For example, users can use productivity-enhancing apps to set up individual goals or common goals in a team project and track the achievements of team members. In other words, an employee can determine how effective they are when working remotely to determine necessary adjustments.

The proposed model is not limited to physical activities and work tasks at the individual or organizational level. Goal setting and goal tracking functions could be applied to nutrition and diet apps for users who want to lose weight or for diabetic patients with

recommended dietary guidelines (Tang et al., 2015). The role of goal setting and goal tracking on goal achievements and behavioral changes in the MFA context is also generalizable and can be adjusted to investigate user behavior in different contexts such as new language learners (Bursali & Öz, 2018), energy conservation users (Loock et al., 2013), online advanced coursework learners (Handoko et al., 2019), dieters in nutrition and diet apps (Tang et al., 2015), and financial saving users in FinTech apps (Gargano & Rossi, 2020).

In addition, this study goes a step further to explore the effect of user age and experience on the interrelationships among constructs in the MFA success model. The results of the first post hoc analysis reveal that with older users (35 and older), IS quality is not significantly related to IS use, whereas with Gen Z and millennial users (18 to 35), IS quality and IS use have a strong and positive relation- ship. This finding indicates that the use of MFA goal setting and goal tracking used by older users is not influenced by information and system qualities. The results of the first post hoc analysis also show a difference in the effect of IS use on IS impact between older users and Gen Z and millennial users. Specifically, the relationship between goal setting and goal achievement (GS -> GA) and the relationship between goal tracking and behavioral change (GT -> BC) are not supported for MFA older users. These findings indicate that MFA goal setting use does not influence older users' performance toward achieving their fitness goals, and that MFA goal tracking is not associated with a change in fitness behavior by MFA older users. This finding contributes to MFA research by underlining the impact of user age on the relationship between IS quality and IS use, and the relationship between IS use and IS impact. Future researchers can extend our knowledge by studying the factors that cause these differences between the two age groups.

The second post hoc analysis focused on investigating the effect of user experience on the interrelationships among constructs in the MFA success model. The model was tested by two groups of user experience: Novice users (0–2 years of experience) and Expert users (more than two years). In the Novice users group, hypothesis 7 (GS -> GA) and hypothesis 1 (SQ -> GS) are not supported. The results show that, for inexperienced users, the higher system quality does not guarantee more MFA goal setting use, and more goal setting use may not lead to a

higher chance of goal achievement. An explanation is that novice users need more time to adapt to MFA functions, and some may set long-term goals that are too high at the early stages of use. For experienced users, hypothesis 6 (GT -> BC), hypothesis 8 (GT -> GA), and hypotheses 2 and 4 (IQ -> GS and IQ ->GT)) are not supported. These findings indicate that as users gain more experience with MFAs, the effect of information quality becomes insignificant on goal setting and goal tracking use, and that goal tracking use becomes ineffective in the users' efforts to achieve desired physical performance. A plausible explanation of this phenomenon is that, over time, MFA users tend to develop their own physical routines and habits. Thus, they rely less on information quality and goal tracking to achieve their desired levels of physical performance. For future research, it would be worthwhile to study what fac- tors cause MFA users to develop physical habits.

It is important to note that our data sample was collected before the pandemic. Our data showed a skew in favor of female in MFA users: 64% female and 36% male. The gender proportion of our data, which were collected before the pandemic, is consistent with the previous statistics, showing that a female is more likely to use MFAs than a male in 2017 (Statista, 2020). However, installation of specific apps, such as health and fitness apps, increased by 67% in a brief time from late March to early April of 2020, compared to the same period of 2019 because of the lockdown (Statista, 2020aa). Also, about 70% of respondents would be less likely to go to the gym during April of 2020 because of the pandemic (Statista, 2020cc). We expect that the data collected during and after the pandemic may have more balance in gender difference and that long-term users may discontinue to use MFAs when they can safely go outside or come back to the gym. For example, the sale of Peloton Interactive Inc., an exercise equipment and media firm, increased significantly during 2020. However, its equipment sale was down by 17% in Dec 2021 and the resale marketplace shows that Peloton equipment for sale has increased by 77% since April 2021. (Bhatnagar, 2021)

Practical contributions

The SEM results support the hypotheses that increased information quality and

system quality will encourage more users to utilize the goal tracking and goal setting functions provided by MFAs. The significant causal effect of MFA use on IS impact, including goal achievement and behavioral change, possibly encourages users, who are skeptical of the benefits of MFAs, to start using it. The results also support the use of goal tracking and explain why goal tracking is one of the top reasons for individuals to use MFAs (EMarketer, 2014). MFA users increase their use of goal setting functions and more frequently track their performance when the MFA functions efficiently and produces complete and well-formatted feedback. The results show that users should choose MFAs that provide a complete set of fitness information (Completeness), well- formatted information (Format), correct information (Accuracy), most recent/real-time information (Currency), reliable information (Reliability), easily-accessible information (Accessibility), flexible functions (Flexibility), and integrated data (Integration) because those functions will increase the frequency of using goal setting and goal tracking functions, which, later, significantly assist users to achieve their goal and positively change their habits (physical activities). The findings are consistent with the literature that data inaccuracy or uselessness is one of the reasons for users to stop using a tracking fitness app (Attig & Franke, 2020). These characteristics of system quality and information quality are also a helpful guideline for MFA designers or providers to attract more users and increase frequency of using MFAs.

While positive habits are the keys to successful behaviors, not all positive habits are equally important. Duhigg (2012) introduced “keystone” habits that can spark other good habits. For example, the domino effect of the keystone habit “doing more physical exercises” leads to less time for other addictions, better quality of sleep, and physical and mentally performance improvement. The better quality of sleep and increased performance possibly may lead to more success at work, which, later, increases the chance of getting promotions and expand professional net- works. Thus, the achievement of behavioral change in physical activities, a keystone habit, benefits users more than what they initially expect. The proposed model and the results support that the use of MFA goal setting and goal tracking are crucial to developing a keystone habit.

The first post hoc analysis results show that MFA goal setting use and goal tracking

use are more beneficial for Gen Z and millennial users than for the group of older users. In other words, it is more likely that the group of Gen Z and millennial users have more of a chance to achieve their goal and behavior changes through frequent use of goal tracking and goal setting functions than older groups. The discrepancy in terms of the mobile efficacy or learning beliefs between those groups could explain this phenomenon. Reed et al. (2005) expressed the negative correlation between learning beliefs and users' age and the significant impact of age on the reduction in computer skills acquisition. It does not mean that older people do not or cannot gain the ability to use a computer or electrical devices effectively. Still, their conventional beliefs or distrust of themselves, in general, prevent them from actively learning those new skills. This finding is important for MFA developers who want to attract more users, other than the group of Gen Z and millennial users. Their advertisement should increase the ease of use and focus on basic tutorials forusers with low levels of computer or mobile phone efficacy or messaging that encourages older people to learn to use MFAs more effectively.

The second post hoc analysis results reveal, for experienced MFA users, information quality does not influence goal setting or goal tracking use, and that goal tracking use is not significantly related to goal achievement or behavioral change. These findings indicate that, after using MFAs for a longer time (over two years), users could develop their own pattern of exercise. The role of information quality and goal tracking function is no longer vital for them to maintain physical activities and performance. The results are consistent with other previously published studies (Armitage, 2005; Miller et al., 2002; Sallis et al., 1990), showing that past perceived behavior is an important predictor of physical activity maintenance. Maher et al. (2017) and Attig and Franke (2020) also found the "happy abandonment" achieved when users reached their fitness goals and successfully formed physical activity habits. They no longer needed a fitness app to track their activities, and would more likely stop using the app. To deal with the issue from these expert users, developers may redesign or integrate their apps with gamification elements such as point reward systems or competition with other users to motivate users to accumulate/redeem points or create a competitive exercise environment among users, as suggested in Huang et al.'s (2019) study. This finding is crucial for MFA

developers to keep updating their products or create more ties to make it harder for expert users to quit the app.

Conclusion

The increasing usage of mobile devices and MFAs has led many researchers to focus on either finding the driving factors of MFA use or investigating its impact on user performance. The literature shows that, among many functions provided by MFAs, goal setting and goal tracking are the two most frequent and important activities. However, the driving factors of using goal setting and goal tracking functions provided in MFAs and the direct impact of these functions on users' achievement or behavioral changes have not been studied. Therefore, this study addresses a void in the literature by proposing and testing a robust model that examines MFA system usage and system impact by integrating goal setting theory, IS success model, and Wixom & Todd's model. The new model addresses the call of Fanning et al. (2012), Bort-Roig et al. (2014), and Higgins (2016) for more studies investigating the use and the impact of MFAs on users' performance.

This study confirms the importance of system quality and information quality on MFA goal tracking and goal setting use. The results also develop guidelines for MFA providers and designers to determine the key functions needed to increase user activities. Consistent with pre- viously published studies (e.g., Erez, 1977; Locke & Latham, 1990, 2002), this study is the first to confirm the benefit of the combination of goal setting and goal tracking in the context of MFAs. The model also has the potential to investigate the impact of goal setting and goal tracking use for team or group performance or applied to other types of mobile apps such as health, diet, or learning apps. The findings empirically show that Gen Z users and millennial users are two groups that gain more benefits of goal achievement and behavioral changes by using MFA goal setting and goal tracking than older groups. The use of goal tracking helps users create positive habits in phy- sical training. However, it is no longer important for MFA users when the habit is well developed.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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