Measuring the Influence of a Persuasive Application to Promote Physical Activity

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Abstract. A fundamental challenge for employees in the office environment is the difficulty of being physically active. The long-term effect of physical inactivity can lower work effectiveness and cause health problems. The non-substantial indication from recent research suggests that persuasive techniques can create a significant impact on motivating people. This study investigates the overall influence of using a persuasive application in promoting physical activity in the workplace, such as office environment. To motivate individuals for healthier behaviour, we implemented and tested an application incorporating Self-Determination Theory (SDT). We conducted an eight-week long usability evaluation of the application, using the UTAUT model. The questionnaires were based on the factors: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Behavioural Intention, and Use Behaviour. We found that our persuasive application was satisfactory to motivate users for physical activity promotion.

Keywords: Persuasive Application, Behaviour Change, Motivation, UTAUT.

1 Introduction

The World Health Organization (WHO) stated that 60 to 85% of adults worldwide are leading inactive lifestyles [11]. It is recommended for every adult to take part in 150 minutes of physical activity per week [2]. Physical inactivity is related to the change of physiologic processes resulting e.g. in reduced exercise capacity, muscle atrophy, and altered energy balance [3]. Physical inactivity leads to the risk of obesity, stroke, type 2 diabetes and mental health problems. Various chronic diseases are caused by these risk factors that lead causes of death [4]. On the other hand, regular physical activity prevents modern society diseases, such as heart diseases, diabetes, depression and cancer [5][6]. The long-term effect of physical inactivity such as long sitting periods during a day can lower the working progress. However, the workplace has been recognized by the WHO as a priority setting in promoting health [7]. Technological

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solutions can be used to support behaviour change, e.g. physical activity through persuasion.

Persuasive technology is a term that refers to any interactive computing system designed to transform people's behaviours and attitudes [8]. Approximately, there are more than 40,000 smartphone apps which are designed to persuade users to transform their health behaviours, such as physical activity, diet, and smoking [9]. Even though there is an ascending number of research publications in the area [10], content analysis of existing mobile apps disclosed the use of theories on behaviour change or persuasive technology and contains little evidence-based content [11][12][13]. There is a need to make better use of theory and evidence when designing mobile application destined to encourage behaviour change [14][15]. Research has shown little evidence on theoretical approaches to designing the persuasive technologies [16][17].

This study, therefore, explored how satisfactory and persuasive technologies following theory-driven system design are in increasing physical activity, through fostering daily walking among individuals who are engaged in their office environment. We aimed to incorporate the psychological Self-Determination Theory (SDT) in the design and implementation of an app for promoting physical activity [18].

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a widely used technology acceptance model [19]. It has been used as a list of factors that can affect integration of technology-mediated communication e.g. smartphones. The aim to formulate UTAUT was to adopt research and theory with respect to individual acceptance of the information and communications technology (ICT) into an integrated theoretical model [19]. Eight models were considered by comparing the usage of ICT and determinants of intention and later, conceptual and empirical similarities were analysed to formulate UTAUT [19]. Previously UTAUT model has been applied to analyse students' ICT adoption [20] and students' use of English E-learning Websites [21]. It can be envisioned that UTAUT can be used to analyse the usage and acceptance of persuasive application to promote physical activity in addressing our research question. Yet, there is no empirical evidence in the literature on using the UTAUT model in analysing the effect of a persuasive application to promote physical activity for the employees. This study aims to fill the gap by answering the main research question: *What is the influence of using a persuasive application in promoting physical activity in the office working setting?*

To answer the research question, we designed an Android OS based app named iGO incorporating SDT and the User-Centered-Design (UCD) process. The app was used for eight weeks to measure the users' regular physical activity. The app recorded the recommended 10 minutes walking after breakfast/lunch. This study was tailored to motivate employees to boost their physical activity at their office. The results can support in building a persuasive application for a healthier lifestyle and in motivating employees to do daily physical activities such as walking and exercise while working for a long time at the office and sitting idle for a long time.

2 Literature Review

2.1 Motivation

There has been an acknowledgement of SDT [22] in health research particularly in the context of physical activity [23]. Autonomy support, psychological needs and motivation explain the physical activity behavioural change process in SDT. Autonomy support describes individual's point of view about the social atmosphere for him/herself, which helps to facilitate choices and requirements, and accepts individual's option and justification at the time of selecting choices. Individual psychological needs of autonomy, competence and relatedness are influenced positively by the higher level of autonomy support. Autonomy can be derived as *"the perceived origin or source of one's own behaviour"* in the physical activity [24]. Competence helps to *"feeling effective in one's ongoing interactions with the social environment and experiencing opportunities to exercise and express one's capabilities"* [24]. Relatedness helps to feel connected with others [25]. Thus, if the level of self-determined motivation is greater, that will be the result of these psychological needs. Within SDT, three types of motivation are recognized: intrinsic motivation, amotivation, and extrinsic motivation. *Intrinsic motivation* signifies doing something that is enjoyable or interesting intrinsically. *Amotivation* can be described as the state of not being present willingly to get involved in physical activity. *Extrinsic motivation* refers to rewarding, i.e. one will likely do an activity if he/she will get a reward at the end of the activity. Self-determination motivation with higher level relates to additional physical activity involvement [26][27]. In physical activity context, SDT has not been used in the entire SDT sequence (Fig. 1) but only in the autonomy support, psychological needs, and self-determination motivation. Recently the adequacy of SDT has been confirmed for physical activity [28] but not particularly in the workplace. In this study, SDT is applied from the workplace perspective to motivate employees to walk/exercise after breakfast and lunch to achieve positive working hour productivity.

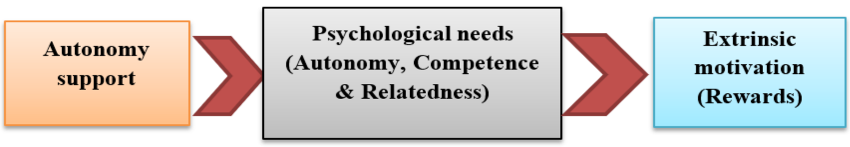

Fig. 1. Our approach of the entire SDT sequence

2.2 UTAUT

UTAUT model had been formulated by integrating eight technology acceptance models [19]. These includes, the Theory of Reasoned Action (TRA) [29], Social Cognitive Theory (SCT) [30], the Technology Acceptance Model (TAM) [31], the Theory of Planned Behaviour (TPB) [32], Model of PC Utilization (MPCU) [33], Motivational Model (MM) [34], the Combined-TAM-TPB [35] and Innovation Diffusion

Theory (IDT) [36]. UTAUT model leverages individual acceptance of individual research by combining the theoretical technology acceptance models from literature. It incorporates four moderators to justify for dynamic influences, including age, gender, voluntariness, and experience. According to UTAUT, the use of technology can be influenced by the four key constructs: *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions* (Table 1).

Table 1. UTAUT four key constructs

Four constructs of UTAUT	Definition	Reference
Performance expectancy	*"The degree to which an individual believes that using the system will help him or her attain gains in job performance"*	[19]
Effort expectancy	*"The degree of ease associated with the use of the system"*	[19]
Social influence	*"The degree to which an individual perceives that important other believe he or she should use the new system"*	[19]
Facilitating Conditions	"*The degree to which an individual believes that an organizational and technical infrastructure exists to support use of system*"	[19]

Factors performance expectancy, effort expectancy and social influence affect the users' behavioural intention. Facilitating conditions and behavioural intention influence the actual use of the technology [19], such as a persuasive application.

2.3 Benefit of Physical Activity using Persuasive Application

Technology is a useful tool for supporting behavioural change e.g. physical activity through persuasion. Two types of behaviour (internal and external) influence the techniques of persuasion. Persuasive applications mostly focus on external behaviour [37], e.g. a tracker for exercise [38], which is convenient and influencing. Persuasive applications have been designed for psychological encouragement such as displaying a virtual garden to persuade emotional connection to the personal level of physical activity [39]. Promoting physical activities through a persuasive application is a prospective way to support healthier lifestyle in one's life, e.g. by sending a reminder to do exercises and monitoring the daily data about the health condition. It is shown that physical activities increase work productivity [40]. Evaluation of the usefulness of health applications to encouraging physical activity has been recommended [41].

3 Methodology

3.1 Research Model

UTAUT model was used to analyse the acceptance and use of the persuasive application (iGO physical activity promotion app) by employees at their office to promote their physical activities. According to UTAUT model, the use of a physical activity app can be influenced by the four factors: performance expectancy, effort expectancy, social influence, and facilitating conditions (Fig 2). In our case, the curbing effect of age, gender, voluntariness and experience was not considered. We assume that these factors do not have a significant effect on the results due to their homogeneous professional background and intention for physical activities. We have modified our research model accordingly.

3.2 Hypotheses

The UTAUT model incorporates the eight-technology acceptance theoretical models and consists of the core factors of usage intention [19]. Factors performance expectancy, effort expectancy, and social influence significantly influence behavioural intention. Factors facilitating conditions and behavioural intention influence the use behaviour. In our present study, we hypothesise (Fig. 2):

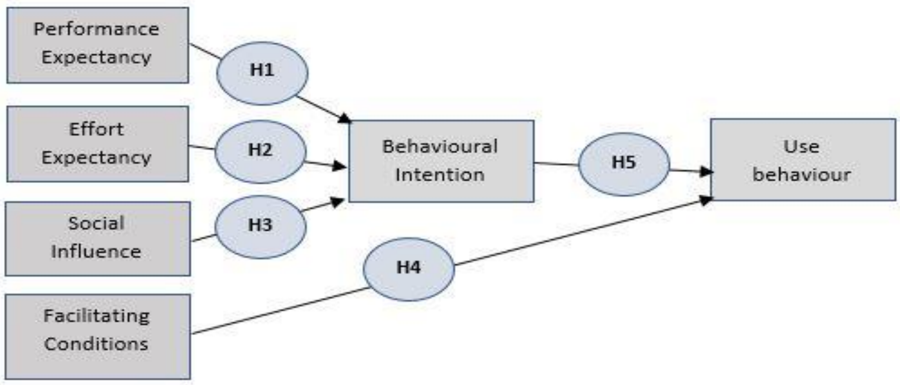

Fig. 2. UTAUT model for a persuasive application in promoting physical activity. Hypotheses (H1-H5) of the study are shown here. UTAUT = Unified Theory of Acceptance and Use of Technology (Venkatesh, Morris, Davis and Davis, 2003)

H1) Performance expectancy positively influences user's intention to use persuasive application for promoting physical activity;

H2) Effort expectancy positively influences user's intention to use persuasive application;

H3) Social influence positively influences user's intention to use persuasive application;

H4) Facilitating conditions of persuasive application positively influences users' use behaviours of actual use of a persuasive application; and

H5) Behavioural intentions to use a persuasive application positively influences users' behaviours of the actual use of a persuasive application.

3.3 System Design

We designed a persuasive application iGO [18] to encourage workers to exercise and walk more often during working hours. iGO is a gamified and persuasive application that encourages users to perform their regular physical activity. It records their use behaviour by encouraging self-determination task and by allowing them to save their individual choices and selections (Fig. 3).

iGO application is based on the proposed system model [42]. This model was a recipe of the SDT theory, game elements (points, badges and leaderboard), and positive and motivating outcomes (exercise and weight control). The existing Ryan's SDT theory model of health behavioral change [43] was applied to support the proposed

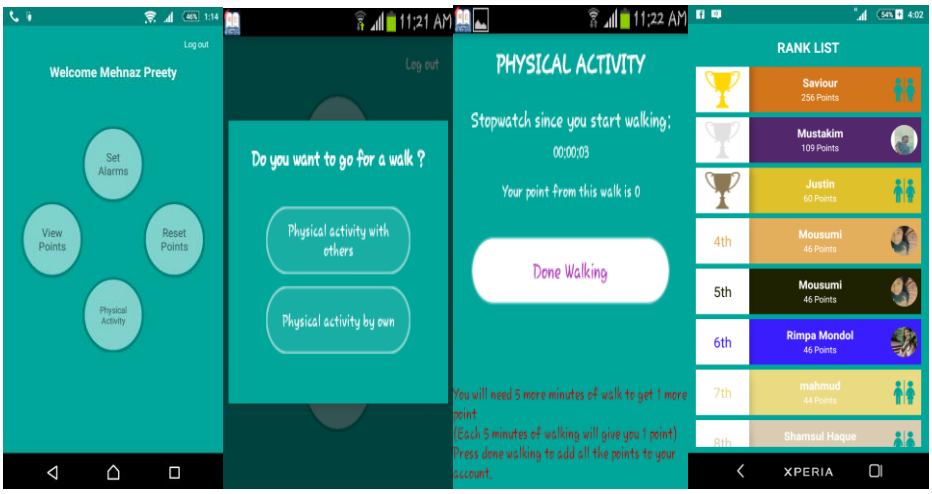

Fig. 3. Print screens of the iGO physical activity app

system model. The approach of the SDT sequence (autonomy support – psychological needs – extrinsic motivation) was adopted for measuring health behaviour change. The proposed system model was implemented to a prototype of the iGO application. The prototype was built using the UCD process [42] and the over-all usability of the designed prototype was evaluated for a week-long study before the implementation of the iGO application. The function of the iGO app is simple and personalized due to users' recommendation when using the UCD process to develop the prototype.

People can feel demotivated to complete a task enthusiastically, e.g. by messaging through mobile texting, which had been used to improve self-efficacy of glycemic control for the diabetic patients [44]. Therefore, alarm/vibration was added as a reminder to the iGO application. It starts with an alarm after the breakfast and lunch recess. Taking a light exercise or walking brings health benefits such as weight loss [45], suppresses postprandial serum triglyceride [46] and more precisely walking 10 minutes after each meal reduces blood sugar levels in type 2 diabetes [47]. Here, the application will show an option on the main menu to choose “yes” or “no” in terms of having breakfast or lunch. If a user selects “no” for not having breakfast, then the alarm will appear again after 10 minutes and will ask user to select option. If user selects “yes”, then the system will ask for a choice of preference for physical activities i.e. “physical activity with others” or “physical activity by own”. Time starts to count for 10 minutes if user chooses “physical activity with others”. Each 5-minute slot gives 1 point (10 minutes = 2 points). We applied the PBL (points, badges and leaderboards) game design elements, in order to motivate users to walk for 10 minutes and earn points towards their goal. Within the physical activity research, it has been shown that points and badges [48], and leaderboard [48] can persuade individuals to complete a specific goal. 3000 steps in 30 minutes has been suggested to lead people for a meaningful exercise [49]. Therefore, we adopted this for every minute equaling to 100 steps. The accelerometer sensor in the smart device tracks the footsteps of the user and keeps count of steps (targeting 1000 steps in 10 minutes). On the other hand, if a user selects “physical activity by own” then the system follows the above function gain. Users can see a leaderboard as a social interactive display by selecting “view-points” from the main menu. The leaderboard shows the rank list of the individuals. Leaderboard has the options to show user profile photo and name. If a user prefers, his/her name and picture will appear on the leaderboard based on their earned points. Users can customize their picture and name visibility settings when signing into their iGO account.

In our previous iGO design [18] users received a nice portrait image if they scored highest points and the ones who scored less received a portrait image with a fatty face. After testing the application, users suggested skipping this idea due to privacy concerns. We upgraded a newer version of the iGO based on users’ recommendation, and the one on the leaderboard in the 1st position will receive a Gold Badge, the 2nd will receive Silver Badge and the 3rd will receive a Bronze Badge. In the context of the users, designing application should be based on the operation of the application such as what are the functions and how they supported users. The aim of the iGO app was to collect users’ data and analyse them so that users can receive useful information that will make them concerned in using the application [50].

3.4 Data Collection

To evaluate user acceptance, we collected end-user data in relation to the acceptance and use of the persuasive application to promote physical activity. Participants were recruited for using the iGO app. The android OS based iGO app was designed for the participants to send reminders to do daily physical activities after breakfast and lunch and record users’ daily physical activities. After an eight-week period of using the iGO app, participants filled a questionnaire that was modified from the question items of [19]. The questions related to performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intentions and user behaviour were as follows: *(1) "using the iGO physical activity app improves work productivity at office", (2) "finding the iGO physical activity app is easy to use", (3) "colleagues' and others' thinking approach on the users to use iGO physical activity app", (4) "resources e.g. internet access while using app", and (5) "intentions to use iGO app in future physical activity and the overcoming physical inactivity during the month while actually using the iGO physical activity app"*. The questionnaires were analysed quantitatively using correlation analyses.

3.5 Participants

To recruit the participants, an invitation email/telephone was sent to participate in the study to 56 employed/self-employed individuals residing in Finland, UK, Ireland and Bangladesh. Participants were healthy adults, most of them employed in multinational ICT companies. Some of them were self-employed in their own business and others were fully employed and studying on a part-time. Forty-seven participants responded to the invitation through email/telephone. Out of those, 31 participants agreed to take part in the eight-week long pilot study, and the information and consent form and pre-questionnaire were sent to them. The pre-questionnaires were filled by 28 participants, who formed the study group for the pilot study (Fig. 4). The pilot study was designed to use the iGO app on their android smartphones for 8 weeks. A smartphone was issued to them under the returning terms and conditions to those who did not own an android smartphone. Six participants dropped out due to their professional reasons and re-location-shifting to new cities etc. Thus, 22 healthy participants completed the study.

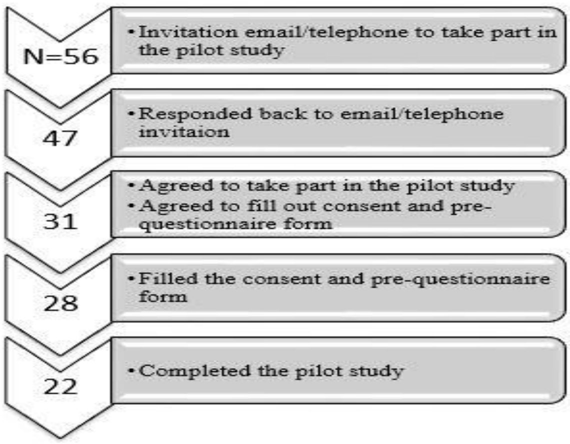

Fig. 4. Flowchart of study participants

3.6 Procedure and Materials

The iGO app was installed on participants' smart devices (android phones / tablets) Participants were requested to use the iGO app daily for at least 10 minutes after the breakfast and lunch while walking during the recession at the office. It was recommended for them to carry the smart device when walking. A total of 20 minutes had been assigned for each participant to use the iGO app (10 minutes after the breakfast and 10 minutes after the lunch). A reminder was sent via alarm/vibration to participants during the breakfast and lunch time to use the iGO app. Their walking after breakfast and lunch was monitored, and they earned reward points every five minutes they used the iGO app. A total of 1000 footstep during the 10 minutes was rewarded by 2 points. Participants could choose to walk with colleagues or walking alone by choosing options from the app. Participants were instructed to use the iGO app for at least eight weeks. The participants started to use the iGO app between March-May 2017. A post-questionnaire was sent after 8 weeks when they finished using the iGO app. The post-questionnaire was addressed to the usability issues of the iGO app and to observe how motivated the participants' feel in the context of their working progress and physical health. We used performance expectancy, effort expectancy, social influence behavioural intentions, facilitating conditions and use behaviour as factors to design the UTAUT post-questionnaire. It was used to analyse the effectiveness of the persuasive application in promoting physical activity. The questionnaire had a 7-point Likert scale of 1 : 7 corresponding to Completely disagree : Completely agree.

The purpose was to analyse the data of the users and measure the acceptance and use of the technology (iGO app). Correlation analysis was used to analyse data. If Y is the independent variable and X is the dependent variable, the correlation is Y = f (X). Here, in our study, to test the hypotheses we followed the criteria in below.

- (H1) Hypotheses 1; Y1: Performance Expectancy = f (X1: Behavioural Intention)
- (H2) Hypotheses 2; Y2: Effort Expectancy = f (X2: Behavioural Intention)
- (H3) Hypotheses 3; Y3: Social Influence = f (X3: Behavioural Intention)
- (H4) Hypotheses 4; Y4: Facilitating Conditions = f (X4: Use Behaviour)
- (H5) Hypotheses 5; Y5: Behavioural Intention = f (X5: Use Behaviour)

To acquire more accurate analysis, we used the ANOVA for calculating the range of correlation coefficient and p-value for each hypothesis to confirm their statistical significance. Several values are accepted for interpreting the correlation coefficient, R [51]. Whereas +1 and -1 show perfect positive and negative relationships, values between 0 and .3 indicate a weak positive and between 0 and -0.3 indicate a weak negative relationship, values between 0.3 and 0.7 denote (0.3 and −0.7) show a moderate positive while -0.3 to -0.7 denote negative, and values between 0.7 and 1.0 indicate a strong positive and between −0.7 and −1.0 shows a strong negative relationship [51]. Moreover, the relationships were considered statistically significant if $p<0.05$.

4 Results

4.1 Quantitative Results

Participants responded to the question item of performance expectancy between “Somewhat agree” and “Mostly agree” (mean value M=5.6, standard deviation SD=0.9), see Fig. 5, participants mostly considering that the iGO app improved their work productivity. Participants responded similarly in response to the question items of effort expectancy (M=5.9, SD=0.6), social influence (M=5.5, SD=1.0) and behavioural intentions (M=5.8, SD=1.2) (Fig. 5). Conversely, participants reported between “Neither disagree or agree” and “Somewhat agree” in terms of facilitating conditions (M=4.4, SD=1.4) i.e. they could not have enough resources to use the iGO app. However, the overall satisfaction to use the iGO app to promote physical activity was between “Mostly agree” and “Completely agree” i.e. participants responded significantly in terms of the user behaviour (M=6.4, SD=0.9).

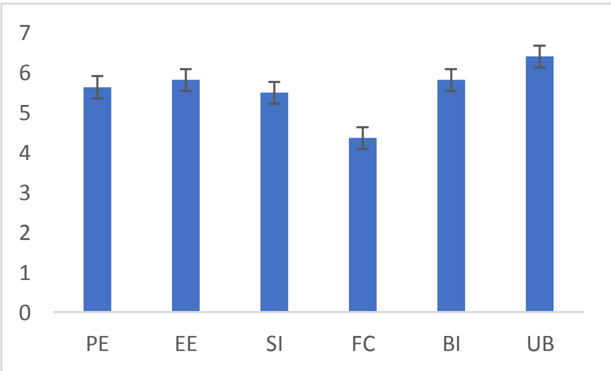

Fig. 5. Mean and standard deviation of performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), behavioural intention (BI), use behaviour (UB)

4.2 Research Hypotheses Results

To study the H1, we analysed the correlation between variables performance expectancy and behavioural intentions (Fig. 2). Correlation between variables effort expectancy and behavioural intentions were analysed to test the H2. To prove the H3, social influence and behavioural intentions were analysed. On the other hand, when testing the H4, the correlation between the facilitating conditions and use behaviour was analysed to test H5. Users indicated the following result relating to our hypotheses. Performance expectancy positively correlated with users’ intentions to use the iGO physical activity app (p=.007 R=.561), see Table 2. This implies that when employees expect a persuasive application to promote their physical activity, they increase their intentions to use the application. Effort expectancy was positively associated with users' intentions to use the application (p=.027, R=.470). This indicates that when users expect a persuasive application to be convenient for them to use, they increase their intentions to use the application (p=.027, R=.470). This indicates that when users expect a persuasive application to be convenient for them to use, they increase their intentions to use it. Social influence positively affected users' intentions to use the application (p=.007, R=.558). This indicates that when employees interact with their colleagues for a suggestion to use a persuasive application, the employees increase their intentions to use the application. Facilitating conditions did not significantly influence use behaviour of actually using the application (p=.361, R=.204), see Table 1. Behavioural intention positively influenced users' use behaviour of actually using the application (p=.019; R=.497) and thus, when users are more intended to use the application to promote physical activity, they use the iGO application more often.

Table 2. Confirmation of Hypotheses

Hypotheses	R	P	Strength	Support
H1	.561##	.007**	Moderate	Yes
H2	.470##	.027*	Moderate	Yes
H3	.558##	.007**	Moderate	Yes
H4	.204	.361	Low	No
H5	.497##	.019*	Moderate	Yes

*p < .05, **p < .01, ***p < .001, ##0.3< $|R| \leq 0.7$, ###0.7< $|R| \leq 1$.

The overall results of the hypotheses support UTAUT model except the factor facilitating conditions. In some cases, users were not having reliable internet access from their mobile phone network provider or WIFI access in their offices. From the developing side of the app it was acceptable since anyway the app was accessible using internet connection. We can conclude here that facilitating conditions were satisfactory for the development of the application but not for the existing workplace environment of the users. However, facilitating conditions can be solved by upgrading the app. Furthermore, users should be informed that the iGO app shall be supported by the facilitating conditions.

4.3 Limitations and Further Research

We measured the influence only through the subjective experience of the participants with questionnaires instead of actually measuring whether the app had an effect for doing more exercise or not. Based on the confirmation of the hypotheses, the iGO physical activity app needs still to be upgraded to fulfil the requirements of facilitating conditions, such as having the option to use the iGO app when they are offline.

The iGO installed in the smartphone should be able to keep the record of offline activities and update the record into the data server when online. As an example, social media network Facebook has the similar option that the system update user's status when the internet is available. The sensor to track the physical activities were also not compatible with all the smartphone models, i.e. it was working only on those which has the built sensor. More options for the users (option to walking more than 10 minutes) and offline activities for the users might be useful. The number of the dropouts was comparatively low. Only six out of 28 participants dropped out during the eight-week study, which suggests that the design of the iGO app was a rather successful approach using psychological theory SDT. Anyway, most of the participants were busy with their personal and professional lives, which may explain the dropouts. Total participant number to take part in the pilot session was still limited, and the statistical strength would increase with a higher sample size. A larger number of participants might demonstrate the specific effects of the persuasive application in more accuracy. This is a work-in-progress paper. Initially, we tested the usability issues such as the effect of the persuasive application in terms of users' physical activity promotion at their workplace. Next, we will measure and analyse weight management and the psychological needs of autonomy, competence and relatedness of the users.

5 Conclusion

This paper examined the influence of persuasive application in encouraging the physical activity of the employees at their workplace during the office hours. To do this, SDT was selected to design and build a physical activity app iGO. SDT runs explicitly as a psychological level of analysis, finding reasons of users' motivation, their emotions, thoughts and reactions. SDT confirmed healthy environment to improve the intrinsic motivation of the users by fulfilling their psychological needs of autonomy, competence and relatedness. After building the iGO physical activity app, we conducted an eight-week pilot study. Participants used the iGO app just after their breakfast and lunch breaks to monitor their physical activities e.g. walking and exercise. After the eight-week period, the participants filled out a post-questionnaire form that was modified based on the UTAUT model, which combines eight theoretical technology models from literature. All factors of UTAUT appeared to work well in terms of technology acceptance except the facilitating conditions. This was mainly due to internet connection, which may suggest an updated version of the iGO app. The overall effect of the persuasive application iGO was positive in the context of user's satisfaction in promoting physical activity at the workplace. Further study to analyse the iGO app by measuring the psychological needs of SDT will gauge the effectiveness of the persuasive application to encourage physical activity and to improve work productivity.

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