A Theory-Driven System Model to Promote Physical Activity in the Working Environment with a Persuasive and Gamified Application

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Abstract

Physical activity (PA) is important to prevent and lessen the risks of various diseases as well as progress in physical and mental health. Employees expend a lot of time at their workplace such as office environment. Working efficiency may be harmfully affected if the worker is physically inactive. The purpose of this study was to design a system model to guide employees at their workplace on their PA promotion. We propose a system model integrating the psychological theory known as Self-determination Theory (SDT) which indicates that people can be motivated extrinsically through the fulfilment of three psychological needs: autonomy, competence, and relatedness. To do this, game elements such as points, badges and leaderboard were applied into the system model. We utilized the system model to design a gamified persuasive application. We developed a prototype of PA promotion app using the User-Centered Design (UCD) process. We conducted UCD iteration and pilot-tested the prototype of an app with end users. They used the prototype of an app to perform some activities e.g. walking after breakfast and lunch hour. We found that it brings a positive impact on the employees in promoting their PA in their workplace. The result of the study will be used to build an actual persuasive application with gamification techniques.

1 Introduction

Recently, persuasive applications, targeted at changing behaviors, have become well-known and popular in health domain [1]. Persuasion is one of the most effective tools to support change behaviour [2]. Persuasive Technology has been proposed as an actual method to encourage behaviour change and it has a potential for improving health-related quality of life [3]. Thus, by using PA promotion application it might be possible to increase work productivity and to improve weight management. To design persuasive applications, researchers use game design elements in non-game contexts as an effective technique to encourage employees to achieve their goals. Gamification is an effective catalyst to persuade individuals submissive to roles [4-5]. Furthermore, persuasive technology and gamification research share common ground with respect to the psychological factors [6].

In recent times, persuasive applications have been designed for psychological influence. E.g. goals and feedback was applied in a mobile phone app to promote PA among young adults [7]. Rewards, feedback and goal setting have been used in a smartphone application to increase PA among the patients [8]. Health Month [9] is an application in which game elements (points and badges etc.) have been used to inspire users to select rubrics for health-related behavior for one month. Users can win or lose points based on those rubrics and receive inspiration via a social platform. However, research has shown diminutive evidence about gamified systems e.g. persuasive application for PA promotion in the working

environment. Gethealthapp [10] is an intuitive mobile application for employees and an online dashboard for employers allowing effective tracking and management of their wellness programs. Employees use the application to check their daily health tasks, such as move, munch, and mind. The move is like PA, munch is to eat well and mind is to keep one's mind calm like napping. The mobile application uses gamified methods such as it gives the employees to gain rewards as points and leaderboard of friends and colleagues. Recent research revealed methodological limitations in gamified systems – *"proper psychometric measurements, absence of motivational affordance, psychological and behavioural outcomes"* [11]. Our project deliberates theoretical constructs using the game mechanism, UCD process and implementing our application. The main purpose of this study is to answer the key research question:

Can we incorporate a psychological concept in designing a gamified system model for employees' PA promotion in the working environment?

To answer the research question, the previously established SDT was selected because it brings the capability to support individual's behaviour to offer reinforcement by the three psychological needs known as *autonomy*, *competence*, and *relatedness*. We present a system model by using these psychological needs inclined by autonomy support to encourage the employees in their PA promotion in their working environment. Previous research has indicated that applications which are developed focused on the users' models are more likely to have effectiveness than those applications which are not focused on users' models [12]. Therefore, we applied our proposed system model to design a gamified persuasive application using the UCD process. Our system model is grounded on the Ryan's SDT theory model of physical activity behavioural change [13].

2 Literature Review

2.1 Motivation

Two motivational approaches are accepted by the human which is intrinsic and extrinsic motivation [14]. According to SDT, there are three types of psychological needs that are *competence*, *autonomy* and *relatedness* which can intrinsically motivate people [14] in their PA promotion. *Competence* is the sense of being able to finish an activity, e.g. after the breakfast and lunch period at the office, walking for 10 minutes. *Autonomy* refers to the feelings of having the choice to view one's social environment and enabling selections corresponding to complete an activity, e.g. the ability to go for a 10-minute walking with colleagues or alone. *Relatedness* is the ability to connect with others, e.g. to stay connected with other colleagues using a PA application. Employees are motivated intrinsically when they sense happy while doing activities whereas more extrinsically motivated employees perform the activity because they want to achieve to some degree from completing the activity, for example, earning badges/points after walking for 10 minutes after the breakfast/lunch period. The employees who are not interested in doing any activities are regarded as *amotivated.*

2.2 Game Design Elements

Gamification is defined as the use of game design elements in non-gaming environments [4]. Gamification refers to motivating users by making their experience more playful and fun [15]. According to the theory of motivation [16], human behaviour is principally motivated by extrinsic factors for example incentive or reward [16-17]. The reward is offered to *"an individual as a result of the accomplishment of a specific task or the achievement of a target behaviour"* [18]. Within the domain of persuasive technology research, reward acts as the construct to measure how fit the reward as a persuasive approach can persuade individuals to perform a target behaviour. The reward can be implemented as virtual points and badges etc. [18].

Moreover, competition is a persuasive approach that delivers from the Theory of Competition [19]. Competition refers to *"the act of seeking or endeavoring to gain what another is endeavoring to gain at the same time"* [20]. Within the domain of persuasive technology research, competition acts as the construct to measure how fit the competition as a persuasive approach can persuade individuals to perform a target behaviour. In the persuasive applications, Competition can be implemented as a leaderboard on which users' performance is demonstrated [21]. Competition allows users to know their position, view and compares their performance of a target behavior by means of the performance of others [22].

3. Designing System Model

3.1 Game Elements

Out of the game elements found in the literature, we selected some possible game elements. In general, empirical research has found that the implementation of reward i.e. points and badges and leaderboards is a practical means to encourage users' behaviour in non-game contexts [23]. Specifically, within the PA research, the game elements reward i.e. points and badges [24-30], and leaderboard [24-26,28-29] can persuade people to accomplish a specific activity such as PA promotion i.e. exercise/walking in the working environment.

3.2 System Model

The approach used here was a combination of the theoretical concept of SDT, regular game elements (points, badges and leaderboard), and positive and motivating outcomes (exercise and weight control). We utilized the existing Ryan's SDT theory model of health behavioral change [13] to scaffolding the proposed system model. Ryan's SDT theory model indicates that the satisfaction of autonomy, competence and relatedness brings positive outcomes for mental health (higher quality of life, less anxiety, depression and somatization) and physical health (workout/exercise, weight loss, glycemic control, non-smoking medication use, healthier diet and dental hygiene). This study, however, highlighted the physical health elements particularly exercise/walking and weight control (Fig. 1). SDT has been selected as it runs principally as an analysis for psychological level, seeks for the sources and reasons of the individual level of motivation, their thoughts, reactions and emotions. Thus, SDT theory indicated the purpose of motivation to improving motivational progress and wellbeing [31]. SDT facilitates a gateway to understand the outlines of PA-related behaviour consequences e.g. walking/exercise, the three basic psychological needs and autonomy-supportive elements that support the purpose of PA. This effort of SDT helps to conceptualize a system model, for example, our system model for employees to do PA. As an example, we assume a mobile application to which SDT is applied and employees update their daily activities (10 minutes of walking after breakfast/lunch) period. On the application, if the employee selects to go for walking alone which implies their expression of the psychological need *autonomy*. If the employee chooses to go for walking with others/colleagues, it indicates their expression of the psychological need *relatedness*. Active peering with others (e.g. display- a leaderboard on the application to perceive others' accomplishments) implies their expression of the psychological need *competence*.

We selected extrinsic motivation to use the game elements (e.g. rewards - scoring points and earning badges to monitor the progress of everyday walking after breakfast/lunch period). We integrated the entire sequence of using SDT, autonomy support – psychological needs – self-determination motivation,
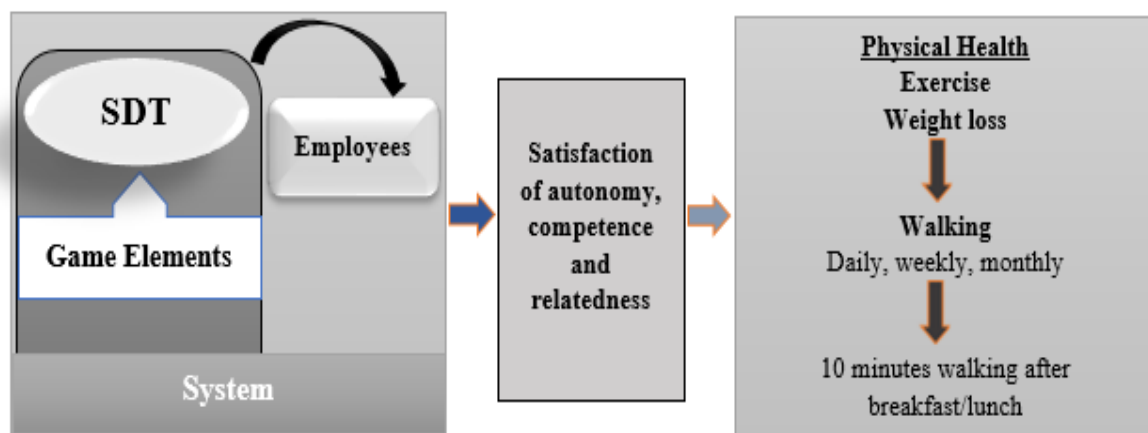

Figure 1: Proposed system model through the lens of Ryan's SDT theory model of behavioural change

using these game elements to build an application. For PA promotion such as exercise or weight control, employees monitor their daily achievement when walking after breakfast/lunch period. An example of a milestone is that an employee starts to walk for 20 minutes daily. They divide this task into two parts, i.e. 10 minutes walking after the breakfast period and another 10 minutes walking after the lunch period, and they get rewards (scoring points and earning badges) in return. Similarly, other milestones can be monitored for example positioning 1st, 2nd or 3rd on the leaderboard based on total earned points. Their physical activities can be measured by an application daily to track their walking, and how they prefer to walk (walking with colleagues or walking alone etc.). Data-driven approaches can be used to measure user's fulfillment of autonomy, competence and relatedness. To do this, an application followed by the system model is expected to record the everyday data of the users' activities and a comparative analysis of several weeks can be conducted. The application may count how active users are by calculating their earned rewards and their time spent in using the application etc.

3.3 User-Centered Design (UCD) Process

UCD is an iterative application design process that focuses on how the users use the application [32]. It consists of five steps: *Empathize*, *Define*, *Ideate*, *Prototype*, and *Test*. *Empathize* is described as the sense of understanding when answering a problem. *Define* indicates making the sense of information collected from the Empathize step and concludes with a problem statement i.e. a point-of-view (POV). *Ideate* focuses on creating ideas for designing prototypes that fit users' recommendations and needs. Examples of ideation are body storming, mind mapping and sketching. *Prototype* denotes to an initial stage of an application release. This prototype can be a hard copy/paper object or an interactive display in smart devices) to support in creating the final design. *Testing* confirms that the prototype and result are polished, reconnoitering the needs of the users and clarifying the POV. Multiple ideas were considered to build a prototype by using several game elements. Ideation occurred in this time leading to prototyping to generate the final design. The prototype was then tested by few participants.

3.3.1 Empathize

Eight employees living in the Finland were interviewed face-to-face. Participants were from three nationalities. The purpose of the interview was to perceive employees' views in relation to their willingness of PA promotion in their office environment. The employees were asked to describe their views and experience of overcoming physical inactivity at the office such as how do they conduct PA when sitting for long-time and thoughts about anything that might motivate them and any technology-mediated tools that might support them to do PA. Six employees (75%) reported the lack of PA in the working environment. Seven employees (88%) strongly recommended for a technological tool to which they can do PA particularly walking and weight control, and connect with others such as the tool can have the option to choose walking alone or walking with others. They wanted to see their daily progress in a leaderboard. They showed their interest to experience something that can make them competitive, for example, lower points holder will appear on the leaderboard with fatty face They showed interest to use the game elements: (scoring points and earning badges -1st, 2nd and 3rd). However, some recommended exchanging the points in real time voucher/gift, for example, a tea/coffee voucher. The above observation has informed us to move to the Define step to come up with an actionable problem statement.
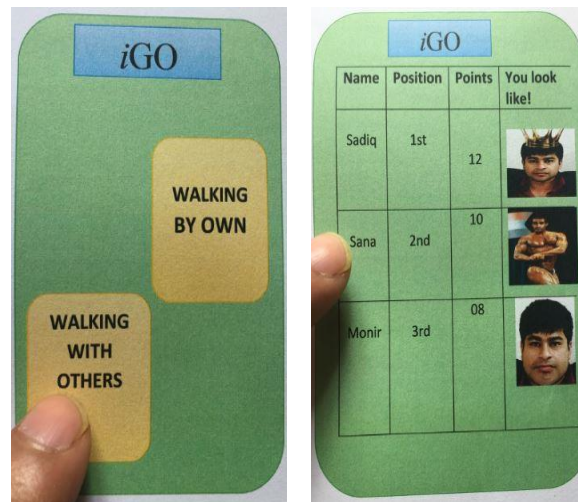

Figure 2: Testing the prototype of a PA promotion app

3.3.2 Define

Based on the results of the interviews the following problem statement has been concluded:

Employees sense a lack of being physically active in their working environment. A technological tool using game elements can help them overwhelming the state of their physical inactivity and can help them to motivate in walking and tracking everyday walking history.

The above POV has drawn attention on how we might build an application with the aid of game elements to which users can experience more fun in their PA promotion.

3.3.3 Ideation

The POV from the Define step has led us to design the prototype of the PA application. The idea of designing the prototype was to observe users' response and how they responded using game elements in accordance with the SDT sequence. The prototype was designed by adding PBL game elements (points, badges and leaderboards).

3.3.4 Prototype

The objective of building the prototype was to verify whether users can run a gamified persuasive application, and how do they react in using the application that incorporates SDT using game elements. A low fidelity paper prototype (Fig. 2) was built which lets the user to input his/her initial details to log-in (name, age and weight etc.). After logging into the application, the user had the option to go for physical activity with others or alone (Fig. 2). Once a user selects an option to walk, time starts to count for 10 minutes, and the user receives 1 point for every 5 minutes. After the walking session, users can track their tier activities on the leaderboard.

3.3.5 Test

Ten Employees had been invited via email/telephone. Out of those, 5 employees confirmed their availability to take part in the study.

The prototype was not interactive i.e. participants used printed paper to access the paper prototype. Each participant had been allocated for 15 minutes to test the prototype. The aim was to observe the usability issues of the prototype, and how users valued to use the SDT sequence using game elements. Employees were informed briefly how to use the prototype, e.g. they had been guided to pretend using the prototype similarly as

they were using it in real time. The participants were asked to report whether the prototype motivated them to promote their PA in the working environment. Our intention in this study was to find the qualitative information data of how participants use the prototype and response to the game elements in the prototype. We collected participants' response that was compelled by qualitative data. The data showed their progress in completing the tasks facilitated by the prototype.

4 Results and Limitations

Based on the first iteration of the UCD process on a persuasive and gamified application for promoting PA at working environment, we have concluded the following results. Four participants felt that choosing the options to go for a walk with others or alone gave them the freedom of choice. Three participants expressed interest for a reminder that can be set before using the application. People naturally sense idle to do anything enthusiastically but may be tricked by external triggers such as diabetic patients improved their self-efficacy to control glycemic through text messaging [33]. Overall, most participants positively reported in using the paper prototype i.e. it motivated them to go for PA. Participants showed their interest in earning the points and badges (Gold, Silver and Bronze). Participants were interested to view the leaderboard except for one participant who was confused about the ranking list. This prototype should be updated to build an actual PA promotion app with a built-in reminder, e.g. alarm/vibration, and a detailed feature with the game elements. The findings of the study suggest us that adopting SDT using game elements to design a system model followed by the Ryan's SDT theory model of health behavioral change is a successful approach to motivate employees in their PA promotion.

Moreover, through the study, the limitations have been uncovered. The concrete motivational outcome may differ when implemented in an actual PA promotion app. Therefore, we plan to examine the effect of the system model implemented in an actual gamified persuasive application. Also, our study has not tested in long-term use since users ran the prototype of an app for only 15 minutes and pretended to use the application. Users pretended to use the actual application when using the paper prototype of an app to walk for a 10-minute and thus, using the actual PA promotion app may bring

different effect to walking consequences such as weight control and work productivity etc.

5 Conclusion and Future Work

Our study presents the system model to motivate the employees for physical activity promotion in the working environment that was implemented in a paper prototype of an app. This study contributes to the Human-Computer Interaction (HCI) community to deepen understanding of how psychological theory can be integrated to design a system model as well as using game design elements within the system model. The secondary objective of the paper was to develop a prototype of a PA promotion app based on our proposed system model. We tested the system model through a pilot followed by the UCD iteration. Results have shown that employees within their office environment, felt that using a PA promotion app could increase their PA-related behaviours such as walking after breakfast and lunch hour. The pilot study was small-scale and due to the paper prototype-based study and participants cannot really draw generalizable conclusions. The limitations of the study addressed us to examine the application empirically. Our results can guide us to develop an actual PA promotion app by adding extra features e.g. reminders and tracking record built in the app. This study also opens the gateway for further examination. Further research should concentrate on building the actual application, evaluate in comparison with existing applications i.e. experimental and control condition, and work out exactly where the game elements play a significant role by tracking users' daily activity from the data-server connected with the PA promotion app. Further research should also focus on users actually using the PA promotion app, its usability issues and a long-term study to examine the real effect of the PA promotion app.

References

[1] S. Chatterjee, A. Price. Healthy Living with Persuasive Technologies: Framework, Issues, and Challenges. *Journal of the American Medical Informatics Association*. 16, 171–178, 2009.

[2] D. J. O'Keefe. *Persuasion theory and research* (2nd. Sage Publications, Thousand Oaks, CA, 2002.

[3] B. J. Fogg. Persuasive Technology: Using Computers to Change What We think and Do, 2003.

[4] S. Deterding, M. Sicart, L. Nacke, K. O'Hara, and D. Dixon. Gamification: Using game-design elements in nongaming contexts. In *Proceedings of. CHI EA '11*, ACM Press, 2425-2428, 2011.

[5] L. Singer, and K. Schneider. It was a Bit of a Race: Gamification of Version Control. In *Proceedings of the 2nd international workshop on Games and software engineering*, Zurich, 5-8, 2012.

[6] J. Hamari, J. Koivisto, and T. Pakkanen. Do Persuasive Technologies Persuade? – A Review of Empirical Studies. In: Spagnolli, A. et al. (Eds.), *Persuasive Technology,* LNCS 8462, 118-136, 2014.

[7] L. S. Belmon, A. Middelweerd, S. J. Te Velde, and J. Brug. Dutch Young Adults Ratings of Behavior Change Techniques Applied in Mobile Phone Apps to promote Physical Activity: A Cross-Sectional Survey. *JMIR Mhealth Uhealh*. 12,3, 2015.

[8] M. Casey, P. S. Hayes, F. Glynn, G. OLaighin, D. Heaney, A. W. Murphy, and L. G. Glynn. Patients' experiences of using a smartphone application to increase physical activity: the SMART MOVE qualitative study in primary care. *The British Journal of General Practice*. 64,625, 2014.

[9] Health Month. Game Elements for Social Connection, Retrieved on August 27, 2017 from http://healthmonth.com, 2016.

[10] Gethealthapp. The complete wellness platform. Retrieved on August 27, 2017 from http://gethealthapp.com, 2017.

[11] J. Hamari, J. Koivisto, and H. Sarsa. Does Gamification Work? – A literature review of Empirical Studies on Gamification, *47th Hawaii International Conference on System Science,* 2014.

[12] R. O. Orji. Design for Behaviour Change: A Model-driven Approach for Tailoring Persuasive Technologies. *University of Saskatchewan*, Canada, 2014.

[13] R. M. Ryan, H. Patrick, and E. L. Deci, and G. C. Williams. Facilitating health behaviour change and its maintenance: Interventions based on Self-Determination Theory, *European Health psychologist*, 10, 2008.

[14] E. L. Deci, and R. M. Ryan. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior, *Psychological Inquiry*, 11, 2000.

[15] S. Deterding, S. L. Björk, and L. E. Nacke, D. Dixon, and E. Lawley. Designing gamification: creating gameful and playful experiences. In *ACM CHI'13 Human Factors in Computing Systems.* 3263–3266, 2013.

[16] Incentive Theory of Motivation and Intrinsic vs. Extrinsic Motivation. Retrieved on September 04, 2017 from https://www.boundless.com/psychology /textbooks/

boundless-psychology-textbook/motivation-12/
theories-of-motivation-65/incentive-theory-of-
motivation-and-intrinsic-vs-extrinsic-motivation-25
2-12787, 2016.

[17] K. Cherry. The Incentive Theory of Motivation. Retrieved on July 26, 2017 from http://psychology.about.com/od/motivation/a/incentive-theory-of-motivation.html, 2015.

[18] K. Oyibo, and J. Vassileva. Investigation of Social Predictors of Competitive Behavior in Persuasive Technology. *In Proceedings of the 12th International Conference on Persuasive Technology (PT'17),* Springer, Amsterdam, Netherlands, 2017.

[19] H. Oinas-kukkonen, and M. Harjumaa. Persuasive Systems Design: Key Issues, Process Model, and System Features. *Communications of the Association for Information Systems.* 24, 485–500, 2009.

[20] M. Mead. Cooperation and competition among primitive people. *Transaction Publishers*, 2002.

[21] R. Orji, J. Vassileva, and R. L. Mandryk. Modeling the efficacy of persuasive strategies for different gamer types in serious games for health. *User Modeling and User-Adapted Interaction.* 24, 453–498, 2014.

[22] A. Stibe. Socially Influencing Systems: Persuading People to Engage with Publicly Displayed Twitter-Based Systems, 2014.

[23] E. D. Mekler, F. Brühlmann, K. Opwis, and A. N. Tuch. Do points, levels and leaderboards harm intrinsic motivation? An empirical analysis of common gamification elements. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications,* 2013.

[24] Y. Chen, P. Pu. HealthyTogether: exploring social incentives for mobile fitness applications. In *Proceedings of the Second International Symposium of Chinese CHI. ACM*, 25–34, 2014.

[25] K. Thorsteinsen, J. Vittersø, G. B. Svendsen. Increasing physical activity efficiently: an experimental pilot study of a website and mobile phone intervention. *International Journal of Telemedicine Applications,* 2014.

[26] O. Zuckerman, and A. Gal-Oz. Deconstructing gamification: evaluating the effectiveness of continuous measurement, virtual rewards, and social comparison for promoting physical activity. *Pers. Ubiquitous. Computing*. 18,7, 1705–1719, 2014.

[27] L. Reynolds, V. S. Sosik, and D. Cosley. When Wii doesn't fit: how non-beginners react to Wii fit's gamification. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications. ACM*, 111–114, 2013.

[28] S. Riva, A. L. Camerini, A. Allam, and P. J. Schulz. Interactive sections of an Internetbased intervention increase empowerment of chronic back pain patients: randomized controlled trial. *J. Med. Internet Res*, 16,8, 2014.

[29] F. Spillers, S. Asimakopoulos. A diary study comparing mobile health applications. Design, User Experience, and Usability. *User Experience Design Practice.* Springer, 358–369, 2014.

[30] I. Kuramoto, T. Ishibashi, K. Yamamoto, and Y. Tsujino. Stand up, heroes!: gamification for standing people on crowded public transportation. Design, User Experience, and Usability. Health, *Learning, Playing, Cultural, and Cross-cultural User Experience. Springer*, Berlin Heidelberg, 538–547, 2013.

[31] P. M. Wilson, D. E. Mack, and K. P. Grattan. Understanding Motivation for Exercise: A Self-Determination, Theory Perspective. *Canadian Psychology, Canadian Psychological Association,* 49,3, 250–256, 2008.

[32] An introduction to design thinking process guide. Retrieved on August 27, 2017 from http://dschool.stanford.edu/sandbox/groups/design/resources/wifi/36873/attachments/74b3d/ModeGuideBOOTCAMP2010.pdf?sessionID=573efa71aea50503341224491c862e32f5edc0a, 2017.

[33] V. L. Franklin, A. Waller, C. Pagliari, and S. A. Greene. 2006. A randomized controlled trial of Sweet Talk, a text-messaging system to support young people with diabetes. *Diabetic Medicine*, U.K. 23,1, 2006.