DESIGNING FITNESS APPS USING PERSUASIVE TECHNOLOGY: A TEXT MINING APPROACH

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Abstract

Popularity and pervasiveness of mobile apps have great potential to motivate healthy behavioural modifications. Considering the increased prevalence of obesity, overweight and sedentary lifestyle in modern societies, this study takes an important step in proposing design elements for fitness apps that can stimulate enhanced physical activity behaviour. We posit that persuasive technology principles infused into social cognitive theory elements will lead to the design of successful fitness apps. We empirically validated our conceptualization using app descriptions and lifecycle data of mobile apps. Implications for practice and future research are discussed.

Keywords: Fitness Apps, Persuasive Technology, Social Cognitive Theory, Physical Activity.

1   INTRODUCTION

Smartphone industry has experienced an exponential growth in recent past. The third party software applications that run on smartphones (usually referred as mobile apps or simply apps) are extensively used in day-to-day activities. The absolute number of apps in app stores and their rate of growth are tremendous. In the third quarter of 2014, 85 billion apps have been downloaded from major app stores i.e. Apple, Android, BlackBerry, and Windows)[1]. An average smartphone user spends 127 minutes or more than two hours with mobile apps each day[2]. Global app market revenue is expected to surpass 76.52 billion US dollars by 2017[3]. As mobile apps are versatile, ubiquitous and are being with us always at our finger tips, they have a great potential to promote healthy behaviours.

Contemporary health related mobile apps (i.e. health and fitness apps) (such as RunKeeper, MyFitnessPal and Nike+ Running) are built-in with GPS (Global Positioning System) technologies, sophisticated sensors (e.g. calorie calculator, heart rate monitor and biometric sensors), and social networking capabilities (i.e., sharing in Facebook and Twitter) that can improve the effectiveness of health interventions. Moreover, the availability of free apps and low priced apps drastically reduce the cost and increases the reach of these health interventions. Thus, health and fitness apps are a viable cost effective solution for the problem of increasing lifestyle diseases (such as obesity, heart disease, and type 2 diabetes) in modern societies. Despite the popularity and potential of health and fitness apps in assisting individuals to lead a healthy lifestyle, research related to the design of such apps is limited. Therefore, there is an urgent need to examine the effectiveness of these apps, in order to yield beneficial health outcomes.

As of June 2014 there are more than 20,000 health and fitness apps available for the consumers to download from major app stores (iTunes and Google Play). However, only 30% of these apps achieve 90 days user retention and the rest of the 70% apps are failures[4]. Thus, we need to understand, what makes some apps successful and others to fail. This knowledge can help building successful and effective healthcare apps that engender positive health outcomes. Particularly, it is important to understand the design features that could yield app success.

As obesity, overweight and sedentary lifestyles are rising health concerns in modern society, we aim to investigate on the apps that belong to 'fitness' category. More specifically our research question is "What is the impact of design features on fitness app success?" Drawing from Social Cognitive Theory (SCT), Persuasive Technology and employing Text Mining approach, this study aims to offer design principles for developing successful fitness apps. Successful fitness apps generally have desirable features that would engage users and motivate greater physical activity behaviour.

We previously proposed a conceptual model that utilized persuasive technology principles that can guide the design of fitness apps (Yoganathan & Kajanan 2013). Persuasive technology design can encourage people with greater physical activity behaviour and apps with such features thus become successful. This paper analyses the efficacy of the persuasive design principles in successful fitness apps. To empirically validate our conceptualization, we collected and analysed app descriptions and lifecycle data of 5716 fitness apps in the Google Play app store. Our analysis validated our conceptualization.

The paper is structured as follows. The immediately following section provides the literature related to our study. Then we describe the conceptual model and hypothesis, followed by study design and data

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[1] http://www.statista.com/statistics/263794/number-of-downloads-from-the-apple-app-store/
[2] http://blog.flurry.com/bid/92105/Mobile-Apps-We-Interrupt-This-Broadcast
[3] http://www.statista.com/topics/1002/mobile-app-usage
[4] http://blog.flurry.com/bid/90743/App-Engagement-The-Matrix-Reloaded

collection. Subsequent sections provide discussion on the data analysis and findings. Finally, we conclude with the implications for theory, practice and recommendations for future work.

2 LITERATURE REVIEW

Theoretical models and constructs play a vital role in the design of successful interventions that promote physical activity behaviour (Rovniak *et al.* 2005). Following sub sections provide the theoretical basis of our conceptual model.

2.1 Social Cognitive Theory

Success of a fitness intervention depends on the motivation and engagement of the participants. Therefore, in order to design successful fitness apps, we need to understand the factors that would motivate physical activity behaviour. Thus, in the search for motivation theories, Social Cognitive Theory (SCT) (Bandura 1986) appears to have a strong potential to explain the physical activity behaviour of individuals and to develop clinically relevant interventions to promote physical activity (Keller *et al.* 1999). The SCT constructs have been used health in promotion efforts such as weight loss (Fontaine & Cheskin 1997), smoke cessation (Nicki *et al.* 1984)and diabetes self-care (Clark 1997). Therefore, in this study we have chosen SCT to understand the physical activity behaviour of individuals

Social Cognitive Theory (SCT) (Bandura 1986) posits a framework for understanding human motivation, thought and action from a social cognitive perspective. i.e., it explains how people acquire and maintain behavioural patterns. Thus, SCT provides the basis for behavioural change interventions. The theory postulates that individual's behaviour change is a function of self-efficacy (i.e. expectation regarding one's ability to perform the given behaviour) and outcome expectation (i.e. expectation about the outcome that would result from performing the given behaviour). Moreover, Performance attainment outcomes inform and alter their environments and beliefs, which in turn inform and alter their subsequent performances. Thus, human behaviour is an interaction of environmental events, personal factors, and behaviour i.e., triadic reciprocal determinism.

While SCT provides the basis for understanding physical activity behaviour of individuals, the theory doesn't provide much detail on the precise design elements that can be used to construct successful fitness apps. Therefore, we have chosen Persuasive Technology (Fogg 2003) design principles to guide the design of successful fitness apps. Persuasive technology (Fogg 2003) provides various design strategies that can trigger and motivate behaviour. When people find it difficult to incorporate physical activity into their daily routines, they must be sufficiently convinced and stimulated to initiate and maintain physical activity behaviour.

2.2 Persuasive Technology

Persuasive Technology is "is an interactive technology that can be utilized to change the attitudes and behaviours of people" (Fogg 2003). The framework developed by Fogg (i.e., functional triad) provides a basis for understanding persuasive technology design (Fogg 2003). According to the framework, interactive technologies can persuade users in three basic ways, depending on their functional roles. They are as 'tools', as 'media' and as 'social actors'. Each role has set of persuasion techniques that can change the user's attitude or behaviour or both.

In their role as tools, computing products persuade users by making activities easier, leading people through a process, and performing math calculations or measurements that motivate. In the role as persuasive media, computers shape the attitude and behaviour by providing simulated experience. These simulations persuade people by allowing to them explore the cause-and-effect relationships, motivate with vicarious experience and help to rehearse behaviour. Finally, the role as social actors,

persuade users by providing variety of social cues that elicit social responses from users. Persuasive technology has been used in many disciplines including advertising, marketing, games and healthcare. Particularly, it has been used in encouraging good eating habits (Intille *et al.* 2003), internet advertising (Lee & Lee 2003), encourage responsible sexual behaviour (Strachan & Gorey 1997). Thus, we utilize design principles from persuasive technology in designing successful apps. Following section details our conceptual model.

3   RESERCH MODEL

Based on Social Cognitive Theory and Persuasive Technology design principles, we develop a research model that embed persuasive technology principles into SCT concepts that can lead to the design of successful fitness app. Persuasive technology (Fogg 2003) concepts were entrenched into SCT (Bandura 1989) constructs based on their theoretical definitions.

In this study we propose that existence of features that enhance the exercise self-efficacy, promote positive outcome expectations, enable effective self-regulation, and support social facilitation will positively affect fitness app success.

3.1   Fitness app success

Fitness app success refers to "heavily used, greatly valued and highly recommended fitness apps that fulfil the fitness needs of users" (Yoganathan & Kajanan 2013). When an app effectively helps a user with greater exercise performance, it is more likely that the user highly rates the app (5 stars, 4 stars), positively recommend it to his/her friends, write positive comments (i.e. positive sentiments) and more and more users will be using the app. Studies on consumer goods have emphasized that user WOM indicated by product rating volume (Dellarocas *et al.* 2010), rating valence (Li & Hitt 2010) and review sentiments (Asur & Huberman 2010) have been important determinants of product sales and profit. Thus, in this study app success is measured through rating volume (rating count), rating valence (rating score/star rating) and review sentiments. Thus, app success metrics in this study, measure an app's ability in promoting effective and positive physical activity change behaviour (in fitness app users).

3.2   Self-Efficacy

Self-Efficacy refers to "people's judgment of their ability to organize and accomplish necessary courses of action to attain the desired types of performance or outcome" (Bandura, 1986). It is an individual's perception of "can I do this?". Designing apps with features that enhance the exercise self-efficacy of users can promote greater physical activity behaviour and hence lead to the success of that fitness app. Persuasive design principles such as 'reduction' and 'tunnelling' can effectively enhance the exercise self-efficacy of individuals.

3.2.1   *Reduction in fitness apps*

Reduction in fitness apps is defined as the "design that reduces the complex exercising behaviours into simple manageable tasks" (Yoganathan & Kajanan 2013). When exercise is broken down into simple tasks, it increases physiological arousal to engage in exercise and hence the person's belief in his/her ability to perform exercise increases (Fogg 2003). Thus, reduction technique increases the person's motivation to engage in exercise more frequently, promotes the competence, self-esteem and enhance the exercise self-efficacy of user (Bandura 1997).

3.2.2   Tunnelling in fitness apps

Tunnelling in fitness apps refers to "guided persuasion", "a design that guides user throughout the exercise by a systematic step-by-step process in order to accomplish the physical activity task" (Yoganathan & Kajanan 2013). When users are guided throughout, the process becomes easy to follow (Fogg 2003) and it enhances their commitment in the physical activity (Plous 1993). This improves the positive attitudes about physical activity thus enhances the self-efficacy (Fogg 2003).

Therefore, persuasive technology features that enhance the exercise self-efficacy of fitness app users will enable them to easily accomplish exercise task and enhance the exercise performance. Hence, fitness apps with such features will be highly valued, popular and successful among users. Thus we hypothesize that

> *H1: Existence of features that enhance the exercise self-efficacy of users will positively affect the fitness app success.*

3.3   Outcome expectation

Outcome expectation refers to "an individual's belief that a given behaviour will lead to the anticipated outcome" (Bandura 1986). It is an individual's perception of "what will happen if I do this?". Persuasive design principles such as simulation, conditioning and suggestion technologies enable people to have positive outcome expectations.

3.3.1   Simulation in fitness apps

Simulation in fitness apps refers to the "design that artificially imitates real-world entities in order to encourage individual's exercise behaviour" (Yoganathan & Kajanan 2013). As simulations help users to explore and experiment various exercise activities in a safe, non-threatening environment (e.g., bicycling), and demonstrates the cause and effect immediately (Fogg 2003), it enables people to have positive outcome expectations about exercise.

3.3.2   Conditioning in fitness apps

Conditioning in fitness apps refers to "the design that uses principles of operand conditioning to promote physical activity behaviours of individuals (Yoganathan & Kajanan 2013). Operand conditioning or reinforcement theory (Skinner 1969) uses reinforcements to change the frequency (i.e., re-occurrences), strength, and form (shape) of the behaviour. Therefore, reinforcements on current behaviour can strengthen the motivation for a particular outcome and enable users in formulating positive outcome expectations about future exercise activities. Different types of feedbacks (e.g. voice, text) may be appropriate based on the activity type (Yoganathan & Kajanan 2014)

3.3.3   Suggestion in fitness apps

Suggestion in fitness apps refers to "the design that allows intervening or providing suggestions at the right time to enhance the physical activity behaviour" (Yoganathan & Kajanan 2013). Interactive and ubiquitous nature of smartphone helps in intervening and offering suggestions at opportune moments. Thus, would increase the potential to persuade and enable users to have positive outcome expectation about the physical activity. Suggestion technology, function as a cue to re-evaluate an individual's behaviour (Fogg 2003).

Therefore, persuasive technology features that enable users in formulating positive physical activity outcome expectations would enable them to improve their exercise performance, support in effectively

achieving their fitness goals and facilitate being physically active throughout the day. Hence, such apps will be highly valued and very much recommended by users (i.e. hence such apps become popular and successful among users). Thus, we hypothesize

> *H2: Existence of features that promote positive outcome expectation about*
>
> *physical activity in users will positively affect the fitness app success.*

3.4 Self-regulation/goals-setting

Self-regulation refers to the "standards that people set on themselves for behaviours and responding to their own actions self-evaluatively" (Bandura 1986). Effective self-regulatory goals would in turn enhance their subsequent physical activity performances. Persuasive design principles such as self-monitoring and tailoring technologies enable users to formulate effective self-regulatory strategies/optimal goals that can yield greater exercise performances.

3.4.1 Self-Monitoring in fitness apps

Self-Monitoring in fitness apps refers the "design that allows the user to track his or her own physical activity performance or status" (Yoganathan & Kajanan 2013). Self-monitoring makes exercisers to know how well they are performing, helps to learn about themselves and hence they are at a position to make effective future goals based on the present performance (Bandura, 1997). Thus, self-monitoring enables embracing effective self-regulatory/goal setting strategies that can intrinsically motivate enhanced physical activity behaviours(Fogg 2003).

3.4.2 Tailoring in fitness apps

Tailoring in fitness apps refers to "persuasion through customization" i.e. "providing users with the exercise related information(e.g. physical, physiological, and behavioural) exclusively relevant to them" (Yoganathan & Kajanan 2013). Enabling users to create personalized goal that considers individual's needs, interests, mood, emotions and contexts (Fogg 2003)., facilitate users to self-regulate exercise behaviour. This enhances the commitment and involvement in exercise (Plous 1993)

Therefore, persuasive technology features that enable self-regulation would enhance the physical activity performance of individuals. Hence, such app would be well preferred and highly valued by its users. Thus, we hypothesize that

> *H3: Existence of features that enable effective physical activity related self-*
>
> *regulatory mechanism in users will positively affect the fitness app success.*

3.5 Social facilitation

Social facilitation refers to "socio structural factors that enable individuals to enhance their physical activity behaviour" (Yoganathan & Kajanan 2013). The social networking capability of contemporary fitness apps provides various avenues to persuade individuals' exercising behaviour. Social facilitation techniques such as normative influence, social comparison, competition, cooperation, and social recognition can enhance the physical activity behaviour of fitness app users.

3.5.1 Normative influence in fitness apps

Normative influence in fitness apps refers to "the design that allows pressures to conform" such that users tend to change their attitudes or behaviours related to physical activity in order to meet the expectations of friends and family members" (Yoganathan & Kajanan 2013). Due to sedentary lifestyle, people find it difficult to incorporate physical activities into their daily routine. Prior studies

have found that merely observing others engaging in exercise can result in adopting exercise as people have a naturally social urge to conform and 'fit in' to society (Ball *et al.* 2010). Therefore, fitness app that promotes physical activity though social networking sites can motivate individuals to adopt and improve exercising behaviours through normative influence.

3.5.2   Social Comparison in fitness apps

Social Comparison in fitness apps refers to "the design that facilitates benchmarking individual's fitness performance with that of others, and hence provide an opportunity for enhanced motivation in target behaviours" (Yoganathan & Kajanan 2013). Many fitness apps facilitate users to compare their own physical activity performance with their friends' performance.

3.5.3   Competition in fitness apps

Competition in fitness apps refers to "the design that motivate enhanced physical activity performance by leveraging human's natural drive to compete" (Yoganathan & Kajanan 2013). Contemporary gamification apps such as Fit Friendzy and Fitocracy inspire friendly fitness competitions and challenges among buddies through fun games.

3.5.4   Cooperation in fitness apps

Cooperation in fitness apps refers to "the design that motivates users to adopt physical activity behaviour by leveraging an individual's natural drive to cooperate" (Yoganathan & Kajanan 2013). Activities such as cycling in groups, offer tips for common fitness problems can stir the human beings' natural drive to cooperate with each other and hence motivate users to adopt and healthy physical activity behaviours. Thus apps with such features would be successful.

3.5.5   Social Recognition in fitness apps

Social Recognition in fitness apps refers to "the design that offers social acknowledgment for an individual or group, with an aim of increasing the exercise behaviour of that person or group" (Yoganathan & Kajanan 2013). Fitness apps that socially recognize individual or group fitness achievements could motivate greater fitness achievements..

Therefore, social facilitation features in fitness apps that facilitate connection and interactions among members of social network would satisfy the human's innate psychological need for relatedness. This in turn would naturally drive greater physical activity behaviour among individuals and help them to effectively achieve their fitness goals. Therefore, an app with social facilitation features would be much popular and successful among users. Thus we hypothesize that

> H4: Existence of social facilitation feature will positively affect the fitness app success.

4   METHODOLOGY

The data for this study was collected from iTunes. Mobile apps in the 'fitness' subcategory was chosen for this study. Fitness apps are designed for the purpose of losing weight, building muscles and maintaining healthy physical fitness. App related data such as app name, app description, app rating count (i.e. rating volume), app rating score (i.e. rating valence/star rating) and app reviews were collected for this study.

4.1 Operationalization of DV

The dependent variable 'fitness app success' was measured using rating volume (rating count), rating valence (rating score/star rating) and review favourability. Equal weightage was given each item (rating volume, rating valance, and review favourability) of app success. Each app was the unit of analysis. Rating volume/rating count was calculated by counting the number of rating the app has received. It is the number of active users who are using the app (Dellarocas *et al.* 2010). App rating score/rating valence was calculated as the average number of star rating the app has received. It is the worthiness of the app or the referral value (Li & Hitt 2010). Review favourability was calculated using the polarity of review sentiments, the app has received.

$$Review\ favorability = \frac{Number\ of\ positive\ sentiments}{Number\ of\ negative\ sentiments}$$

adapted from (Asur & Huberman 2010).

Sentiment analysis tool (Thelwall *et al.* 2010) was used in analysing the sentiments, in which the tool provides positive, negative and neutral score for each review. Sentiment score for each app was given as a fraction of positive, negative and neutral sentiments. The total sum of positive, negative and neutral sentiments was used as the sentiment score for each app.

4.2 Operationalization of IV

The independent variables (IVs) such as self-efficacy, outcome expectation, self-regulation and social facilitation were measured by the existence of these principles in the contemporary fitness apps. First of all, a set of semantic labels and attributes were generated using WordNet, lexical database (Fellbaum, 2010) for each of the persuasive technology design principles discussed above. The generated semantic labels and attributes were then evaluated by experts for appropriateness. Once the semantic labels and attributes were finalized, natural language processing (NLP) methods such as stemming and lemmatization were carried out to derive the root words (Wang & Zhang, 2006) of generated semantic labels and attributes. Then, these semantic labels and attributes were used to assess the existence of given design principles (refer IVs in Table 1) in each app (i.e. app description).

Construct	Items	Semantic Labels
Self-Efficacy	Reduction,	reduce effort, simple, simplify complex, easy, easily, one-click, automatically, automatic, readymade, one click, reduce extra effort, ease, convenient, at once, unlimited, easier, single click, easy-to-use, quickly, instantly, quick, instant, built-in, one click, anytime, anywhere, simply
	Tunnelling	step-by-step, guide throughout, personal trainer, stepwise, gradual, coaching, couch, personal fitness trainer, guide, steps, instructions, complete, training plan
Outcome Expectation	Simulation	fun game, rehearse, 3D animation, simulated experience, simulated environment, virtual environment, imitate, visualization, video, 3D, game
	Conditioning	feedback, reinforce, reinforcement, goal attainment, goal accomplishment, immediate

		feedback, positive feedback, real-time feedback, response, output, reports, alarm, real-time
	Suggestion	reminder, tips, suggest, intervene, prompt, predispose, strategies, recommendation, alerts, notifications, recommend
Self-Regulation	Self-Monitoring	track activities, track activity statistics, distance, pace, time, track, measure, physiological data, heart rate, calorie calculator, speed, progress, goal, goals, target, objectives, calories, duration, history, view, display, speed
	Tailoring	customization, customized, custom, own, personalization, personal, personalized, individual needs, user's fitness level, profile, customize, customizable, adjust, adjustable, amend, tailored
Social Facilitation	Normative influence, Social Comparison	compare with friends, benchmark, comparison with friends, friends', friend's, comparisons
	Competition	friendly challenge, compete, against, champion, challenge, `competition`
	Cooperation	together, group, join, get-together, community, cooperate, co-operate , network, forums, connect, share, tips, community support, touch, together, supportive, support
	Social Recognition	reward, points, awards, acknowledge, badges, complete milestone, achievement, achievements, medals, prizes
Fitness app success	Rating Volume, Rating Valence, Review favourability	

Table 1.   Operationalization of Constructs

In order to assess the existence of given design principles (refer IVs in Table 1) in each app, initially a corpus was created using the app descriptions (i.e. the app descriptions provided in app stores). The app description contains unstructured rich text with lot of stop words and special characters. Therefore, natural language processing techniques were used to derive the features from app description. i.e., in order to transform the app description into a feature vector, natural language techniques such as part-of-speech tagging, lemmatization, tokenization, stop words removal, and stemming (Wang & Zhang 2006) were employed. Following section details the steps of feature extraction process in detail.

First, each app description was checked for special characters (See row 1 of Table 2). If any special characters were found, they were removed, and then it was subjected to language test. We identified set of non-English apps during the feature extraction process. Thus a translator package (i.e. Bing Translator (MicrosoftCorporation 2011)) was included in our feature extraction process to handle app descriptions with languages other than English.

Special Characters	_ ✳ ★◆✦ ✔•■®♥#*■ν◇▲▼□· ～,àè:)ññé@#$%&(ñó#/.!;-=üä? 【 】 iv 」 ⌐ ）
Stop Words	"a", "the", "above", "after", "all", "again", "already", "at"

Table 2.   Stop words and special characters

After translation process, we removed all the stop words (See row 2 of Table 2) from the app description. Then the processed description was subjected to part-of-speech tagging and lemmatization. We use Stanford part-of-speech tagger (Toutanova *et al.* 2003) to attach a part-of-speech tag to each token (i.e., word) in the app description. More precisely, the app description is parsed into sentences, which are then processed by the part-of-speech tagger. When supplied with a sentence, the tagger can produce an ordered list of part-of-speeches as the output for each word in the sentence (such as noun, verb, adjective, etc). For example, popular fitness app called "Nike + Running" had the sentence like the following in its description: "Now you can add friends and see how you stack up" When we subjected this sentence to part-of-speech-tagger the word 'Now' was tagged as an 'adverb, 'you' as pronoun, 'can' as verb and 'friends' as a noun, and so on. Thus, each word was tagged as part of speeches such as preposition, adverb, personal pronoun, determiner, verb, noun, pronoun, adjective and model. After the app descriptions are tagged, only the verb, adverbs and nouns were extracted as the initial features. Then extracted features were subjected to lemmatization in order to get the root word form a particular extracted token. Lemmatization generally removes inflectional endings and return the base or dictionary form of a word, which is known as the lemma" (Stanford 2012, n.d.). For example the lemmatized version of the word "running" would be "run".

Once initial set of features were extracted based on the above mentioned procedure, it was matched with the semantic labels and attributes generated though WordNet. R scripts were written for this purpose. A value of 1 was given if a match was found and 0 if a match was not found. The score for each category was computed based on the sum of '1's of semantic labels and attributes available in each app. To account for the different number of semantic labels and attributes in each category the summary score was normalized between 1and 0.

In addition to main study variables, since older apps and free apps can have more user base compared to new and paid apps, we controlled for price and age of the app in our model. These control variables (price of the app and age of the app) were included as they can greatly influence app success (Kajanan *et al.* 2012).

For validation purposes 20 apps were randomly chosen and manually coded by 2 independent coders. Higher inter-rater reliability was achieved with a kappa coefficient of 0.90 between the coders. The coders had to manually check if the WordNet (Fellbaum 2010) based semantic labels and attributes were present in app descriptions. Then we ran the automated process for the given 20 apps. The automated process had an acceptable level of accuracy.

5   DATA ANALYSIS AND RESULTS

The conceptual model was analysed using app descriptions and lifecycle data of 5716 apps. Each app was a unit of analysis. The model was tested using 'sem' (structural equation modeling) package in R. Since our study is an early attempt at developing a theoretical model to identify the persuasive design factors that will lead to mobile fitness apps success, 'sem' was used. Besides, the model constructs are latent and were not measured directly. For example Social Facilitation is a latent construct measured through items such as normative influence, social comparison and competition, cooperation, social recognition. The scores for these individual items were calculated using NLP techniques (illustrated in methodology section) that checked the availability of these features in each app. We have used automated NLP approach, considering the huge numbers of mobile apps available in the market.

While the numbers continue to grow, the manual processes become infeasible. Thus, automated NLP approach is more appropriate for this study.

We analysed several fit indices including test-statistic, the root-mean-square error of approximation (RMSEA), standard root square mean residual (SRMR), Tucker – Lewis index (TLI) also known as Non-normed fit index(NNFI), comparative fit index (CFI), and non-normed fit index (NNFI). The fit indices of the model were Test Statistics 699.141 (df=39, N=5716), CFI = 0.93, TLI= 0.90, RMSEA = 0.041, SRMR = 0.029. The fit indices indicate that the model fits the data well. Table 3 provides the results of hypothesis testing.

Construct	Path coefficient	Results
Self-Efficacy	0.216*	H1 Supported
Outcome Expectation	0.069*	H2 Supported
Self- Regulation	0.235*	H3 Supported
Social Facilitation	0.192*	H4 Supported
Price	-0.057*	
Age	0.012*	
Note. *p< .05		

Table 3.   Summary of Hypothesis Testing
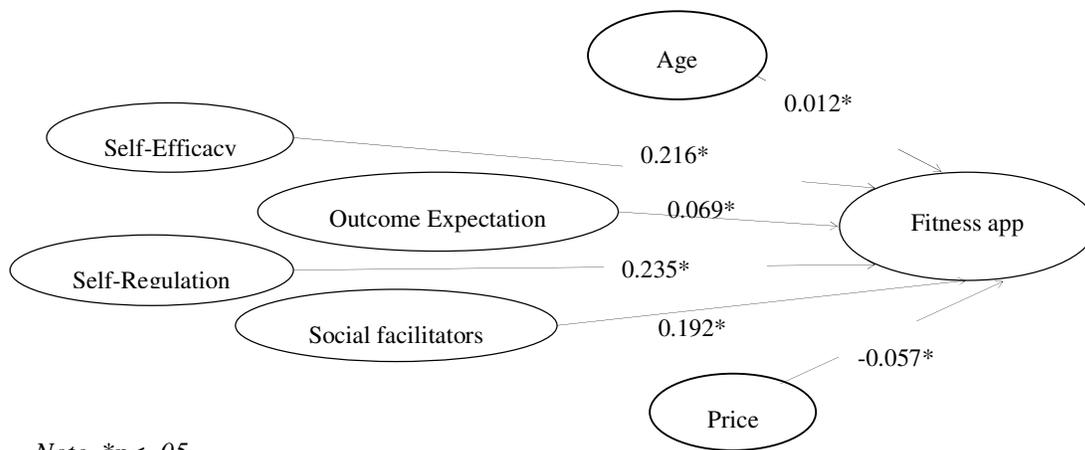
*Note. *p< .05*

Figure 1.   Path Estimates of the research model

In order to analyse the impact of each design principle we examined the R square value of each design principle on the dependent variable app success. Table 4 provides details of this examination.

Variable	R square value
Reduction	0.030
Tunnelling	0.819
Simulation	0.044
Conditioning	0.210
Suggestion	0.199
Self-Monitoring	0.114

Tailoring	0.069
Normative influence	0.316
Social Comparison and competition	0.071
Cooperation	0.258
Social Recognition	0.18
Price	0.056
Age	0.016

Table 4.   Impact of design principles (IV) on App Success

6   DISCUSSION

The findings of this study can have important practical and theoretical contributions. Practically, this study provides important take always for mobile app developers. In particular the findings of this study provide useful insights for designing successful persuasive fitness apps that will be well received by users.

For example the results reveal that designing app with features that enhance exercise self-efficacy, promote positive outcome expectations, enable effective physical activity related self-regulatory mechanism and social facilitation can lead to app success. Particularly, the R square values indicate that features such as social networking, readymade exercises, facilitating personalized goal setting, detailed activity logs, step-by-step instructions and effective feedback mechanism can lead to fitness app success. Similarly the findings could also guide app users in choosing appropriate apps that can enhance their physical activity behaviour. However, this is not the exhaustive list of features that could yield app success. Besides, the success of an app depends on user's reaction about the app (i.e. user ratings and reviews). Therefore, fitness app developers should concentrate on promoting these user WOM indices of the app in order to gain success and greater profit.

Prior studies on mobile based physical activity applications were evaluated on experimental settings and intervention groups were asked to use the applications (Consolvo *et al.* 2006, 2008; Lin *et al.* 2006). However, the current study has analysed the efficacy of fitness applications in natural setting, in which individuals choose their application on their own accord. Thus, the present study has identified the successful features in natural settings, where being physically active in completely discretional. Besides, the general design principles discussed in this study can be applied to any app designed for behavioural modification, such as diet, smoke cessation or alcohol control. This demonstrates the generalizability of our model. However, fitness app context was use.

This study has also several theoretical implications. First, the findings of this study demonstrate that social cognitive theory combined with persuasive technology techniques can be effectively used in the design of successful fitness apps. Second, findings indicate that the crucial elements SCT and Persuasive Technology can be delivered though modern technologies such as smartphones, iPad and Android devices. Thus shows the flexibility of SCT to support different modes (such smartphones, iPad and Android devices). Third, despite the number of research conducted on mobile apps (Datta *et al.* 2012; Garg & Telang 2012; Kajanan *et al.* 2012), studies related to fitness apps are limited. Therefore, this study provides a way of measuring the success of fitness apps. The app success measure used in this study can provide valuable insight for e-business and marketing literature. Finally, the text mining approach used in this study informs the research on deriving useful insights from unstructured data such as app descriptions.

This study is not without limitations. First, the app descriptions provided in the app store were utilized to assess the existence of the design principles in the apps. As these descriptions are provided by app developers it may not correspond to what individuals perceive or value from the app. However given the thousands of apps available in the app stores this is the most suitable approach that can be used to

analyse the features. However, future studies could analyse users' reviews and see the degree to which those attributes were mentioned in their opinions of the apps.

Second, this study analysed the possible variables under the given theoretical lenses. However in addition to the study variables, there could be some other variables that could have an impact. For example, personal characteristics such as competitiveness may affect the degree to which social comparison and competition features affect individuals' willingness to engage in exercise activities and use fitness apps. Moreover, presence of a common group goal (e.g. group of friends want to run a marathon) may be needed for the normative influence, cooperation, and social recognition to play a role.

7 CONCLUSION

In summary, this study posits that persuasive technology principles infused into social cognitive theory elements will lead to the design of successful fitness apps. More precisely, we conceptualized that existence of features that enhance the exercise self-efficacy, outcome expectation, self-regulation, and social facilitation features will positively affect the fitness app success. Persuasive technology principles are utilized as "functions" that enable aforementioned factors work more effectively. We empirically validated this conceptualization using lifecycle data of mobile apps and automated text mining approach. Considering the increased prevalence of sedentary lifestyle, obesity and overweight in the population, studies of this nature can be useful in modifying the lifestyles of smartphone users by persuading them to be physically active. We believe such investigations have rich potential to broaden the research in human computer interaction and hope other scholars will follow the suit.

References

Asur, S. & Huberman, B.A. (2010) Predicting the Future with Social Media. IEEE Computer Society, Washington, DC, USA, pp. 492–499.

Ball, K., Jeffery, R.W., Abbott, G., McNaughton, S.A., & Crawford, D. (2010) Is healthy behavior contagious: associations of social norms with physical activity and healthy eating. International Journal of Behavioral Nutrition and Physical Activity, 7, 86.

Bandura (1986) Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice-Hall, Inc.

Bandura (1989) Human agency in social cognitive theory. American psychologist, 44, 1175.

Bandura, A. (1997) Self-efficacy: The exercise of self-control. Gordonsville, VA: WH Freeman & Co,.

Clark, D.O. (1997) Physical activity efficacy and effectiveness among older adults and minorities. Diabetes Care, 20, 1176–1182.

Consolvo, Everitt, Smith, & Landay (2006) Design requirements for technologies that encourage physical activity. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, pp. 457–466.

Consolvo, Klasnja, McDonald, Avrahami, Froehlich, LeGrand, Libby, Mosher, & Landay (2008) Flowers or a robot army?: encouraging awareness & activity with personal, mobile displays. In Proceedings of the 10th International Conference on Ubiquitous Computing. ACM, pp. 54–63.

Datta, A., Dutta, K., Kajanan, S., & Pervin, N. (2012) Mobilewalla: A Mobile Application Search Engine. Mobile Computing, Applications, and Services, 172–187.

Dellarocas, Gao, & Narayan (2010) Are Consumers More Likely to Contribute Online Reviews for Hit or Niche Products? Journal of Management Information Systems, 27, 127–158.

Fellbaum, C. (2010) WordNet. Springer.

Fogg, B.J. (2003) Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann.

Fontaine, K.R. & Cheskin, L.J. (1997) Self-efficacy, attendance, and weight loss in obesity treatment. Addictive Behaviors, 22, 567–570.

Garg, R. & Telang, R. (2012) Estimating App Demand from Publicly Available Data. Available at SSRN 1924044,.

Intille, S.S., Kukla, C., Farzanfar, R., & Bakr, W. (2003) Just-in-time technology to encourage incremental, dietary behavior change. In AMIA Annual Symposium Proceedings. p. 874.

Kajanan, S., Pervin, N., Ramasubbu, N., Datta, A., & Dutta, K. (2012) Takeoff and Sustained Success of Apps in Hypercompetitive Mobile Platform Ecosystems: An Empirical Analysis. In ICIS. Association for Information Systems.

Keller, C., Fleury, J., Gregor-Holt, N., & Thompson, T. (1999) Predictive ability of social cognitive theory in exercise research: an integrated literature review. Worldviews on Evidence-based Nursing presents the archives of Online Journal of Knowledge Synthesis for Nursing, 6, 19–31.

Lee, J.K. & Lee, J.W. (2003) Internet advertising strategy by comparison challenge approach. In Proceedings of the 5th International Conference on Electronic Commerce. pp. 450–457.

Li, X. & Hitt, L.M. (2010) Price effects in online product reviews: an analytical model and empirical analysis. MIS quarterly, 34, 809–832.

Lin, J., Mamykina, L., Lindtner, S., Delajoux, G., & Strub, H. (2006) Fish'n'Steps: Encouraging physical activity with an interactive computer game. UbiComp 2006: Ubiquitous Computing, 261–278.

MicrosoftCorporation (2011) Bing Translator [WWW Document]. URL http://www.bing.com/translator

Nicki, R.M., MacDonald, G.A., & Remington, R.E. (1984) Self-efficacy, nicotine-fading/self-monitoring and cigarette-smoking behaviour. Behaviour research and therapy, 22, 477–485.

Plous, S. (1993) The Psychology of Judgment and Decision Making. Mcgraw-Hill Book Company.

Rovniak, L.S., Hovell, M.F., Wojcik, J.R., Winett, R.A., & Martinez-Donate, A.P. (2005) Enhancing theoretical fidelity: an e-mail-based walking program demonstration. American Journal of Health Promotion, 20, 85–95.

Skinner, B.F. (1969) Contingencias of reinforcement: A theoretical analysis.

Stanford 2012 (n.d.) Stemming and lemmatization [WWW Document]. URL http://nlp.stanford.edu/IR-book/html/htmledition/stemming-and-lemmatization-1.html

Strachan, W. & Gorey, K.M. (1997) Infant Simulator lifespace intervention: Pilot investigation of an adolescent pregnancy prevention program. Child and Adolescent Social Work Journal, 14, 171–180.

Thelwall, M., Buckley, K., Paltoglou, G., Cai, D., & Kappas, A. (2010) Sentiment strength detection in short informal text. Journal of the American Society for Information Science and Technology, 61, 2544–2558.

Toutanova, K., Klein, D., Manning, C.D., & Singer, Y. (2003) Feature-rich part-of-speech tagging with a cyclic dependency network. In Proceedings of the 2003 Conference of the North American Chapter of the Association for Computational Linguistics on Human Language Technology - Volume 1. Association for Computational Linguistics, pp. 173–180.

Wang, Z. & Zhang, D. (2006) Feature Selection in Text Classification Via SVM and LSI. In Wang, J., Yi, Z., Zurada, J.M., Lu, B.-L., & Yin, H. (eds), ISNN (1). Springer, pp. 1381–1386.

Yoganathan, D. & Kajanan, S. (2013) Persuasive Technology for Smartphone Fitness Apps, In Proceedings of the 17th Pacific Asia Conference on Information Systems.

Yoganathan, D. & Kajanan, S. (2014) Designing Fitness Apps Using Persuasive Technology A Text Mining Approach. In Proceedings of the 18th Pacific Asia Conference on Information Systems.