

Persuasive system based mHealth design for multi-intervention service for smoking cessation

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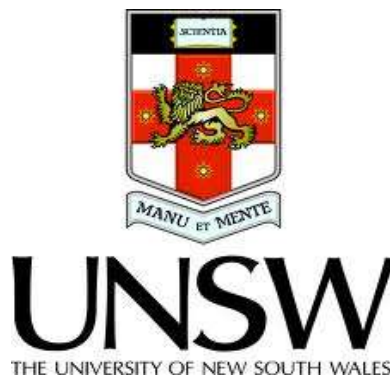
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Persuasive system based mHealth design for multi-intervention service for smoking cessation

Koel Ghorai

A thesis in fulfilment of the requirements for the degree of
Master of Philosophy



Supervisors:

Pradeep Ray and Mathew Chylinski

School of Information Systems, Technology and Management

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Mobile phones, especially smartphones, are increasingly receiving attention from public health scholars for delivery of healthcare services for lifestyle diseases like diabetes and smoking because of their ease of access, low cost and ubiquity. Through literature review, significant gaps regarding acceptance studies for use of mobile phones for health behavior change were identified. These gaps include the following: all studies on mobile interventions for smoking cessation have been SMS/MMS/Call based; none of the studies include System Framework/Design component for developing behavior change services; lack of studies on multi-intervention services for behavior change using Smartphones; none of the studies have explored user acceptance of mobile based smoking cessation services. The current research has been carried out to address some of these gaps while exploring the broad research questions:


- a) How to develop a Persuasive Technology framework and thereby design a Smartphone based multi-intervention mobile phone (mhealth) service for behavior change (in this case, smoking cessation) using the framework?
- b) What are the factors affecting the user acceptance of a Smartphone based multi intervention service for disease prevention through behavior change like smoking cessation?


To answer the first question, Hevner's framework for design science research and Persuasive System Model has been used for developing and designing a Smartphone based multi-intervention service for smoking cessation. For the second question, the Unified theory of acceptance and use of technology (UTAUT) model has been applied for exploring factors like performance expectancy (users' belief that service will improve the process of quitting smoking), effort expectancy (the degree of ease of use), social influence (if others believe they should use the service) and facilitating conditions (the degree of users' belief that an organizational and technical infrastructure exists to support system use) affecting the acceptance of a Smartphone based multi-intervention service for smoking cessation. The results show that the above mentioned factors have significant influence on behavior intention of user, leading to acceptance of mobile based smoking cessation service. These insights therefore need to be incorporated while designing effective mHealth services. Theoretical and practical relevance of these findings have accordingly been analysed and presented in the current research.

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2. Ghorai, K., Jahan, S., Chylinski, M., and Ray, P. (2013). Mobile Phone Including Smartphone based Persuasive System Design for controlling Hypertension and Diabetes in Bangladesh. In the Proceedings of the 24th 24th Australasian Conference on Information Systems (ACIS), December 4-7, Melbourne, Australia.

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Abstract

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Keywords: smoking cessation, mobile health, mhealth, SMS, multi-intervention service, mhealth service, service design, social support, peer support, Persuasive System Design, mHealth for health behavior change.

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List of Abbreviations

Abbreviation	Expansion
mHealth	Mobile health
WAP	Wireless Access Protocol
ICT	Information and Communications Technologies
TAM	Technology Acceptance Model
PSD	Persuasive System Design
SCT	Social Cognitive Theory
PLS	Partial Least Squares
IT	Information Technology
IS	Information System
UTAUT	Unified Theory of Acceptance and Use of Technology
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
IDT	Innovation Diffusion Theory
PE	Performance Expectancy
EE	Effort Expectancy
SI	Social Influence
FC	Facilitating Conditions
UB	Use Behaviour
SMS	Short messaging service
SPSS	Statistical packages from IBM
WHO	World Health Organisation

Chapter 1: Introduction

1.1 Overview (Research Problem, Rationale and Objectives)

Mobile phones have proved to be a ubiquitous mode of communication globally (Kaplan, 2006). It is the fastest growing sector of the communication industry in low income as well as developing countries (Union, 2003). With more than 6.8 Billion mobile subscriptions, mobile phones are owned by almost 80% of the world's population. Out of this subscriber base, 1.08 Billion are Smartphone users. M-health, use of mobile phones and communication devices in healthcare, is a rapidly expanding field of research utilising this relatively new yet growing mobile revolution around the world. Mobile phones today are being used for supporting health behavior to chronic disease management (Cole-Lewis and Kershaw, 2010). With increasing costs of healthcare services, people are opting for cheaper and affordable avenues instead. Mobile communication has the potential of by making services more affordable, accessible and of better quality (Boulos et al., 2011), thereby bringing forth the much needed transformation in healthcare delivery.

1.1.1 Use of ICT/ Mobile Communication

The transition of mobile phone users from generic phones to Smartphones is seeing a steady rise. Increasing competition among cell phone manufacturers has resulted in a drastic reduction in Smartphone prices, making it a lot easier for users in low and middle income countries to access the same. Smartphones have become one of the most frequented touch points for internet access in developed countries. As per figure 1, there has been a sharp rise in the penetration of Smartphones in countries worldwide with UK leading by 51% as of June 2012.

The global mobile phone subscription statistics in Table 1 further shows the potential outreach of this platform vis-à-vis the internet. In fact, mobile based messaging systems have already experienced acceptability when backed by the motivation to undertake certain behavior changes. Such interventions range from informational mass-weekly messages to tailor-made customized messages based on user-input.

Figure 1: Country wise penetration of Smartphones (source Google-our mobile planet, June 2012)

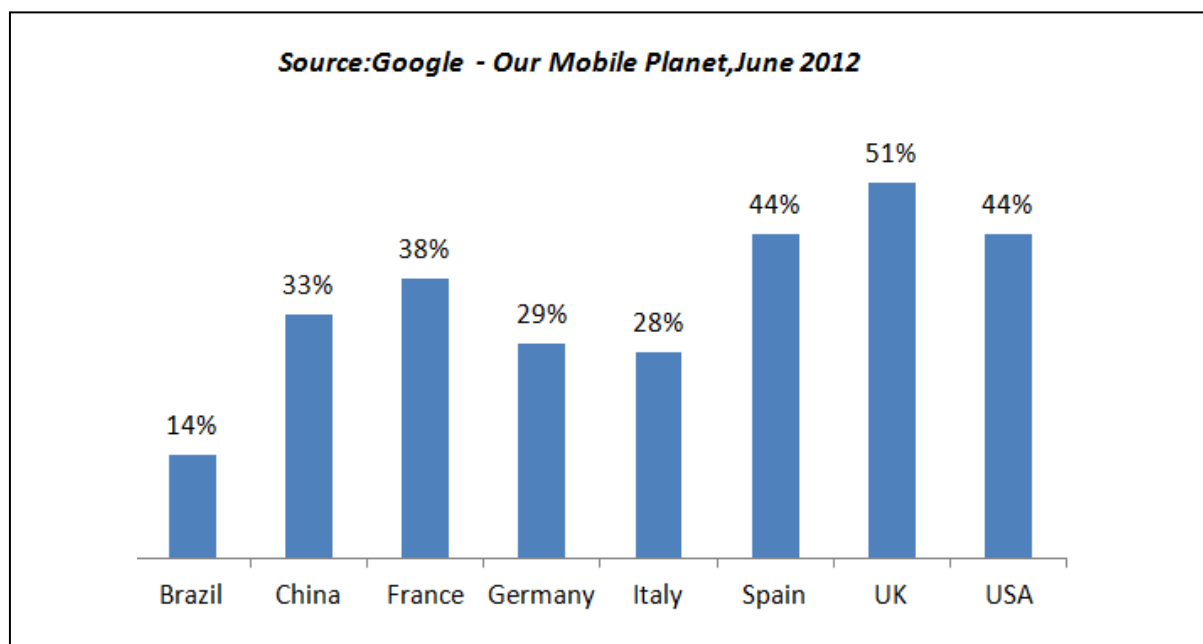


Table 1: Key ICT indicators for developed and developing countries and the world (totals and penetration rates) (ITU 2012)

Countries	(Millions)				Per 100 inhabitants			
	2010	2011	2012*	2013*	2010	2011	2012*	2013*
Mobile-cellular subscriptions								
Developed	1,418	1,475	1,538	1,600	115.0	119.0	123.6	128.2
Developing	3,901	4,487	4,872	5,235	69.0	78.3	84.3	89.4
World	5,320	5,962	6,411	6,835	77.2	85.5	91.2	96.2
Active mobile-broadband subscriptions								
Developed	529	683	788	934	42.9	55.1	63.3	74.8
Developing	249	472	768	1,162	4.4	8.2	13.3	19.8
World	778	1,155	1,556	2,096	11.3	16.6	22.1	29.5
Individuals using the Internet								
Developed	830	875	913	958	67.3	70.5	73.4	76.8
Developing	1,193	1,398	1,584	1,791	21.2	24.5	27.5	30.7
World	2,023	2,273	2,497	2,749	29.5	32.7	35.7	38.8

1.1.2 Mobile Phones for Smoking Cessation

Mobile phones have proved effective in delivering interventions for various diseases and health conditions (Riley et al., 2008, Brendryen and Kraft, 2008, Free et al., 2011, Tufano and Karras, 2005). Mobile based messaging services have gained global acceptability for curing diseases (Jordanova, Durrani and Khoja, 2009). A few interventions have also been designed to deliver customized motivational messages that lead to smoking cessation through behavior change (Riley et al., 2008, Brendryen and Kraft, 2008, Obermayer et al., 2004). These interventions vary from sending customized motivational messages (Obermayer et al., 2004) to multimedia messages (Whittaker et al., 2011a). Various online smoking cessation interventions have proved to be effective as well (Strecher et al., 2005b). These provide distraction through games or videos in addition to sending motivational messages through mails. However, these interventions were not bereft of shortcomings. Firstly, users stopped reading the generic messages after a certain period of time, leading to high participant attrition rates during the intervention. Secondly, accessing web based services is not possible if the phone is not a Smartphone or a web compatible mobile phone. Thirdly, very few interventions have focused on the intervention design aspect using Smartphones. Fourthly, none of the interventions have included instant (real time) peer support which can have a major effect on quit rates. In addition to this, various government policies have restricted the use of messaging services in many countries while rising costs of telecommunication have made SMS more expensive, thus reducing the chances of mass intervention adoption. Finally, a Smartphone based Multi Intervention service for smoking cessation is yet to be tested for user acceptance.

1.1.3 Smoking Prevalence

More than two thirds of the world's smokers live in just 10 countries (WHO(2000)- China, India, Indonesia, Russia, US, Japan, Brazil, Bangladesh, Germany, Turkey, as per Figure 2.

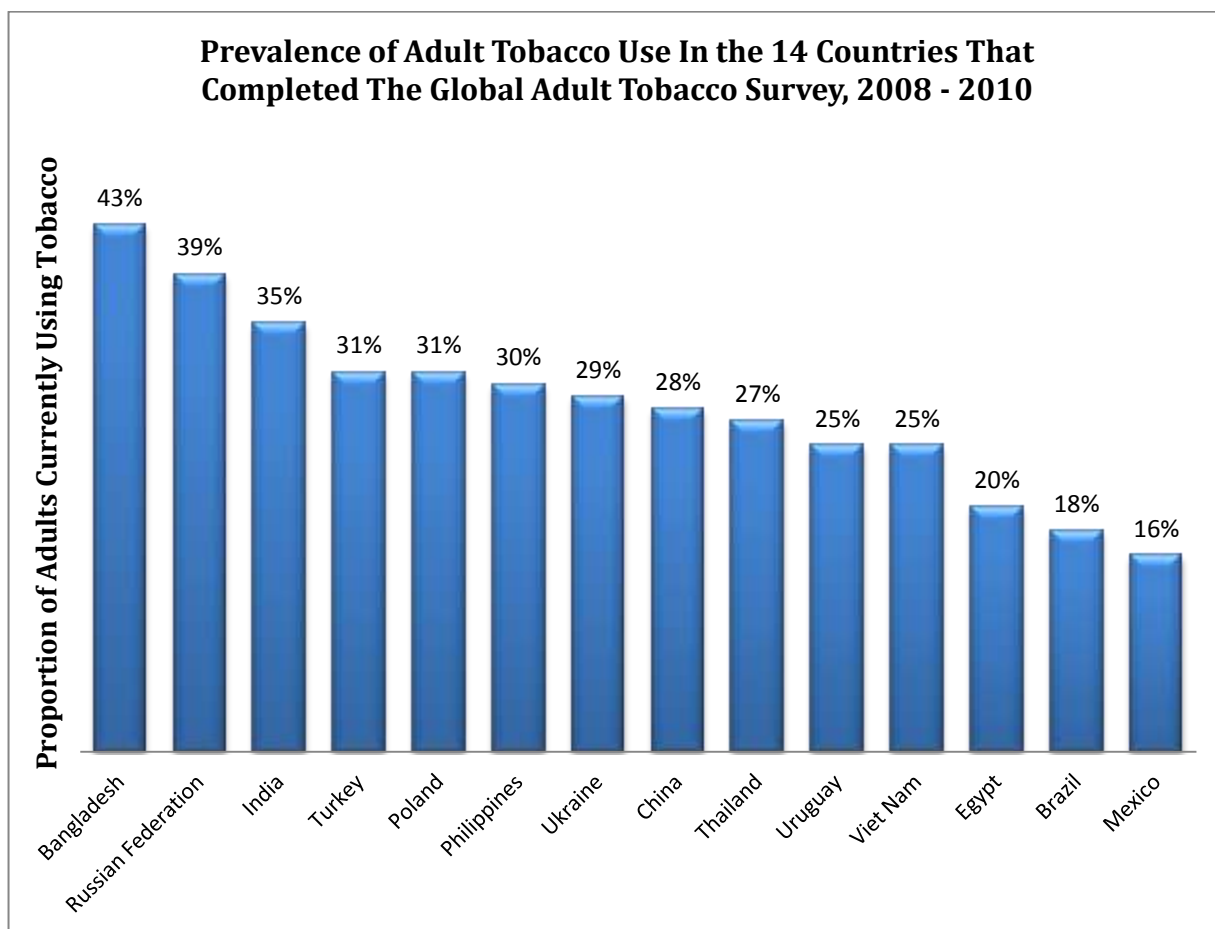


Figure 2: Tobacco prevalence in 14 countries that completed GATS 2008-2010

In China, between 2000 and 2009, the total spending on tobacco quadrupled to US\$28.9 billion from US\$7.2 billion and in Bangladesh, direct costs of smoking are estimated at US\$386 million. Furthermore, between 2003-2008, 11.3% of Egypt's total health expenditure was used to treat tobacco-related illness (WHO, 2013).

Many countries have a very high direct as well as indirect cost to smoking and this is on the rise. At the same time, however, according to the GATS 2008 to 2010 survey, a large percentage of smokers intend to quit smoking. In developing countries such as Bangladesh and India, this is as high as 68% and 47%. In India Smoking causes a large and growing number of premature deaths, thereby promoting a curtailing of the habit. According to a study, 38.4 per cent smokers -- 38.3 per cent men and 38.9 per cent women -- have made an attempt to quit. In a continent like Australia, of the 4.5 million smokers, 3 million want to quit with about 1 million trying to quit each year. Such targeted segments can potentially benefit from the use of mobile technology based

cessation measures. Moreover, mobile technology can play a vital role in extending healthcare support and services to populations living in even the remotest of locations due to the potential outreach of the same.

mHealth has emerged as a viable option for chronic disease management through its wide-spread reach and low-cost solutions. There is a huge potential for positive impact on health outcomes through mHealth in developing as well as developed countries (Consulting, 2009). Especially so, as the use of mobile phones, particularly smartphones, have multiple advantages in the healthcare and public health domain as follows:

1. **Accessibility:** Mobile phones have wireless cellular communication capability, thus allowing continuous interaction and communication from any location through phone calls, text and multi-media messages and internet access via Wireless Access Protocol (WAP) or any other means.
2. **Portability:** Due to its small size and low weight, mobile phones can be easily carried around by the patient.
3. **Capability:** Finally, mobile phones in general and smart phones in particular have the capability to support various multimedia applications which can be developed specifically for healthcare and public health sectors.

These functions have made use of mobile phones and specially smartphones an attractive option for implementing various interventions for disease management and prevention.

Current documented studies on mHealth interventions include text as well as multimedia messaging to support management of diseases like hypertension, diabetes, obesity, asthma, smoking and treatment of HIV among others (Cole-Lewis and Kershaw, 2010, Fjeldsoe et al., 2009, Heron and Smyth, 2010, Krishna et al., 2009, Leach-Lemens, 2009). Regarding smoking cessation in particular, quite a few studies have been undertaken for investigating the effectiveness of mHealth interventions. Various gaps were identified from these studies, a major lacuna being the absence of a smartphone based multi intervention service framework for smoking cessation. Other gaps include high intervention quit rates (users quitting or rejecting interventions altogether) and lack of interest of participants in checking text messages regularly.

This study focuses on the development of an information system based multi-intervention healthcare service framework for behavior change. Multiple intervention programs are characterized by the use of multiple strategies targeted at numerous levels of the socio-ecological system and delivered to multiple target audiences (Edwards N1, 2004). An encouraging trend in this development and mass dissemination of smartphone based applications involving multi-intervention services and programmes has been the increasing penetration of smartphones in developing as well as developed countries. This has motivated us to undertake the current research and thereby fill some of the existing gaps.

Persuasive technologies and psychological theories have been considered for developing such a framework that will help in designing mobile based disease management services, specially targeting smoking cessation. The framework includes factors that need to be considered while designing such a mhealth service for non-communicable diseases. These factors have been discussed in details in the following chapters.

Although mHealth creates positive impact, any new public health and healthcare framework faces concerns about the user-acceptance of the framework and the service. User-acceptance is defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. In this context, user-acceptance of the healthcare service framework is the willingness of a patient to use the service for disease management and/or prevention. User acceptance studies aim to explain the user intentions to use an information system and the subsequent user behavior. The second part of this study accordingly focuses on examining the various factors that affect the user acceptance of the smartphone based multi-intervention service which was designed based on the framework as developed in the first part of the study.

Therefore, the **main objective** of this study is to develop a mHealth based framework for a multi-intervention service for smoking cessation that can be used for developing smartphone based multi intervention services for public healthcare. The **specific objectives** are firstly, to develop a persuasive system based multi-intervention framework for disease management and explore the framework components in the

smoking cessation context; and secondly, to study the user-acceptance of the multi-intervention service which is developed from the framework and accordingly explore the factors which affect the user acceptance of this service.

1.2 Research Questions

Advanced mobile phones like smartphones are enabling the potential of advanced healthcare delivery. Uptake of smartphones for dissemination of health services has grown in even low-and-middle income countries in addition to high income countries. This has paved the way for use of smartphones for developing and disseminating multi-intervention services.

The review of various mhealth services for behavior change and smoking cessation has brought to the forefront questions for healthcare service design framework for smoking cessation. Success of a healthcare intervention depends a lot on service design aspects and how well it caters to the needs of the patients for a successful or positive outcome. It is a well-known fact that patient profiles differ vastly due to various factors like age, behavior and mental conditions. Thus, mhealth service should be designed such as to cater to these vastly differing patient profiles without changing the key features of the service design itself. For this, the system in concern has to be smart enough to evolve with the changing needs of the patients in a gradual process. Keeping this in mind, the following research questions have been addressed in the context of service design framework and smoking cessation:

RQ1: How to develop a Persuasive System based multi-intervention framework and design a Smartphone based multi-intervention mhealth service (mobile application) for smoking cessation using the framework

RQ2: What are the factors that affect the user acceptance of a Smartphone based multi-intervention service for smoking cessation?

For this research Persuasive System Design (Oinas-Kukkonen and Harjumaa, 2009a) and the Social Cognitive Theory (Bandura, 1986) have been identified as theoretical Persuasive system based mHealth design for multi-intervention service for smoking cessation: *Koel Ghorai*

frameworks for developing the persuasive system model for multi-intervention service for smoking cessation. Thereafter, Structural Equation Modelling has been used to evaluate the various factors that can affect the user acceptance of the Smartphone based multi intervention service.

1.3 Research Scope and Theoretical Foundations

This study focuses on the development of a unique mHealth based multi-intervention framework for smoking cessation through behavior change. Current documentation of mobile based smoking cessation programs presents various studies involving individual or a combination of interventions like motivational text or multimedia messages and tele-counselling. However, these were predominantly text messaging interventions (Ybarra et al., 2013, Whittaker et al., 2012, Wells et al., 2011, Vidrine et al., 2012, Snider, 2011, Rodgers et al., 2005a, Riley et al., 2008, Obermayer et al., 2004, Naughton et al., 2012) with none of the studies focussing on a multi-intervention program for the same. In recent years, mobile based smoking cessation interventions have become very popular due to their low cost and ease of dissemination to a larger population. However, despite its popularity, studies have shown that text message based interventions did not have statistically significant short term effects on smoking cessation; nonetheless, some of the interventions had statistically significant long term effects on smoking cessation (Whittaker et al., 2009).

To improve on these shortcomings, the unique multi-intervention service framework will enable patients to access a number of interventions over and above conventional text messages including the following:

- motivational messages
- performance tracking
- instant social/peer support through chat
- motivational videos and games for distraction

Various studies have been conducted for exploring the effectiveness of all these interventions separately but none has explored the impact of these interventions in a single service package.

To design such a multi-intervention framework, the Persuasive Systems Design (PSD) model has been identified as the starting point. It is an information system model that provides various factors for consideration while designing a service. The Persuasive System Design model by (Oinas-Kukkonen and Harjumaa, 2009a) provides a framework for designing Information Systems (IS) services that can be used in the context of healthcare and disease management. The model talks about factors to be considered while designing a system but does not explain the software requirements and implementation features and does not include some factors which are unique to smoking cessation and obesity management services such as instant gratification and distraction. Chapter 4 presents details of the development of a smartphone based application with a multi-intervention service which overcomes some of the gaps mentioned above.

Secondly, a psychological theory, namely, the Social Cognitive theory provides background for behavior change interventions through self-efficacy which is defined as one's belief in one's ability to succeed in specific situations (Bandura, 1986). This theory posits that behaviour change in a person can be brought about by some factors like personal factors and environmental factors.

These two theories together have been used for developing the multi intervention framework especially in the context of smoking cessation. Besides, the development of the framework has also been based on a multi-disciplinary approach by exploring theories from Information Systems (Venkatesh et al., 2003, Davis, 1989, Oinas-Kukkonen and Harjumaa, 2009a) and psychology (Bandura, 1991, Bandura, 1986, Prochaska and Velicer, 1997).

1.4 Research Methodology

The research method chosen to conduct the first part of the study is Hevner's framework for design science research (Hevner et al., 2004). Hevner's framework provides a step-by-step guideline for design science research involving the following steps:

- a) Obtaining a problem from real life;
- b) Identifying existing literature;
- c) Developing a solution to the problem using theories and concepts from existing literature; and
- d) Evaluating the solution.

These steps have accordingly been used to structure the first part of the study.

Further, the second part of this study has entailed the following:

- a) research philosophy: 'quantitative-positivist' (Straub et al., 2004)
- b) data collection technique: 'cross-sectional survey' (Pinsonneault and Kraemer, 1993)
- c) sampling strategy: 'targeted quota sampling methodology' (Watters and Biernacki, 1989)
- d) 'data analysis technique': PLS path modelling.

Data for the research was collected through a web based survey, after the participants were asked to use the service on their smartphones. Responses were collected from 225 smokers through the survey.

1.5 Research Contribution

The contributions of this study are in terms of theory, methodology and practice. Theoretically, the study extends the Persuasive system design framework by combining the features of the PSD model with that of the Social Cognitive Theory in the context of a multi-intervention service for smoking cessation. Methodologically, the study validates that PLS path modelling can be used to estimate the impact of factors affecting the user acceptance of a multi intervention service framework and its association with other variables of the model. In practice, the study provides a smartphone based multi-intervention service for smoking cessation through behavior change. Overall, the study provides significant contribution to developing a multi-intervention service framework that can be used in healthcare and public health programmes for various disease prevention and management like hypertension, diabetes, obesity, depression to name a few. It is a step forward for healthcare service designers for designing behavior change interventions.

1.6 Research Limitations

The study has some limitations. Firstly , this thesis has focussed on the mHealth based multi-intervention technology development and its acceptance by potential users, such as

smokers wanting to quit smoking. However, this research has not investigated the effectiveness of the mHealth based multi-intervention technology in making people quit smoking. This would require a larger scale randomised controlled trial (RCT) with preferably more than 1000 smokers over a period of one year. Secondly, the sample represents participants mainly from USA and India. There can be limitations in the generalizability of findings to other participants in countries, other than these two. Thirdly, the multi-intervention service (smartphone app) designed in chapter 4 is compatible with only smartphone that has a screen size of 3 inches or above. This provides a technological limitation regarding the use of the service for users with lower screen specifications. Fourthly, users with a non Smartphone cannot access all the interventions of the service. Non smartphones or the basic mobiles phones do not provide users the options of playing online games or streaming videos from the internet. This restricts the full utilization of the service. Fifthly, the motivational messages at present have been developed only in English language. This can be later modified to other languages to cater to participants in countries where local languages other than are preferred. Finally, The research was conducted within a specific domain of healthcare, that is smoking cessation. Although similar persuasive system approach will be useful for behaviour change in other public health problems, such as hypertension, diabetes and obesity, these application areas have not been evaluated in the study and would be suitable for future work.

1.7 Future Research

Future work can involve testing the multi intervention service with users over a longer period of time for smoking cessation. In the current study, the users were asked to use the multi-intervention service on their smartphones for a limited period of time (less than a day). In case of longer usage of the service, there might be different repercussions of the moderators like "experience with the service" which can have a direct impact on the "use behavior". Other moderators that can be included in future studies are number of cigarettes smoked per day, smoking pattern, location, quit attempts (number of times a person has tried to quit in the past), use of other mobile based applications and demography.

Secondly, in the study only 225 samples were collected. This might lead to problems of multicollinearity due to high correlations between different constructs. Future work can involve studying the combined effects of the constructs on the independent variables. Increasing the sample size in future studies might reduce problems created due to multicollinearity.

Thirdly, the service can be further developed by allowing language choice for users. At present, online mobile applications and services are globally accessible by one and all, thanks to Information Communication Technology (ICT). The multi-intervention service can be developed for users from different countries by modifying language options.

Fourthly, the research model did not test the effect of moderators like age, gender and voluntariness of use on the use behaviour. In future studies, these moderators can be looked into in details to find their impact on the acceptance of the service in a randomized control trial.

Additionally, the multi-intervention framework can be developed for prevention or control of other non-communicable diseases like obesity, Hypertension and Type-2 Diabetes. A full paper titled "Mobile Phone Including Smartphone based Persuasive System Design for controlling Hypertension and Diabetes in Bangladesh" has already been accepted for publication in IJBET (Journal). This framework can be used for programmes involving health behavior change as the main outcome.

Finally, future research can look into the practical application like carrying out a large scale randomised controlled trial (RCT) of the mHealth based multi-intervention service for the desired benefit of behaviour change (e.g., smoking cessation). Uptake of smartphones by the mass population in developing countries, irrespective of their economic conditions, has increased drastically. This is due to low costs of the technology and services among others. This allows more flexibility in trying out smartphone based multi-intervention health programmes in developing countries like India and Bangladesh. A comparative study of the multi-intervention service between developing countries and developed countries can be included within the scope of future research.

1.8 Structure of the Thesis

This thesis consists of eight chapters starting with an introductory chapter which provides a snapshot of the entire study. Table 2 below provides an overview of the remaining chapters which have been described in details in the following sections.

Chapter	Contents	Details
1	Introduction	<ul style="list-style-type: none"> • Problem definition, rationale, objectives • Research questions • Scope and theoretical foundation • Methodology • Contribution • Future research • Structure of the thesis
2	Literature Review	<ul style="list-style-type: none"> • Growth of mobile communications • Emergence of mHealth • Existing smoking cessation services • Need for Healthcare services design framework for smoking cessation • Discussion
3	Research Methodology	<ul style="list-style-type: none"> • Research Questions • Research Framework • Reliability of the Research Method
4	Service Design	<ul style="list-style-type: none"> • Development of Persuasive System Design framework for smoking cessation • Development of Smartphone based multi intervention service design
5	Evaluation of User Acceptance of Multi intervention Service (Research Model, Hypothesis and Survey Design)	<ul style="list-style-type: none"> • User Acceptance Models • Research Model • Survey Design • Data collection: • Data Analysis: Results and Discussion • Summary
6	Discussion and Conclusion	<ul style="list-style-type: none"> • Contribution • Limitation • Future Directions

Table 2: Structure of the thesis

Chapter 2: Literature Review

The systematic review will help in analysing the strengths as well as the limitations of existing mobile based smoking cessation interventions. The review adheres to the guidelines provided by (Kitchenham, 2004), which includes the following four steps:

- i. Resource Identification
- ii. Selection of studies
- iii. Data Extraction and Synthesis
- iv. Data Analysis

2.1.1 Resource Identification:

As per the experimental method by Dieste (Dieste et al., 2009), the first step commenced with the searching of relevant keywords from Google scholar. From the first 370 searches, “smoking cessation”, “behavior change”, “RCT”, “mobile interventions”, “Application”, “App” were the recurring key words found relevant for the current review. These keywords were thereby selected for the consequent searches. After finalizing the keywords, 15 databases were selected for searching for relevant studies. These databases include Wiley online library, PsycINFO, PubMed, MEDLINE, CINAHL, Web of Science, ERIC, Proquest Science Journals, EMBASE, Informit e-library, Scopus, CochraneDatabase of Systematic reviews, Cochrane Library, Cochrane Central Register for Controlled Trials, Cochrane Methodology Register, Cochrane DSR ACP Journal Club and DARE. In terms of timelines, only studies published between 1980 and 2013 were considered for the review. Among the keywords selected, the search phrases “Smoking Cessation” (And/or) “Mobile” provided the most relevant studies from the databases. The search was carried out involving multiple combinations of the keywords which resulted in 2753 articles.

2.1.2 Selection of Studies

Step 1: Relevant papers were selected from the initial list of searched articles (which included 2753 articles) as mentioned above.

Step 2: Thereafter, the second stage selection of articles was based on the following criteria, i.e. the articles:

- i. Should focus on smoking cessation

- ii. Should be peer reviewed
- iii. Should be in English Language only
- iv. Should have mobile phone as one of the modes of communication throughout the intervention

This step filtered 342 articles from the initial superset, out of which, 106 were found to be duplicates in turn.

Step 3: The third step included three additional inclusion criteria to further narrow down and improve the relevance for review, i.e. the articles:

- i. Should include at least a randomized controlled trial or quasi-experimental controlled trial
- ii. Should have mobile phone as the primary mode of communication in the intervention
- iii. Should have behavior change for smoking cessation as one of the major intervention outcomes

Step 4: The final step included searching papers that had cited the papers found in steps 2 and 3 in turn. With this additional condition, 14 papers were finally selected that showed strict adherence to the entire gamut of the selection criteria. The following diagram (Figure 3) summarizes the above mentioned selection criteria.

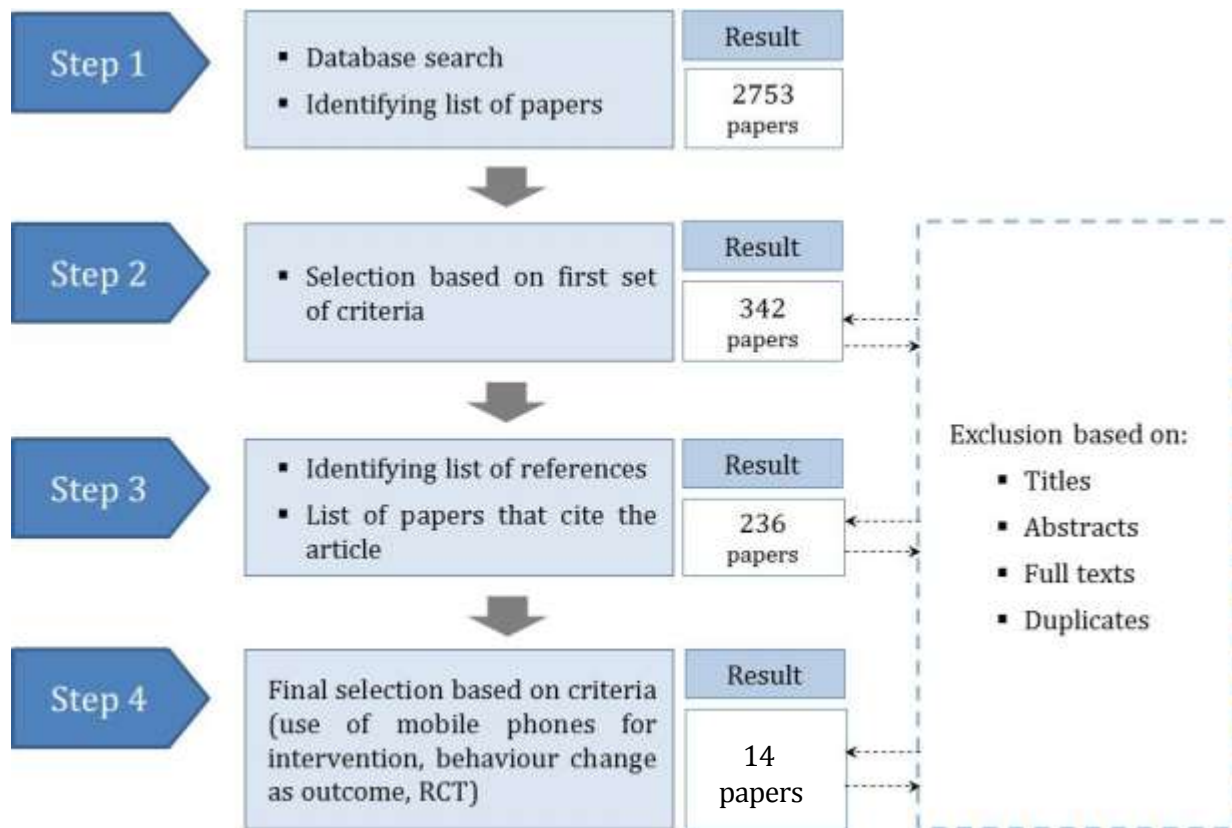


Figure 3: Selection of studies (Kitchenkham, 2004)

2.1.3 Data Extraction and Synthesis:

In this step, the papers were thoroughly reviewed, with key information being extracted from each study. The information was grouped into categories (as give in Appendix D) such as:

- Number of patients (sample size)
- Age group of patients
- Gender
- Number of cigarettes smoked before intervention
- Inclusion criteria
- Study duration

Of the 14 studies that were reviewed:

- 11 studies (Brendryen et al., 2008, Free et al., 2011, Whittaker et al., 2011b, Strecher et al., 2005b, Rodgers et al., 2005a, Bramley et al., 2005b, Naughton et al., 2012, Vidrine et al., 2006, Ybarra et al., 2013, Brendryen and Kraft, 2008, Peterson et al., 2009) were randomized control trials

- Four were pre-post design studies - The intervention period ranged from 4 weeks to 1 year
- 9 studies used self-reported measures and the rest used bio-chemical validations like determination of salivary cotinine level.
- Three of the interventions were based on theories which included Social Cognitive Theory, Trans-theoretical model of smoking cessation and Behavioral Self-Regulation Theory.

2.2 Literature Review Findings

Researchers and IT professionals have developed various kinds of smoking cessation interventions that have firm theoretical grounding. In this review, mobile based and online based interventions have been focussed on.

2.2.1 Mobile and (or) Internet based interventions:

Internet based smoking cessation interventions have been designed and studied in the past couple of years, while various programs and interventions have also been disseminated through mobile phones. Some of the more widely used ones are:

- **SMS based quit smoking services:** These interventions used SMS as the primary mode of communication with the participants, with messages on motivation and quitting related information being sent through mobile phones.
- **Tele-counselling:** Participants were provided tele-counselling services on mobile phones for smoking cessation
- **Multimedia messages based service** (Not as widely used and tested as the first two)

From all the articles reviewed, the advantages of mobile phones for the interventions were found to be low cost, better reach, increased interaction between researcher and participants and easier as well as faster way to send tailored and personalized messages (Akter and Ray, 2010).

The studies can be divided into three groups based on the type of information sharing and interaction with the participants over the mobile phone as follows:

- First, communication through SMS or multimedia messages was seen in eight (Obermayer et al., 2004, Rodgers et al., 2005b, Bramley et al., 2005a, Free et al., 2011, Whittaker et al., 2011a, Vidrine et al., 2006, Ybarra et al., 2013, Naughton et al., 2012) of the studies.
- Second, messages were communicated through SMS as well as through the internet in five of the studies (Brendryen et al., 2008, Brendryen and Kraft, 2008, Riley et al., 2008, Strecher et al., 2005a, Abrams et al., 2012).
- Third, use of telephone or mobile for tele-counselling interventions were found in two (Peterson et al., 2009, Strecher et al., 2005b) of the studies.

The key findings from these studies are as follows:

- Interventions involving mobile as a medium have the capacity to make communication with ethnic minority groups easier and further the reach of the intervention (Bramley et al., 2005a). This also includes improved engagement and retention of adolescents (Obermayer et al., 2004, Riley et al., 2008, Peterson et al., 2009) through mobile based smoking cessation interventions.
- Some of the studies involved personal tailoring of messages (Obermayer et al., 2004, Rodgers et al., 2005b, Bramley et al., 2005a, Brendryen and Kraft, 2008, Riley et al., 2008, Free et al., 2011, Whittaker et al., 2011a, Naughton et al., 2012, Abrams et al., 2012). In some studies tailoring was also done on the basis of participant name, gender, age, participant history, goals and medical condition.
- Only a few of the studies had user-initiated craving support like quit help lines of motivational messages triggered by a CRAVE or HELP message from the participant (Rodgers et al., 2005b, Bramley et al., 2005a, Brendryen et al., 2008, Brendryen and Kraft, 2008, Free et al., 2011, Naughton et al., 2012).
- It was also noticed from the articles that readership of mails was lower and declined substantially as compared to mobile messages whose readership was high and sustained over time (Abrams et al., 2012).
- Only one of the studies used performance comparison for motivating the participants for smoking cessation (Free et al., 2011). It used interactive polls and sharing of performance analysis of the participants.

Table 3: Review of Mobile Based Smoking Cessation Interventions

Sr. No.	Study	Details	References
1	Mode of Smoking Cessation Intervention Delivery	Smoking cessation intervention SMS / Multi Media Messages	Bramley et al. 2005; Free et al. 2011; Naughton et al. 2012; Obermayer et al. 2004; Rodgers et al. 2005b; Vidrine et al. 2006; Whittaker et al. 2011; Ybarra et al. 2013
		SMS & Internet	Abroms et al. 2012; Brendryen et al. 2008a; Brendryen et al. 2008b; Riley et al. 2008; Strecher et al. 2005a
		Mobile/ Telephone for Tele-counselling	Peterson et al. 2009; Strecher et al. 2005b
2	Personal Tailoring of SMS	Tailoring of SMS done on the basis of participant name, gender, age, participant history, goals and medical condition	Abroms et al. 2012; Bramley et al. 2005; Brendryen et al. 2008b; Free et al. 2011; Naughton et al. 2012; Obermayer et al. 2004; Riley et al. 2008; Rodgers et al. 2005b; Whittaker et al. 2011
3	User Initiated Craving Support	Quit help lines of motivational messages triggered by a CRAVE or HELP message from the participant	(Bramley et al. 2005; Brendryen et al. 2008a; Brendryen et al. 2008b; Free et al. 2011; Naughton et al. 2012; Rodgers et al. 2005b

2.2.2 Mobile based Smoking Cessation Intervention Designs

From the literature review it is clear that interventions have been designed solely on a

public healthcare perspective. Most of the interventions have been developed without keeping the end-users or the participants' feedback or perception in mind, although these have been developed and then tested for efficaciousness. Whittaker (Whittaker et al., 2008) conducted a study on content development for a multimedia mobile phone based youth smoking cessation intervention. It focussed on gathering feedback from participants for content development but not for the service development.

Randomized trials: Randomized control trials have been carried out for smoking cessation interventions though involving very few participants. Only four of the interventions had a large sample size (Rodgers et al., 2005b, Peterson et al., 2009, Whittaker et al., 2011a, Strecher et al., 2005a) out of which only three are randomized control trials (Rodgers et al., 2005b, Peterson et al., 2009, Whittaker et al., 2011a). More randomized controlled trials are required with larger sample size to be able to assess the long term impact of new interventions on smoking cessation.

Duration of impact: It was found that most of the interventions had short term positive behavior change but none of the articles gave any information on long term effects of the interventions. At the same time researchers should consider a post intervention follow up to determine the long term impact of the interventions. In some of the studies objective measures were used to assess the intervention outcome. It should be followed more often than self-reported measures in future research. It will provide a better validity to the intervention outcomes.

Mode of communication: Though the SMS based interventions have shown positive behavior change among the participants, they cannot be deemed as the best intervention mode. A multipronged approach like SMS service in addition to mobile internet applications for group chatting and a system to use patient information for sending messages or chats to support, motivate or distract the patient might give better results. With the development of new technologies and increasing mobile subscriptions worldwide, new ways of message delivery can be designed for reaching out to a larger population. In this context it should be mentioned that during the initial search for the systematic review, very few studies were found that focused on mobile and Smartphone

apps for smoking cessation interventions. Though quite a few Smartphone applications have been designed for healthcare management (Luxton et al., 2011) and specially smoking cessation (Abroms et al., 2011), studies are yet to be carried out to measure the impact of these applications. Abroms (Abroms et al., 2011) carried out a content analysis of iPhone apps for smoking cessation. Though there are some iPhone apps that have been developed to help consumers to quit smoking, very few studies have been conducted to measure the outcome of these applications. This can be included in future research for developing mobile/Smartphone apps for smoking cessation. In the intervention designed by Whittaker (Whittaker et al., 2008), video and text messages were developed for participants to view experiences of smoking cessation processes by selected role models. The study tested the reliability of the system and proved the acceptability of the intervention for future studies involving Social Cognitive Theory. At the same time none of the studies talked about self-control theories. According to Baumeister (Baumeister, 2002) self-control refers to altering one's own responses and support the pursuit of long term goals. Theory of self-control can be used for designing interventions that tests their impact on behavior change over a long period of time.

Location: In the review we also found that all the studies were carried out in developed countries. None of the studies were on use of mobile based smoking cessation interventions in developing countries. The feasibility and acceptability of these interventions in developing countries are yet to be studied and analysed. In addition to this, none of the controlled trials for SMS based smoking cessation interventions have been carried out in Australia.

2.3 Identified Gaps

From the systematic literature review, some gaps were identified, which are listed as below

1. **No studies on Smartphone based services for smoking cessation** - None of the interventions included the use of smartphones for smoking cessation. Smartphones can be used for delivering multiple interventions.
2. **Absence of System Framework/Design component for behavior change services** - mHealth applications are integrated with health information systems

in advanced countries, where data are shared both by community health workers (CHWs) and clinicians. Although the quality of mHealth services largely depends on the quality of Information Systems (IS)/technology designs, this study found a paucity of research focusing on this stream.

3. **Multi - intervention services** - Lack of studies on multi-intervention services for behavior change using Smartphones
4. **User acceptance tests** - None of the studies include user acceptance tests of the smoking cessation services.

2.4 Theoretical Foundation

2.4.1 Conceptual Framework of Multi intervention service and Theories Used

This section discusses the theories and models that have been considered for developing the framework of the multi intervention service. This helps in investigating the research question 1 that is how to develop a persuasive technology based model/framework for designing multi-intervention mhealth service for public health (specially smoking cessation).

This section also provides a brief of the contribution of the behavior change theories and the Persuasive System Design model including its features in detail for developing the service framework.

2.4.2 Behavior Change Theories used for the Framework

There has been a constant rise in lifestyle related health challenges. To address these challenges health-practitioners have increasingly focussed on behavior change interventions. Various health behavior models and theories have been adopted from different disciplines for designing and developing these interventions. Quite a few health behavior theories that have been used often for designing health interventions include Theory of Planned behavior, Health Belief Model, The Transtheoretical Model, Theories of Reasoned Action, Protection Motivation Theory and Social Cognitive Theory. We have briefly described the theories that have been used for developing the initial framework.

A. Transtheoretical Model (Prochaska and Velicer, 1997)

According to the Transtheoretical Model, behavior change is brought about through a process involving progress through a series of stages. The stages of behavior change are portrayed in Table 4.

Table 4: Transtheoretical Model: Stages of behavior change

Sr. No.	State	Description	Instructional Strategies
1	Pre-contemplation	No intention of taking action in the next 6 months	<ul style="list-style-type: none"> ▪ Engage the individual with information about need for change ▪ Provide personalized information about risks if no change and benefits of change
2	Contemplation	Intends to take action in the next 6 months	<ul style="list-style-type: none"> ▪ Motivate and encourage the individual to set goals and make specific plans
3	Preparation	Intends to take action in the next month and has taken some steps to change behavior	<ul style="list-style-type: none"> ▪ Help the individual create and implement specific action plans and set realistic goals
4	Action	Has changed behavior for <6 months	<ul style="list-style-type: none"> ▪ Provide problem based learning experience ▪ Provide social support, feedback
5	Maintenance	Has changed behavior for >6 months	<ul style="list-style-type: none"> ▪ Continue to provide social support, assist with problem-solving, positively address slips and relapses if necessary ▪ Employ reminder systems, performance support tools

The stages of change involve the following:

- Pre-contemplation
- Contemplation

- Preparation
- Action
- Maintenance

This model has been use for developing the content for the motivational messages. We have divided the message content into two phases.

- Phase 1 contains the pre-contemplation, contemplation and preparation stage. The message content has been developed accordingly.
- Phase 2 contains Action and maintenance stages.

B. Social Cognitive Theory (Bandura, 1986; 1997): The theory proposes that factors like individual, environment as well as social has direct relation to behavior change (see figure 4). Various constructs for this theory include environmental, situation, behavioral capability, expectations, expectancies, self-control, observational learning, reinforcements, self-efficacy, emotional coping responses and reciprocal determinism.

Social cognitive theory has been widely used for designing various behavior change interventions in the public health care domain. Self-efficacy, which is one of the key features of this theory, has been widely used to predict behavior in various health related situations.

We selected Social Cognitive Theory for our research as it deals mainly with self-efficacy and environmental factors for behavior change. Self-efficacy has been extensively studied in smoking. Optimistic self-belief can help smokers quit smoking (Baer and Lichtenstein, 1988, Carmody, 1990, Haaga and Stewart, 1992)

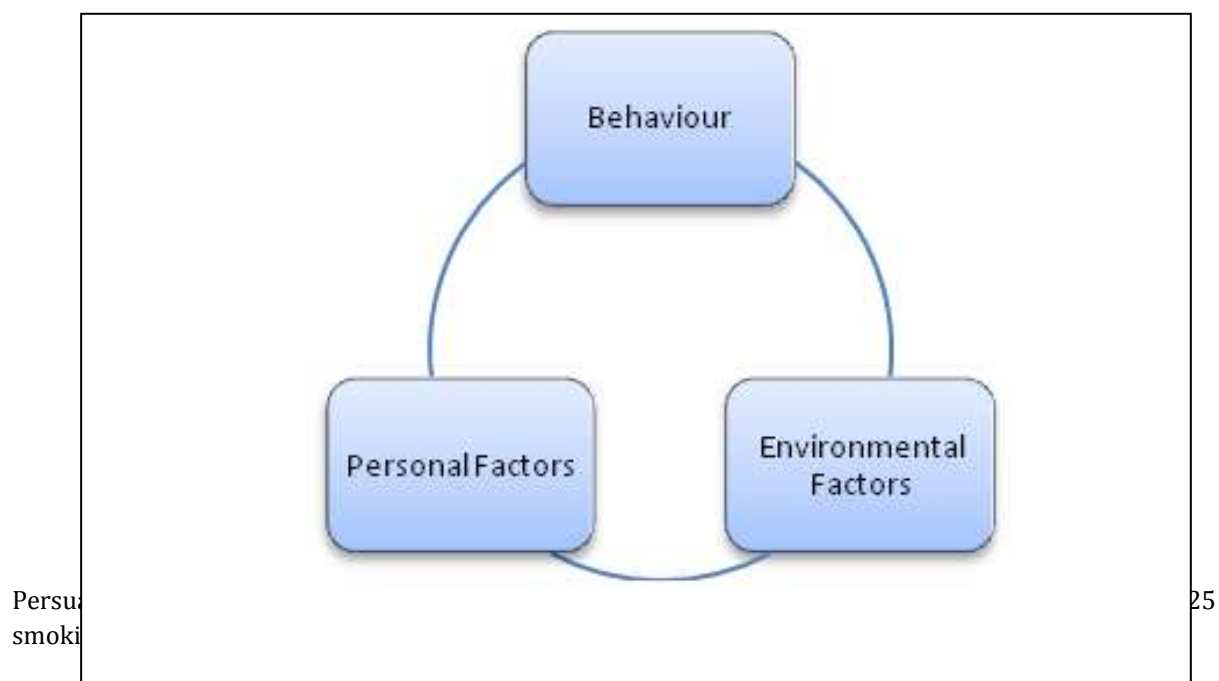


Figure 3: Social Cognitive Theory

2.4.3 Persuasive Technology

Persuasive systems are defined as the technology that is used for behavior change or attitude change in the users (Fogg et al., 2003). These systems combine behavioral theories with system design models for effective behavior changes. These systems have been used across various fields like marketing, healthcare, sales, politics etc. These focus on interaction between computational technologies like mobiles and humans based on psychological theories for studying behavior change issues. Various persuasive systems have been developed for disease management and control. The Persuasive System Design model by (Oinas-Kukkonen and Harjumaa, 2009a) provides a framework for designing IS services that can be used in the context of healthcare and disease management. The model talks about factors to be considered while designing a system but does not explain the software requirements and implementation features.

With the increase in the number of mobile users, researchers have been conducting studies on use of mobile technology for designing persuasive systems. Web, mobiles as well as internet have created various opportunities for designing persuasive systems in collaboration with psychology based theories.

We have focussed on the Persuasive System Design (Oinas-Kukkonen and Harjumaa, 2009a) for developing the persuasive system framework for smoking cessation service.

In the next section we have given a brief description about Persuasive System Design model and how it can be further developed for smoking cessation service framework.

2.4.4 Persuasive System Design (Oinas-Kukkonen and Harjumaa, 2009a)

According to the PSD model by Kukkonen, there are three major phases in the designing of a persuasive system for behavior change (see Figure 5 below).

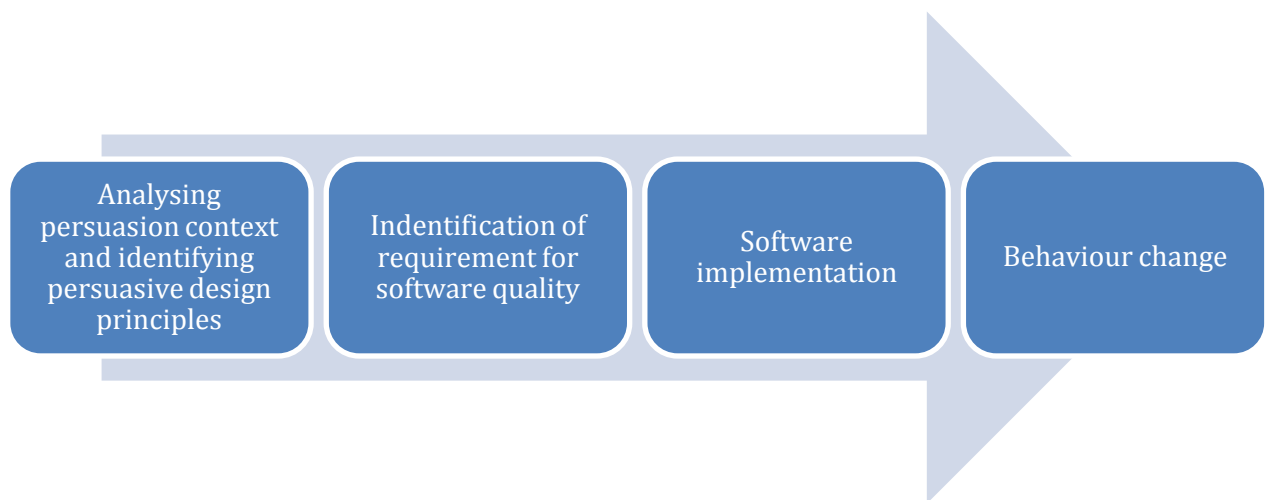


Figure 4: Steps in the development of Persuasive System

The first stage consists of analysing the persuasion context and identifying various design principles that will be used. This stage is followed by the identification of various requirements for software quality. Software implementation is covered in the third stage of the development process.

The persuasive system model beautifully depicts the various stages that should be considered for designing a persuasive system. The model features three main phases (see Figure 6 below). .

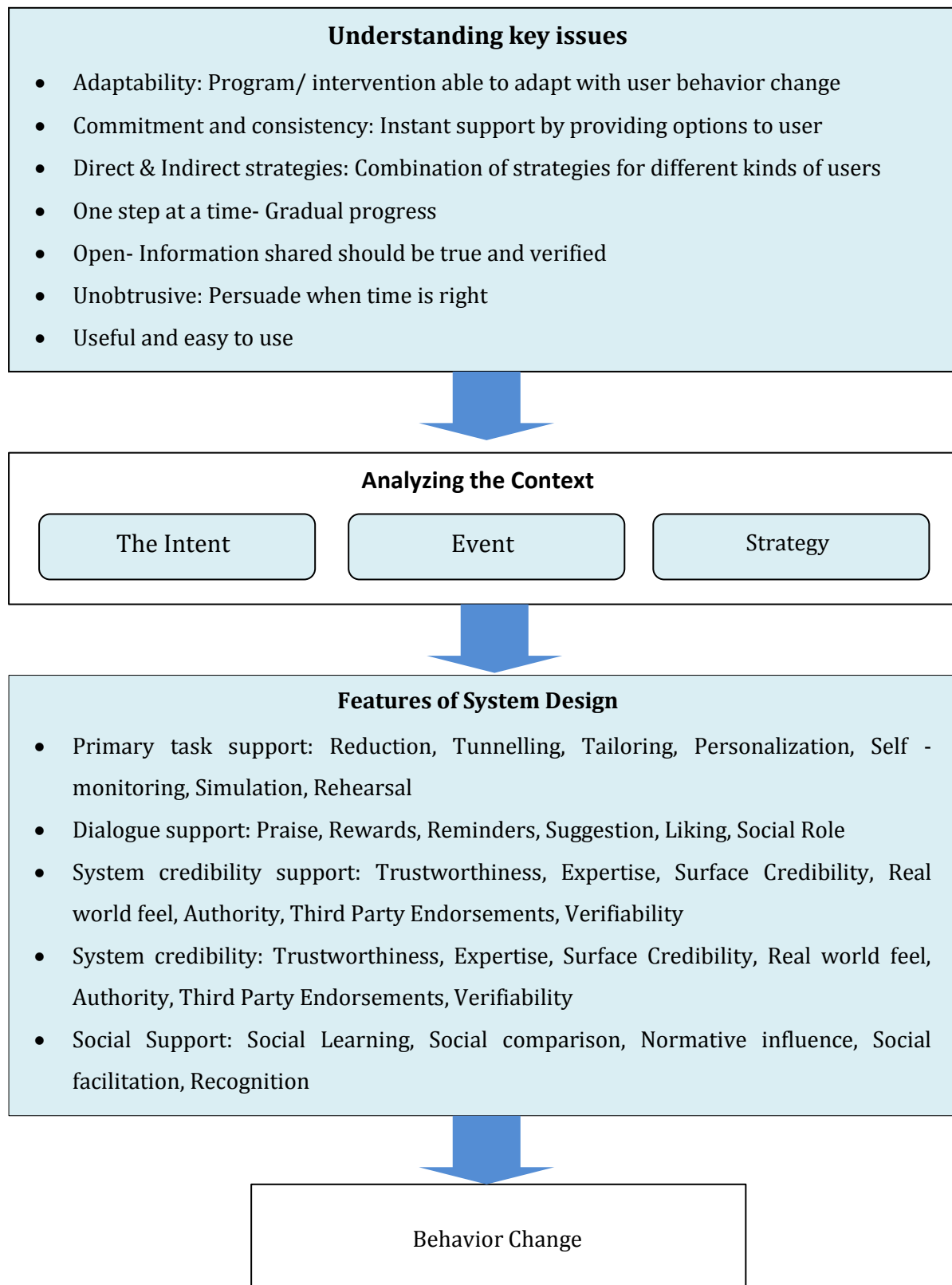


Figure 5: Persuasive System Design Features (Oinas-Kukkonen and Harjumaa, 2009a)

The first phase involves understanding the key issues. It is described below

Phase 1

- **Adaptability:** Smoking Cessation program/intervention should be able to adapt with changes in user behavior.
- **Commitment and consistency:** Instant support by providing options when user craves. Consistent upgrading of application/software and up to date information
- **Direct & Indirect strategies-** Combination of strategies for different kinds of users
- **One step at a time-** Maintain gradual progress through system
- **Open-** Information on smoking shared should be true and verified
- **Unobtrusive:** Persuade when time is right. Notifications should not disturb the user
- **Useful and easy to use:** mobile application/ web service should be simple and effective

Phase 2

- **The Intent:** Create a Smartphone based multi-intervention service for smoking cessation (Endogenous)
- **The Event:** Smoking Cessation through behavior change
- **The Strategy:** A combination of interventions like motivational messaging, games and real time chat facility using Smartphones as mode of intervention dissemination.

Phase 3

The final phase is to identify the features of system design. Kukkonen, in his model (Oinas-Kukkonen and Harjumaa, 2009b), has provided a set of persuasive strategies for the system design, namely Primary task support, Dialogue support, System credibility support and Social support. Each category has been divided into 7 features each. Description of the features is given below

a. Primary task support

4 features were selected based on prior studies on web based healthcare interventions (Lehto and Oinas-Kukkonen, 2011) to be incorporated in the multi-intervention service.

- **Reduction:** System makes task simple for user. The MI service App provides easy to understand and use progress tracker (health and savings) to user. It also provides simple way of updating profile

- **Personalization:** System provides personalized content. Motivational messages was personalized according to user's name, age and profile details
- **Self-Monitoring:** Enable users to track their own progress. Our app will update user progress through easy to understand progress trackers.
- **Simulation:** Provide users information to figure out the cause and effect. Videos and messages will enable users to figure out the effects of smoking.

b. Dialogue Support

In this category, three features were selected for the framework.

- **Praise:** Multi-intervention application praises individuals on accomplishing goals or reducing cigarette consumption
- **Reminder:** The app will remind user their goals of quitting or following healthy lifestyle that will lead to quitting through push notifications and messages.
- **Liking:** The user interface of the application is simple and user friendly, making it visually attractive. It will motivate users to access the MI service and keep using it.

c. System Credibility Support

Two features were selected for this category

- **Expertise:** The app was updated regularly for users to have a good experience throughout. New features were incorporated for better user experience.
- **Verifiability:** The application will provide links to smoking cessation related videos that can be verified by users. This will increase trustworthiness of the service.

d. Social Support

This is the most important category for the service framework. Six features from PSD model were selected for incorporation in the service design.

- **Social Learning:** Users was motivated to change behavior by noticing others performing the same behavior. Progress of other users was shared with individuals to motivate them to quit smoking.
- **Social comparison:** Real time chat service in the app will enable the user to share his progress with other users. It will motivate him to set goals and achieve them.
- **Normative influence:** This is brought about by getting together other users. Peer influence motivates users to be committed to their target. The real time chat service allows user to do so.

- **Social facilitation:** Progress trackers, group tracking will help users to discern progress of other users.
- **Recognition:** Hall of fame aspect of the application will recognize the users who have been able to achieve a target like quit smoking. This will motivate individuals to perform better.

2.4.5 Components of the Framework

The components of the framework have been mapped to the theories and as well as to the different interventions. Table 5 gives an overview of the various interventions and the attributes that connect them to the theories that have been considered for developing the framework.

Table 5: Framework Components Mapped to the Theories Used

Sr. No.	Theory	Contribution	Attributes selected for the service	Implementation through Service
1	Social Cognitive Theory (Bandura, 1986)	Selection of Interventions	1. Motivation/ Distraction (Self efficacy) 2. Social Support	1. Motivation: Messages, videos 2. Distraction: Games, videos 3. Social Support: Instant peer chat
2	Transtheoretical Model (Prochaska and Velicer, 1997)	Stages of Behavior Change	Phase 1: Precontemplation, Contemplation, Preparation Phase 2: Action, Maintenance	Developing content for motivational messages
3	Theory on Distraction (Rogers and Thistlethwaite, 1970; Rogers and Mewborn, 1976; Raiff et al., 2012)	Behavior Change through Distraction	Distraction	1. Games 2. Videos

Sr. No.	Theory	Contribution	Attributes selected for the service	Implementation through Service
4	Persuasive System Design Model (Oinas-Kukkonen and Harjumaa, 2009a)	Selection of Features for the interventions	<p>A. Primary task support</p> <p>(i) Reduction</p> <p>(ii) Personalization</p> <p>(iii) Self-Monitoring</p> <p>(iv) Simulation</p> <p>B. Dialogue Support:</p> <p>(i) Praise</p> <p>(ii) Reminder</p> <p>(iii) Liking</p> <p>D. System Credibility Support:</p> <p>(i) Expertise</p> <p>(ii) Verifiability</p> <p>E. Social Support:</p> <p>(i) Social Learning</p> <p>(ii) Social comparison</p> <p>(iii) Normative influence</p> <p>(iv) Social facilitation:</p> <p>(v) Recognition:</p>	<p>1. Motivational Messages</p> <p>2. Progress Tracking</p> <p>3. Distraction through games and videos</p> <p>4. Disease Awareness through videos</p> <p>5. Social support through Instant peer chat</p>

2.5 Review of persuasive features in mobile based interventions

Eleven mobile as well as web based interventions of behavior change were selected and the features of these interventions were analyzed according to the components of the PSD model (Oinas-Kukkonen and Harjumaa, 2009a). According to Table 6 which presents a snapshot of the analysis of the 11 behavior change interventions, none of the mobile based interventions had instant peer support component for behavior change. They were all sms and/or web based interventions and all were conducted in developed countries and none in developing countries. Based on the gaps identified during the literature review, the research questions for this study were developed. The research questions have been discussed in the next section.

Table 6: Analysis of mobile and web based interventions as per PSD model

Primary Task Support	(King et al., 2008)	(Liu et al., 2008)	(Atienza et al., 2008)	(Beasley et al., 2008)	Ellrott 2005	(Newton et al., 2009)	(Nguyen et al., 2009)	(Prestwich et al., 2009)	Prestwich 2010	Sirriyeh 2010	Burke 2010 (Burke et al., 2010)
Reduction	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y
Tunnelling	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y
Tailoring	Y	Y	Y	Y	N	N	Y	Y	N	N	N
Personalization	N	N	N	Y	Y	N	N	N	N	N	Y
Self-Monitoring	N	Y	Y	Y	Y	Y	Y	N	N	N	Y
Simulation	N	Y	N	N	N	N	N	N	N	N	N
Rehearsal	N	N	N	N	N	N	N	N	N	N	N
Dialogue Support											
Praise	N	N	N	Y	Y	N	Y	N	N	N	Y
Reward	N	N	N	N	N	N	N	N	N	N	N
Reminder	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Suggestion	Y	N	Y	N	Y	N	Y	N	N	N	Y
Similarity	N	N	N	N	N	N	N	N	N	N	N
Liking	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y
Social Role	N	N	N	N	N	N	Y	N	N	N	Y
System Credibility Support											
Trustworthiness	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Expertise	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Surface credibility	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y
Real world feel	N	Y	N	N	N	N	N	N	N	N	N
Authority	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y
Third party endorsements	N	N	N	N	N	N	N	N	N	N	N
Verifiability	N	N	N	N	Y	Y	Y	N	N	N	Y
Social Support											
Social Learning	N	N	N	N	N	N	N	N	N	N	N
Social Comparison	N	N	N	N	N	N	N	N	N	N	N
Normative Influence	N	N	N	N	N	N	N	N	N	N	N
Social Facilitation	N	N	N	N	N	N	N	N	N	N	N
Cooperation	N	N	N	N	N	N	N	N	N	N	N
Competition	N	N	N	N	N	N	N	N	N	N	N
Recognition	N	N	N	N	N	N	N	N	N	N	N

2.6 Research Design Challenges/ Research Questions

The review of mhealth services for behavior change and smoking cessation has brought to the forefront questions for healthcare service design framework for smoking cessation. Success of a healthcare intervention depends a lot on the service design aspects and how well it caters to the needs of the patients for a successful or positive outcome. Keeping this in mind, the following research questions have been addressed in the context of service design framework and smoking cessation:

RQ1: How to develop a Persuasive Technology framework and design a Smartphone based multi-intervention mhealth service for smoking cessation using the framework

RQ2: What are the factors that affect the user acceptance of a Smartphone based multi intervention service for smoking cessation?

For this research, Persuasive System Design (Oinas-Kukkonen and Harjumaa, 2009a), Social Cognitive Theory (Bandura, 1986) and Transtheoretical Model have been identified as theoretical framework for developing the persuasive system model for smoking cessation multi-intervention service.

2.7 Chapter Summary

The literature review provided interesting insights into the use of mobile technology in healthcare, especially in behaviour change programmes. Behaviour change in healthcare is an extensively studied topic and an emerging one at that. However, lot needs to be done when it comes to acceptance of an intervention by its users. The literature review highlighted that mobile based behaviour change interventions and programmes for smoking cessation needed more innovative ideas and frameworks for increasing the user acceptance of these interventions by users and patients. There are opportunities to fill the research gaps by exploring persuasive system models and psychology theories. Based on these broad ideas, the following chapter delves deeper into finding a framework and research method. The discussion then progresses to the formulation of research questions and hypotheses be addressed within this research context.

Chapter 3: Research Methodology

Research methodology can be defined as the theoretical analysis of the body of methods and principles associated with a branch of knowledge. A well planned research methodology guides a researcher on how the research should be conducted in order to achieve the desired goals (Carlsson 2010).

Through the systematic review multiple gaps that existed in the field of service design for smoking cessation were identified. It was also found that there was no persuasive system framework that specifically aided in smoking cessation service development. The need for the development and evaluation of a Smartphone based multi intervention service for smoking cessation was also identified. This chapter presents the research questions as well as a brief description of the research methodology that was used to answer the research questions.

To fulfil some of the gaps thus identified during the systematic review, design science paradigm was chosen. It guided the development of the framework as well as the service for smoking cessation. This study adopted in particular the popular design science framework in Information Systems by Hevner (Hevner et al., 2004).

The research questions and research objectives have been discussed in section 4.2. while section 4.3 discusses the Hevner's framework and its usage in conducting the study and answering the research questions.

3.1 Research Questions

From the literature review it is evident that there is a need for developing the PSD model in the context of smoking cessation. The theoretical frameworks, namely Persuasive System Design model, Socio-Cognitive Theory and Transtheoretical Model have been considered for developing a multi intervention smoking cessation service. Literature review brought forward the fact that there have not been any studies that look into Smartphone based multi intervention services for smoking cessation as well as the user acceptance of such a service. Thus, through this study we have tried to address these gaps thereby developing the following research questions

Research Question 1: How to develop a Persuasive Technology framework and design a Smartphone based multi-intervention mhealth service for smoking cessation using the framework?

Research Question 2: What are the factors that affect the user acceptance of a Smartphone based multi intervention service for smoking cessation?

3.2 Research Framework

This section describes the process that was used to answer the research questions along with the methodology used.

3.2.1 Choice of Research Paradigm: Design Science

According to Hevner (2004), research in the field of information systems can be divided into two paradigms:

- behavior science, which tries to develop and verify theories that explain human-organizational behavior and
- design science, where solutions are scientifically designed to improve or solve real life problems.

Hevner defines design science as a research paradigm where the aim is to *“create innovations that define ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished”*.

Therefore while Design science research produces artifacts, behavior science seeks to predict a phenomena that occurs with respect to the use of artefacts in a particular context.

This study has accordingly tried to conform to a design science paradigm in developing a framework for a multi intervention service for smoking cessation, thereby implementing the framework by developing a Smartphone based service for use by smokers and health professionals using the existing body of knowledge in the literature.

3.2.2 Research Methodology

Choosing a correct design method is important for carrying out the research in a planned and systematic manner. According to Veneble , the design science framework by Hevner

(Hevner et al., 2004) is structured and fits the criteria, standards and guidelines of design science studies. Thus, Hevner's design science framework was selected over other design science methods ((Nunamaker Jr and Chen, 1990, Walls et al., 1992, March and Smith, 1995, Venable and Travis, 1999, Markus et al., 2002, Pries-Heje et al., 2007).

As suggested by the Hevner's framework, the four steps that have been followed for this study are

- a. Obtaining awareness of the problem from the environment
- b. Putting forward suggestions for solving the problem
- c. Contributing to the pool of study through publications
- d. Evaluating the solution to validate the generalizability and correctness of the solution

Hevner's framework was adopted and modified in the context of this study. The following Figure 7 describes the process involved in the study.

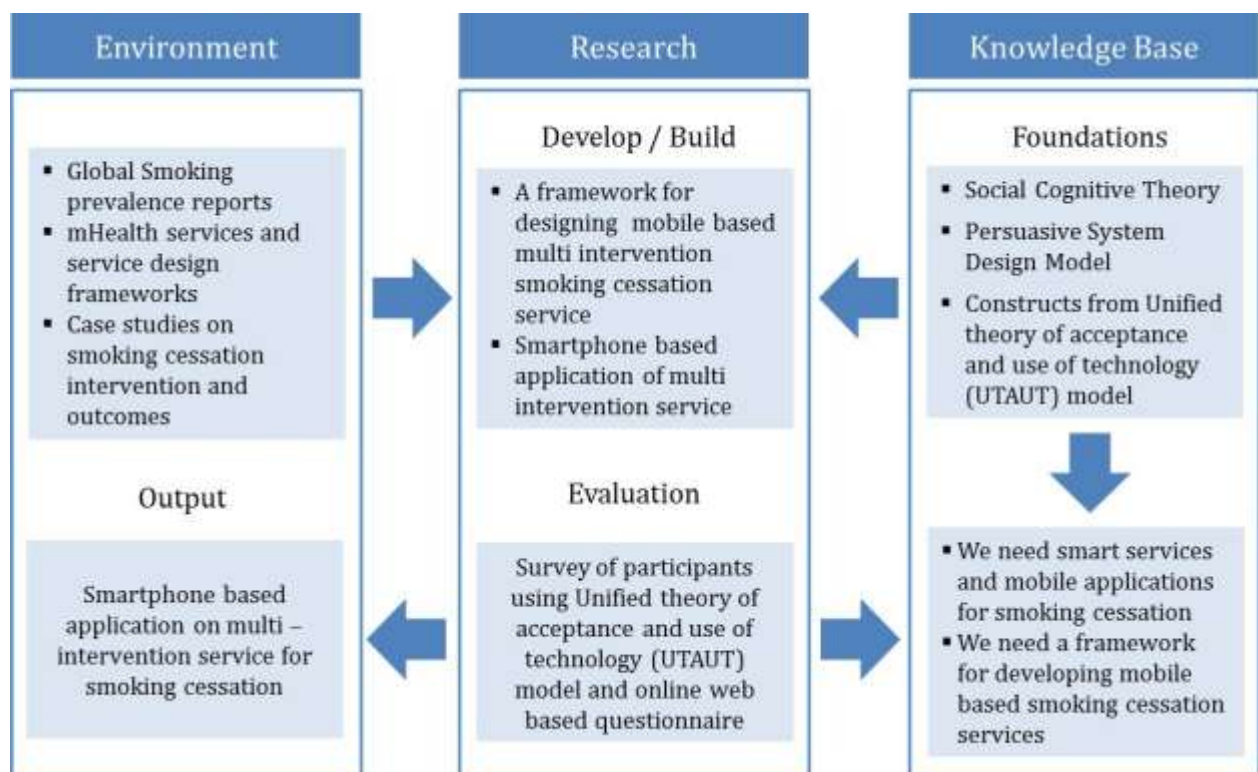


Figure 6: Hevner's framework for design science research

The first step of the framework involves identification of the problems in the environment. For this purpose, mhealth based interventions and smoking cessation studies were chosen from the healthcare sector. These studies helped in identifying the problem that exists in healthcare service design and thus provided the motivation for designing a framework as

well as a service for smoking cessation.

This was followed by a systematic literature survey that was conducted to review all the existing studies involving smoking cessation interventions and service designs. Based on the literature review, a framework for designing Smartphone based multi intervention service was developed using Persuasive System Design model. A major gap that was identified during the literature survey was that a framework specific for smoking cessation was needed for service designing and development.

Hevner's framework was thereafter used for answering the following research questions.

Research Question 1: How to develop a Persuasive Technology framework and design a Smartphone based multi-intervention mhealth service for smoking cessation using the framework?

To answer this question, a framework was developed using Persuasive System Design model and Behavior Change Theories. The framework will help in developing a mobile based multi intervention service for smoking cessation. The steps for developing the framework has been discussed in details in chapter 5.

Research Question 2: What are the factors that affect the user acceptance of a Smartphone based multi intervention service for smoking cessation?

The next step in Hevner's framework is evaluation of the research contribution which in this case is the Smartphone based multi intervention service. For answering this research question, Unified Theory of Acceptance and Use of Technology (UTAUT) model was adopted. This model has been used for studying the user acceptance of the multi intervention service in real life setting. The evaluation involved a web based survey and helped in understanding the various factors that affect the user acceptance of a Smartphone based multi intervention service for smoking cessation.

Overall, the main contributions of this thesis are

- **Persuasive System Design framework for Smoking Cessation:** Based on the gaps

identified through the literature review, a framework for designing a Multi intervention service for smoking cessation has been developed. Chapter 5 discusses the process that has been followed for developing the framework in details.

- **Development of Smartphone based Multi intervention service for smoking cessation:** This is the main contribution of the research. Based on the Persuasive System Design framework for smoking cessation, a Smartphone based application has been developed and tested on users who are all smokers. This mobile application incorporates the features of the framework and is a multi-intervention service package which consists of interventions like motivational messages, progress tracking, instant peer chat support and distraction.

3.3 Reliability of the research methodology

Reliability and validity of the methodology was evaluated using the guidelines by (Hevner et al., 2004). Three guidelines were followed for the evaluation. They are as described below.

3.3.1 Guideline 1. Design as an artefact

According to Hevner's guidelines, "*design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation*" (Hevner et al., 2004). Following the guidelines, Table 7 presents the constructs, model and instantiations that are produced through the design science research.

Table 7: Research Products

Sr. No.	Artefact	Description
1	Construct	The various features of the Persuasive System Design framework for smoking cessation form the constructs. This is explained in details in section 5.1.
2	Model	The framework also provides a model for multi intervention service development especially for smoking cessation.
3	Instantiation	Based on the PSD framework for smoking cessation, a Smartphone based application was developed which

		incorporates various features of the framework. This has been explained in details in chapter 5.
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3.3.2 Guideline 2. Problem relevance

According to Hevner, aim of any design science research should be to solve a real life problem. The PSD framework for smoking cessation is relevant in the healthcare context. As mentioned in chapter 1, smoking is the leading cause of various psychological and physiological conditions. To curb smoking, smart systems and services are needed. The framework would guide in developing the multi intervention service for smoking cessation and has been implemented through the development of a Smartphone based application for smoking cessation.

3.3.3 Guideline 3. Design Evaluation

According to Hevner (2004), utility, quality and efficacy of a service design must be validated using well executed methods. A web based survey was therefore conducted to evaluate the acceptance of the multi-intervention service framework. The survey instrument has been designed from a pretested instrument. Details of the evaluation process have been provided in chapter 5.

3.4 Chapter Summary

The broad research agenda identified through the literature review has been refined to arrive at the research questions that current study will focus on. This chapter provides an outline of the objectives of the research and the method used to answer the research questions. The objectives of this research is to develop a multi-intervention service framework for behaviour change (smoking cessation) and evaluate the user acceptance of the multi-intervention service. Hevner's framework for design science was chosen. This chapter also discusses the various steps of the framework that are followed to generate the necessary results with the first step being awareness of the problem in the environment. The second step involves conceptualizing solutions to the problem which in this case is the multi-intervention framework for behaviour change. The third step involves evaluation of the framework. In this case the multi-intervention service, which has been developed based on the framework, has been evaluated for user acceptance. The

last step of Hevner's framework involves contribution to the knowledge base. This has been done through two conference publications and two journal publications (details given at the beginning of the paper).

Chapter 4: Service Design Framework and Smartphone Application

The following section discusses the development of the framework for smoking cessation in particular and the reasons for adding two new additional categories to the framework, namely (a) Instant Gratification and (b) Hardware/Software/Network support.

4.1 Persuasive System Design Framework for Smoking Cessation

Smokers try to quit smoking for a variety of reasons. The key factors that influence the success or failure of quit attempts include the following:

- Physiological: This can include high or low level of nicotine dependence, different withdrawal symptoms, affinity to gain weight
- behavioral (e.g. slip-ups, pattern of smoking)
- Physical or social (e.g. living or working with smokers, having smoking friends, home or workplace subject to smoke free policies or seeing tobacco products displayed)
- Psychological or emotional/affective (e.g. stress, depression, anxiety, fear of weight gain, psychiatric disorders)
- Cognitive (e.g. knowledge, self-exempting beliefs, perceived disadvantages, motivation, self-efficacy)
- Barriers to access to interventions (e.g. affordable quitting medications, treatment programs)
- Social context or life circumstances that may result in the smoker giving quitting a low priority (e.g. poverty, social isolation, lack of perceived safety, social norms).

These factors can accordingly be divided into two categories-

(a) Personal Characteristics - These involve

- Duration of smoking: The duration of smoking refers to the number of years or months the person has been smoking. If the person has been smoking for

a very long time, it might not be as easy for him or her to quit compared to someone whose smoking duration is comparatively shorter.

- **Level of Dependence (heavy or light):** Heavy smokers have higher level of dependency and light smokers have lower levels on nicotine dependency. This might impact smoking cessation.
- **Withdrawal symptoms:** When people try quitting smoking, they undergo different kinds of withdrawal symptoms. It differs from person to person and it can affect the quitting process. Sometimes, due to inability to cope with the withdrawal symptoms, smokers relapse.
- **Poor self-efficacy or low confidence:** Low self-confidence or poor self-efficacy can affect quit attempts.
- **Recognition of Stress/ Depression/ Anxiety**

(b) External Factors: There are some external factors that can influence quit attempts. These include

- Social factors
- Cultural requirements
- Tobacco marketing/ advertising

Though the external factors cannot be directly controlled, the personal factors can be influenced using behavior change theories and incorporating them in a multi intervention service. The framework for such a service design will require the inclusion of well thought out features that would influence the factors crucial for smoking cessation.

Various studies have been conducted for behavior change interventions for smoking cessation. However, there is still a need for developing a framework that would provide the requisite features for designing a smoking cessations service.

As per studies, behavior change can be brought about through

- **Motivation** (Hughes, 2003): Motivating patients on a regular basis has proved to be effective in smoking cessation.
- **Distraction** (Rogers and Thistlethwaite, 1970, Rogers and Mewborn, 1976, Raiff et al., 2012): Though very few studies have been conducted, distraction strategies are considered to be effective in smoking cessation interventions. Some studies have used video games while others have tested the effect of physical exercises

(Shiffman, 1984) as distraction strategies for smoking cessation. These studies have yielded positive results though success rates are not very high.

- **Social support:** Studies have shown that social support has a positive effect in smoking cessation interventions (Wagner et al., 2004, Stewart et al., 2010, Mermelstein et al., 1986, May and West, 2000, Cohen et al., 1988) though the exact kind of support has not been studied extensively.

Considering these three factors - motivation, distraction and social support - the system design framework was developed based on the Persuasive System Design Model (Oinas-Kukkonen and Harjumaa, 2009a) while specific features (see Figure 8) were selected and added to make the framework more pertinent in the context of smoking cessation. The development of this framework has been elaborately described in the following section.

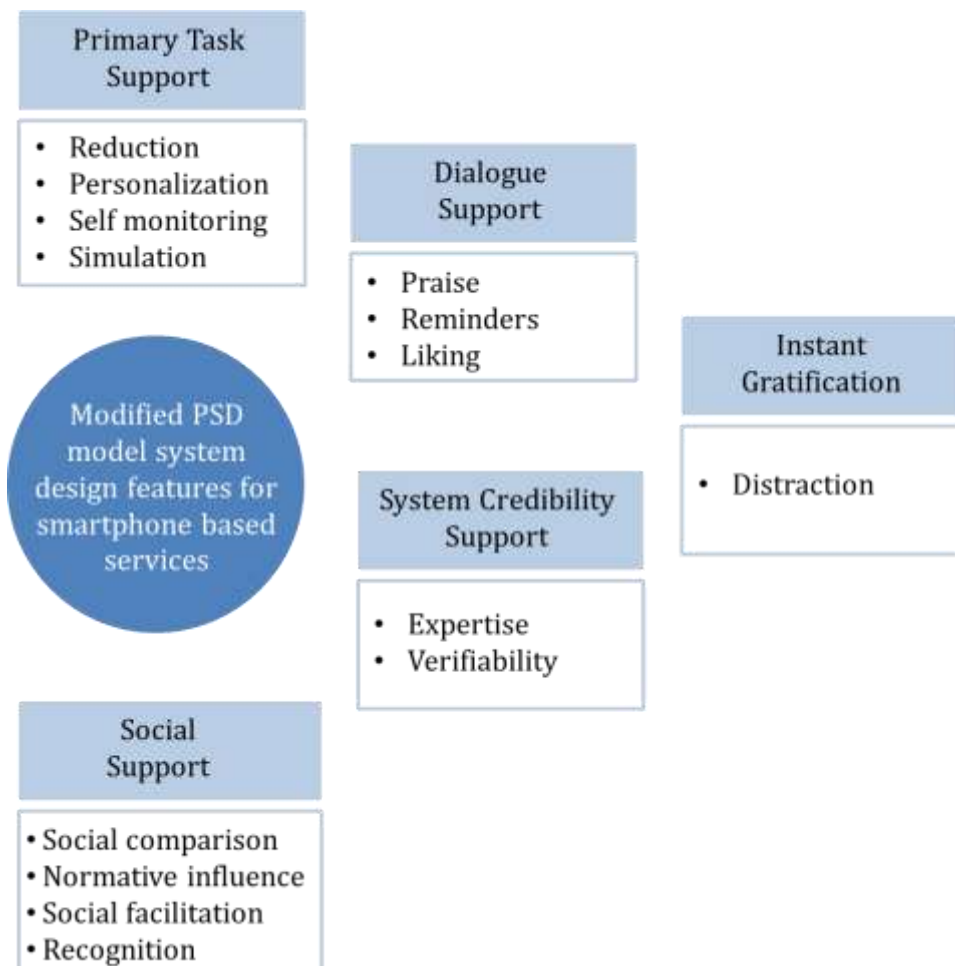


Figure 7: Modified PSD model System Design Features for Smartphone based smoking cessation service

In the PSD model, the author (Oinas-Kukkonen and Harjumaa, 2009b) has provided a set of persuasive strategies for the system design, namely Primary task support, Dialogue support, System credibility support and Social support. Each of the categories has been divided into 7 features each (see figure 9 below), description of which is as given below

A. Primary task support:

In this category, 4 features based on prior studies on web based health care healthcare interventions (Lehto and Oinas-Kukkonen, 2011) were selected for incorporation in the multi-intervention service as tabulated below.

Table 8: Primary task support features		
Sr. No.	Feature	Description
1	Reduction	<ul style="list-style-type: none"> ▪ System makes task simple for user. ▪ The multi-intervention service App provides easy to understand instructions and provides progress tracker (health and savings) to user. ▪ It also provides a simple way of updating one's profile
2	Personalization	<ul style="list-style-type: none"> ▪ System provides personalized content ▪ Motivational messages are personalized according to the user's name, age and profile details to create a greater impact in the communication
3	Self-Monitoring	<ul style="list-style-type: none"> ▪ Enables users to track their own progress. ▪ Our app will update user progress through easy to understand progress trackers
4	Simulation	<ul style="list-style-type: none"> ▪ Provides user information to figure the cause and effect ▪ Videos and messages will enable users to figure out the effects of smoking.

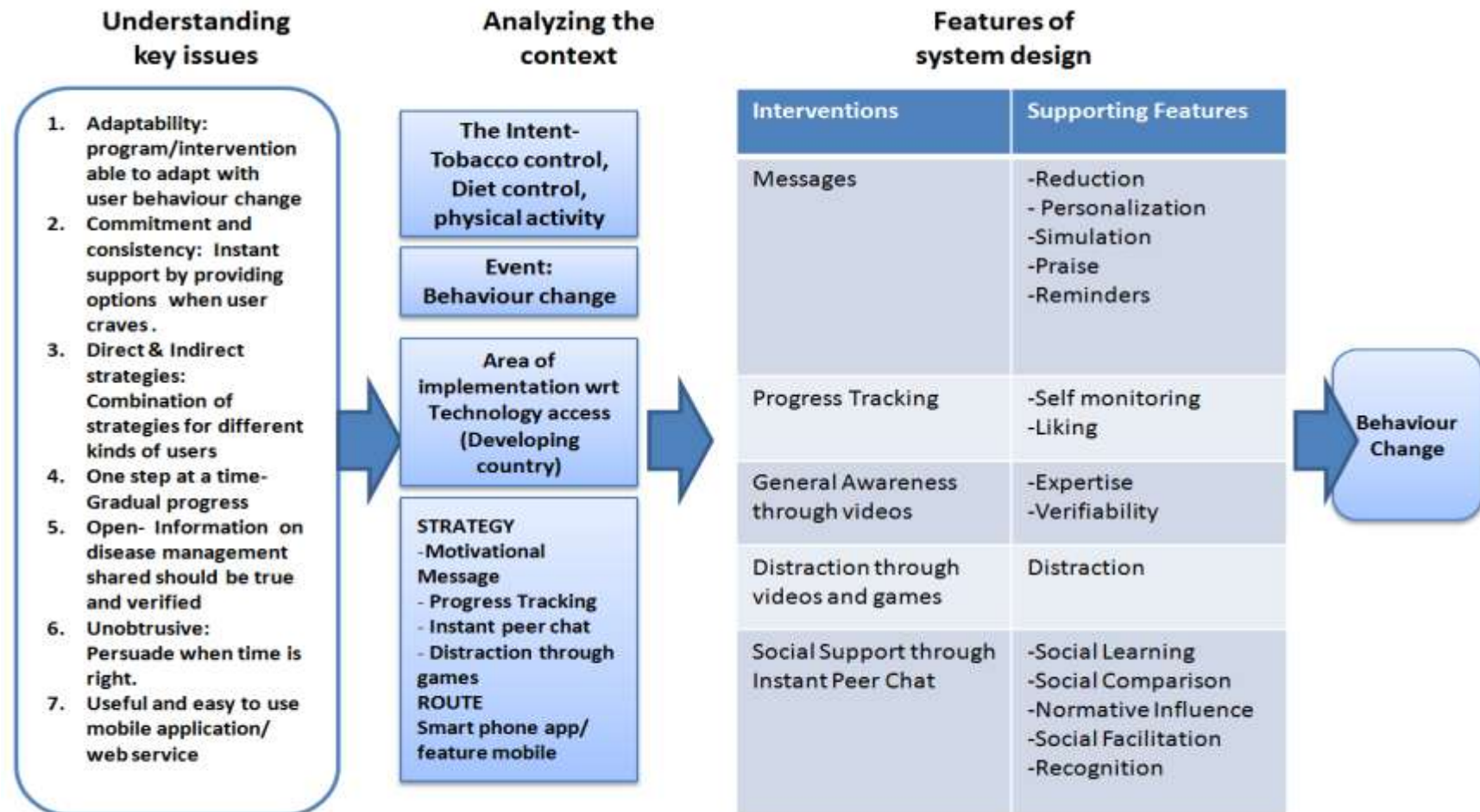
According to table 8, the primary task support features are reduction, personalization, self

monitoring and simulation. These features have been incorporated in the multi-intervention service framework (as shown in figure 9). The features have been mapped to interventions like reduction, personalization and simulation has been mapped to motivational messages and self-monitoring has been mapped to progress tracking intervention.

B. Dialogue Support: In this category, 3 features were selected for the framework as detailed below.

Table 9: Dialogue support features		
Sr. No.	Feature	Description
1	Praise	<ul style="list-style-type: none">Multi-intervention application praises individuals on accomplishing goals or reducing cigarette consumption
2	Reminder	<ul style="list-style-type: none">The app will remind user of their goals of quitting or following healthy lifestyle that will lead to quitting through push notifications and messages.
3	Liking	<ul style="list-style-type: none">The user interface of the application is simple and user friendly, making it visually attractive. It will motivate users to access the multi-intervention service and continue using it.

Figure 8: Multi-Intervention Service Framework: Modified Persuasive System model for Smoking Cessation



C. Instant gratification:

This new category was included specifically in the context of smoking cessation. Studies have shown that smokers feel the need of instant gratification when they are craving. They generally fulfil this need through relapsing or taking a puff. The framework therefore has a strong feature in this category to counter the user's needs by providing necessary distraction.

Table 10: Instant gratification features

Sr. No.	Feature	Description
1	Distraction	<ul style="list-style-type: none"> Studies on distraction for smoking cessation has given positive results in the past (Raiff et al., 2012). Video games or talking to peer have been used as distraction strategies for various interventions. The multi intervention application will have games and instant peer chat support as distraction strategies for smokers when they are craving

D. System Credibility Support:

Two features were selected for this category focusing on creating customer experience and increasing trustworthiness of the service

Table 11: System Credibility Support features

Sr. No.	Feature	Description
1	Expertise	<ul style="list-style-type: none"> The app was updated regularly for users to have a good experience throughout. New features like new games, upgraded user interface and technology support options were incorporated for better user experience.
2	Verifiability	<ul style="list-style-type: none"> The application will provide links to smoking cessation related videos that can be verified by users. This will help increase trustworthiness of the service.

E. Social Support:

This is the most important category in the service framework. 6 features were selected for this category. These are described below.

Table 12: Social Support features

Sr. No.	Feature	Description
1	Social Learning	<ul style="list-style-type: none"> Users are motivated to change behavior by noticing others performing the same behavior. Users can understand factors that have motivated other users to change habits, thereby inculcating the same
2	Social comparison	<ul style="list-style-type: none"> Real time chat service in the app will enable users to share their progress with others Progress of other users is shared with individuals to motivate them to quit smoking. Users will be motivated to set goals and achieve them
4	Normative influence	<ul style="list-style-type: none"> This is brought about by getting together other users. Peer influence motivates users to be committed to their target. The real time chat service allows user to do so.
5	Social facilitation	<ul style="list-style-type: none"> Progress trackers, group tracking will help users to discern progress of other users.
6	Recognition	<ul style="list-style-type: none"> Hall of fame aspect of the application will recognize the users who have been able to achieve a target like quit smoking. This will motivate individuals to perform better.

4.2 Development of Smartphone Application (app) with multi-intervention service

The multi-intervention service brings together tested interventions in smoking cessation and provides a framework for developing smoking cessation services that adhere to PSD model by Kukkonen. The service provides motivational messages, games and informational video links for distraction, real time instant peer support through chat

Persuasive system based mHealth design for multi-intervention service for smoking cessation: Koel Ghorai

facilities. It adheres to 25 of the 28 persuasive features suggested by Kukkonen in his PSD model. The system thus has five major service components as shown in Figure 10 below.



Figure 9: Multi-Intervention Service design for Smoking Cessation

The Persuasive system model features have been further mapped to the various interventions as shown in Table 13 below

Table 13: Service Interventions and supporting features

Sr. No.	Interventions	Supporting Features
1	Messages	<ul style="list-style-type: none"> - Reduction - Personalization - Simulation - Praise - Reminders
2	Progress Tracking	<ul style="list-style-type: none"> - Self- monitoring - Liking
3	General Awareness through videos	<ul style="list-style-type: none"> - Expertise - Verifiability
4	Distraction through videos and games	<ul style="list-style-type: none"> - Distraction
5	Social Support through Instant Peer Chat	<ul style="list-style-type: none"> - Social Learning - Social Comparison - Normative Influence - Social Facilitation

Sr. No.	Interventions	Supporting Features
		- Recognition

The mobile application has the multi-intervention service at its core. The multiple interventions include motivational messages, distractions, progress tracking, real time peer support. These interventions are easily accessible through customized messages, games, awareness videos, progress tracking features and well as instant chat support from other smokers available on the application.

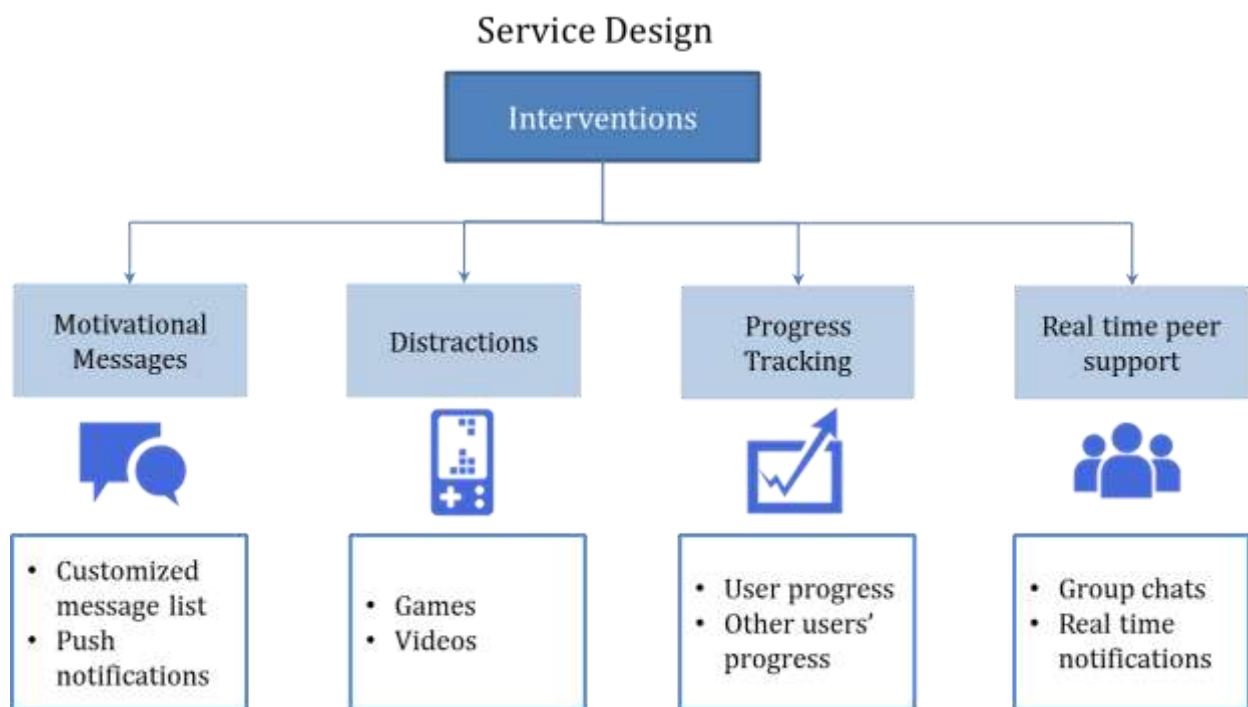


Figure 10: Service Design of the smoking cessation service

4.2.1 Multi-intervention App features

The application, developed from the multi-intervention framework, revolves around four interventions. These interventions involve social support through social chat groups,

progress tracking, distraction through videos and games and motivation through messages. The various features of the mobile application are described below

A. Social chat groups: The users are provided real-time chat support where they can chat with other members who are also in the quitting phase (see Figure 12 and Figure 13 below). In the system default groups are created for different purposes.

Chat groups: As soon as a user registers, he/she is automatically added to the relevant support group(s). For example, if a user has already quit, he / she is added to a particular set of groups that are most relevant to him / her.

Creating new user groups: User can also create new groups and invite others to join.

Real-time notifications: Notifications are sent when a new message is received. User can notify a group when they are craving or have relapsed to get help in real-time from their peers. Some of these factors have not yet been tested for service design.

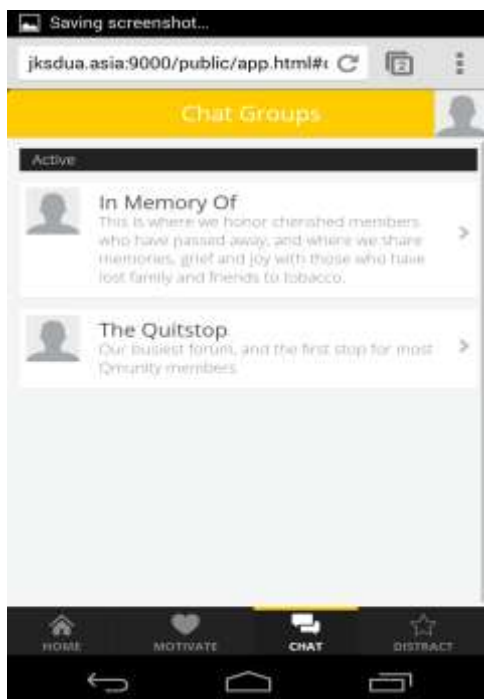


Figure 11: Social chat groups for instant support

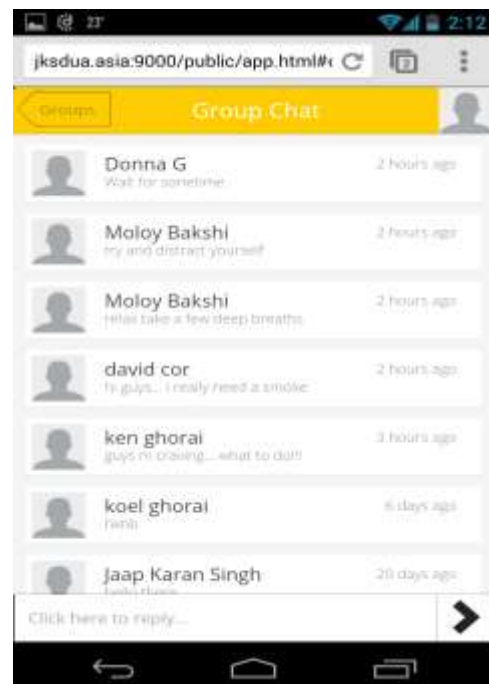


Figure 12: Instant chat messages from peers

B. Progress tracking – A user can view current progress in line with progress of other users in the system. A comparative analysis is provided to users. The progress can be shared with peers for receiving recognition or support in case of cigarette reduction or relapse. A screen shot of progress tracker on the app is given in Figure 14.

C. Distractions - The Smartphone application has embedded games and videos content sorted by "likes" and "views" that uses collaborative filtering (see Figure 15). Distractions provided might not be relevant to smoking but the purpose is to provide instant distraction to the user by leading him to games and inspirational videos.

D. Motivational messages- A pre-compiled list of messages is pushed at regular intervals as push notifications to the user's phone. These messages (see Figure 16 below) are targeted to participants for providing motivation for quitting smoking or preventing relapse. Messages are personalized using the participant's user name or display name and may also include his progress or current cigarette consumption rate.

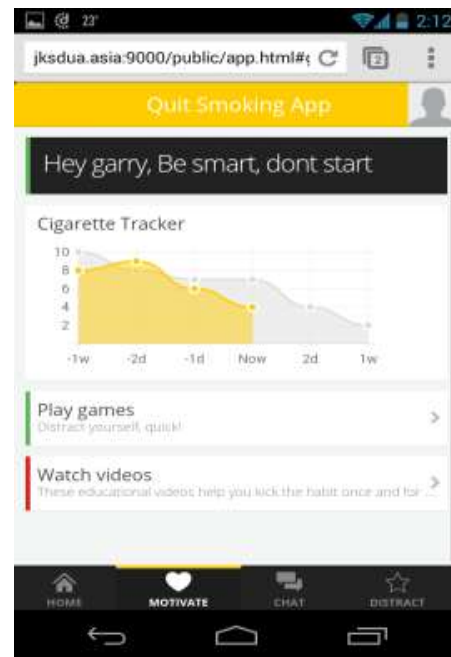


Figure 13: Progress tracking through cigarette tracker

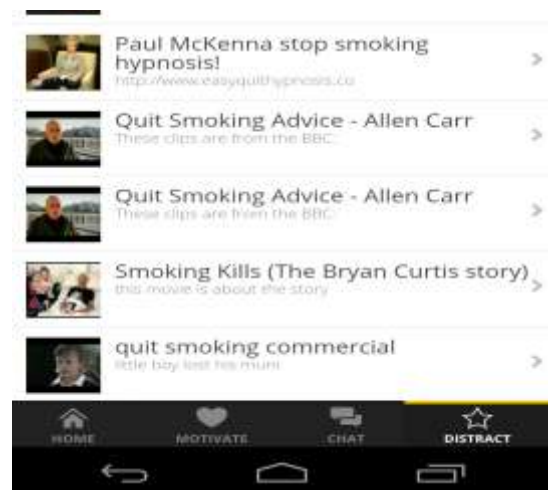


Figure 14: Games and videos for distractions

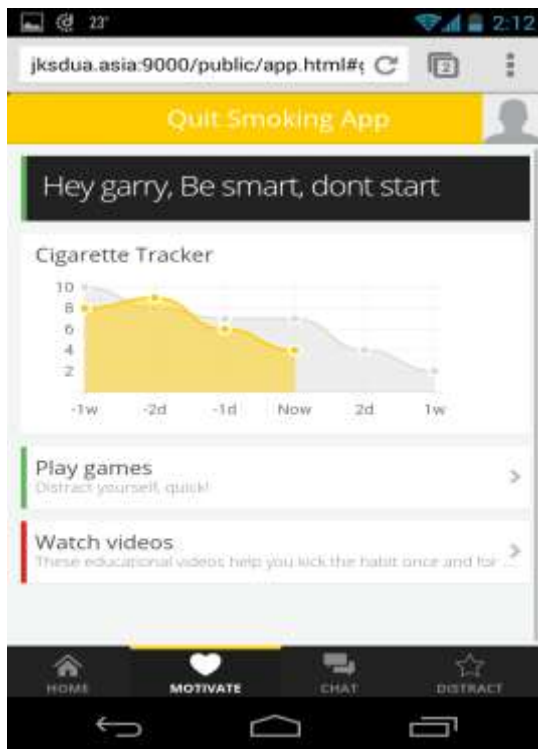


Figure 15: Motivational Messages

4.2.2 System workflow:

The system workflow can be described in the following steps as per Figure 17.

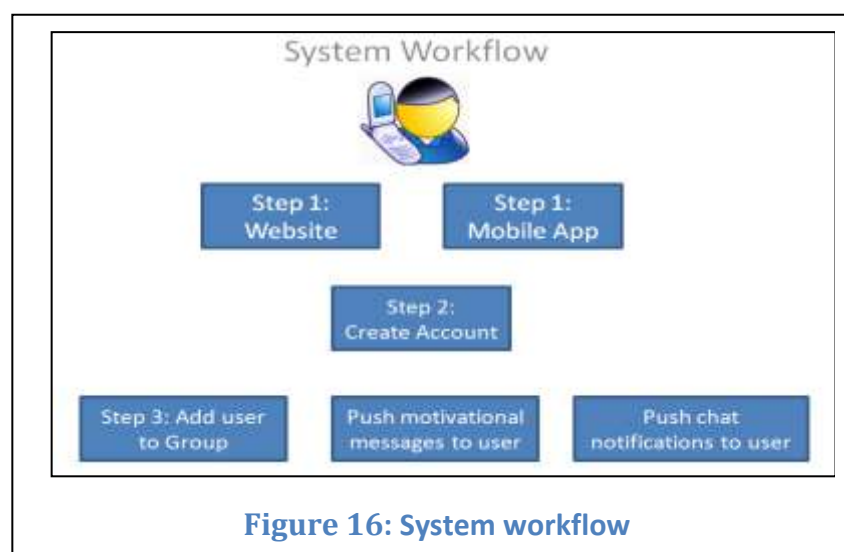


Figure 16: System workflow

- Step 1: User visits our website or goes to the app store and downloads the app.
- Step 2: User creates an account

- Step 3: System adds user to groups based on their profile
- Step 4: System starts pushing messages to them
- Step 5: System starts pushing chat notifications to them

4.2.3 System architecture:

The system consists of a simple architecture. Figure 18 depicts the architecture components which are also discussed in detail below.

- **Database:** The database stores three major categories of information
 - Message template with basic tagging like gender and age - Pre compiled messages are stored and these are customized for each user, using their profile information like name, age etc.
 - Chat content (sent and received) - Content of the chat groups is stored for future studies and reference.
 - User profiles - User profile consists of name, age, gender, contact details, images, personal quotes, health information if any.

System Logic: Representational State Transfer (RESTful) API has been advocated for pushing user content and messages. In recent times REST has been emerging as one of the most predominant web API design models. The reasons for selecting REST herein are twofold – firstly, the client and server are decoupled for mobile apps ; secondly, it has properties like simplicity, infrastructure friendliness, cacheability, scalability, statelessness or statefulness and efficiency, all of which are highly relevant and necessary for the given situation. In addition to the REST API, Real time chat works on web sockets which provide huge scalability of the real time web.

- **User Interface:** Mobile phone app has been tested on 3" - 7" screens, Android 2.3+, iOS 4+, Blackberry 10+
- **Data Collection:** The data collected through pressing of button or through surveys for tracking progress of user was analysed through Google analytics.

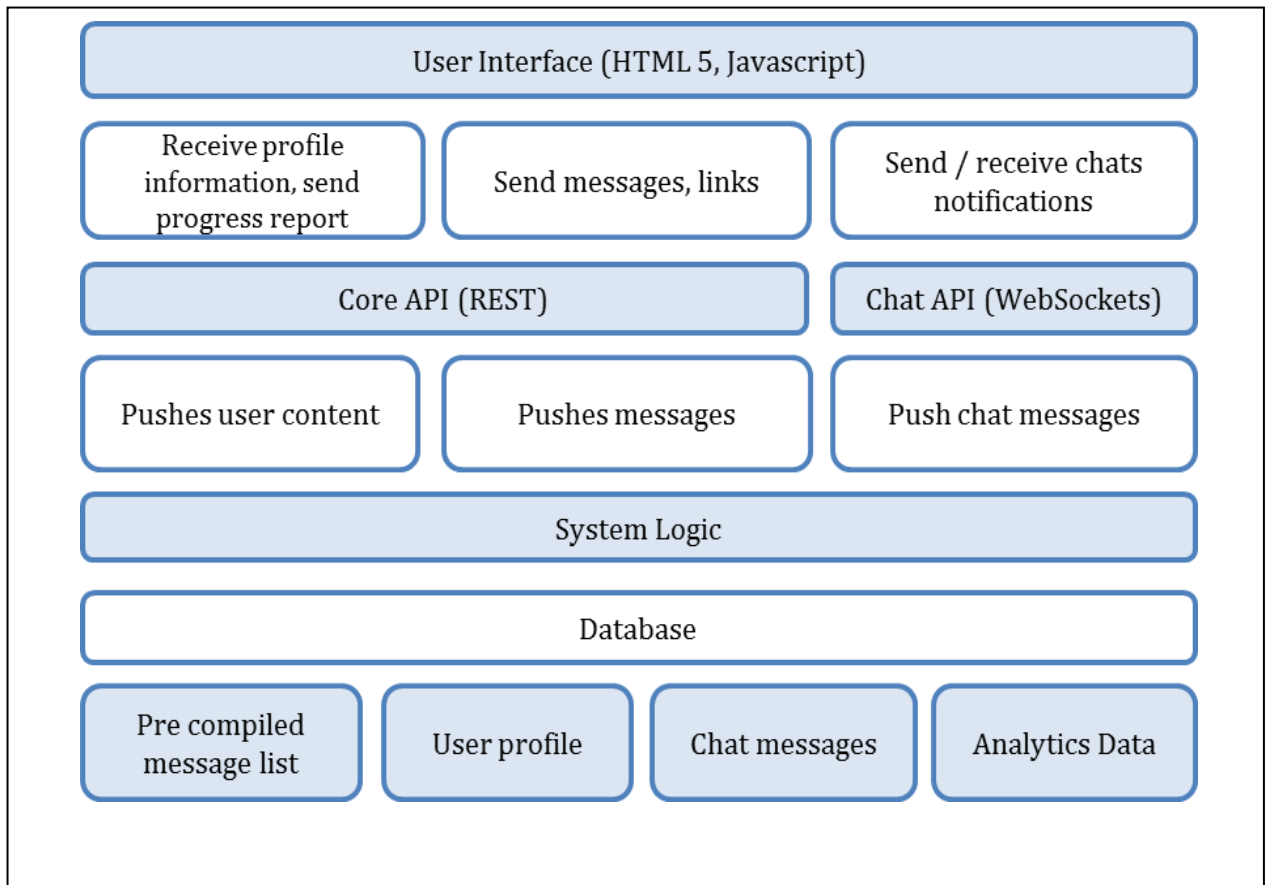


Figure 17: System architecture

4.3 Chapter Summary

This chapter brings forth the research endeavour formulated through the studying of the extant literature, identifying the opportunities that have significant impact on research as well as practice and developing a framework that can be used to fulfil the existing gaps. This chapter focuses on development of the multi-intervention framework using extant literature and research studies on healthcare as well as information systems. Having developed the framework, the study goes on to develop a smartphone based application for smoking cessation. The second part of this chapter focuses on the various features of the application and describes how the framework is related to the various interventions of the application. The next chapter will discuss these evaluation of the user acceptance of the multi-intervention service through evaluation of the mobile application.

Chapter 5: Evaluation of User Acceptance of Multi intervention Service (Research Model, Hypothesis and Survey Design)

This chapter deals with the second research question that is exploring the factors that affect the user acceptance of a Smartphone based multi intervention service for smoking cessation. Success of a new service or technology depends heavily on the user acceptance, although it is difficult to predict how a new service or technology will be adopted by the users. It is however important for service designers and developers to comprehend the users' expectations for developing an application to cater to their needs. Several models have been established for determining user acceptance of a service or technology. This chapter presents some of these widely used models for exploring and predicting user acceptance along with the model that has been used for evaluating the multi-intervention service for smoking cessation. Finally, this chapter also presents the research model, hypotheses as well as survey design for the user acceptance study.

5.1 User Acceptance Models

In Information Systems, there are various models for assessing the user acceptance of a service or technology. According to Venkatesh (Venkatesh et al., 2003), there is a basic conceptual framework underlying most user acceptance models. This framework (see Figure 19 below) includes three main components, namely:

- Individual reactions to using information technology
- Intention to use information technology
- Actual use of information technology

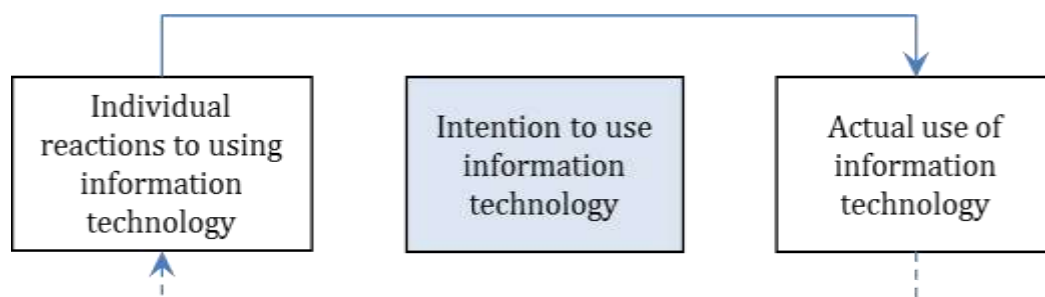


Figure 18: Basic conceptual framework underlying User Acceptance models (Venkatesh et al., 2003)

5.1.1 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980) is one of the most influential theories on human behavior prediction. The theory has been widely used in the field of new technology adoption (Venkatesh et al., 2003). TRA posits that people's behavior is mainly determined by their intention or motivation and they will engage in a particular behavior when they evaluate it positively (attitude) and believe that significant others want them to engage in the behavior (subjective norms). The three main determinants (see Figure 20 below) of the theory, therefore are:

- **Behavior Intention:** the degree to which a person intends to engage in a behavior
- **Attitude:** the combination of a person's belief regarding the consequences of a behavior and his evaluation of the consequences
- **Subjective Norms:** the combination of influence of individuals or groups on the person's behavior intentions to comply with their expectations

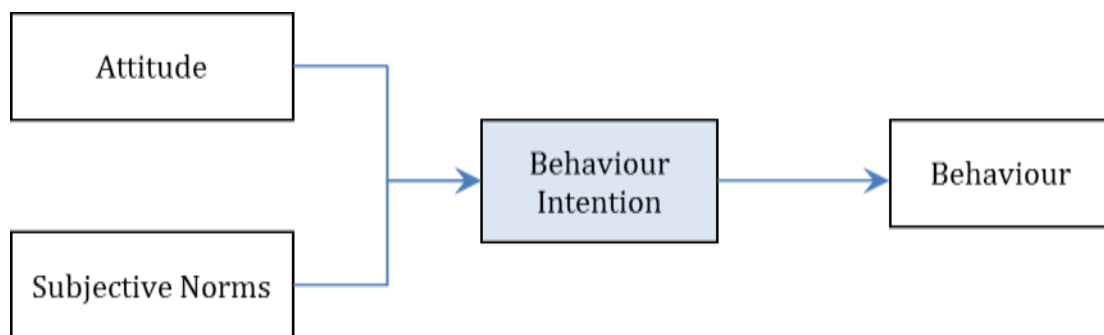


Figure 19: Framework of Theory of Reasoned Action (Ajzen and Fishbein, 1980)

5.1.2 Theory of Planned behavior (TPB)

The Theory of Planned behavior (Ajzen, 1991) builds upon the theory of Reasoned Action and posits that an additional construct - Perceived behavior Control (PBC) - has direct influence on the Intention to use and Use behavior of a person. Perceived behavior control is the degree of perception of ease or difficulty of a person to perform a behavior. It also reflects a person's past behavior and anticipated obstructions. The author posits

that the more favourable and higher the Attitude and Subjective norm as well as PBC are respectively, stronger will be the intention to perform a behavior. The framework of TPB is given in Figure 21.

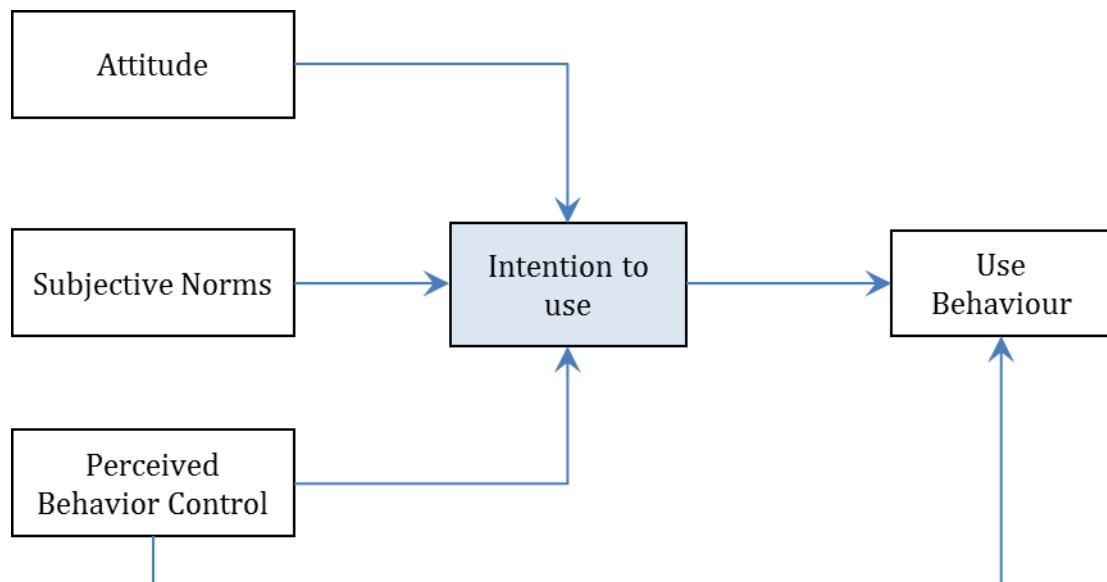


Figure 20: Framework of Theory of Planned behavior (Ajzen, 1991)

5.1.3 Innovation Diffusion Theory (IDT)

Innovation Diffusion Theory (IDT) (Rogers, 1995) is one of the most widely used theories on technology acceptance. According to Rogers, diffusion is “the process by which an innovation is communicated through certain channels over time, and are transferred and adopted among the members of a social system”. The main constructs of the theory are

- The innovation
- Communication channels
- Time
- Social system

The central theme of this theory is to reduce uncertainties regarding acceptance of an innovation. According to IDT, an individual passes through five stages before accepting an innovation. These are described below

1. Knowledge: Gaining knowledge of the new innovation and understanding its features and functions

2. Persuasion: Forming an positive or negative attitude about the innovation based on the knowledge and understanding
3. Decision: Choosing whether to adopt or reject the innovation
4. Implementation: Following the decision phase, implementing the innovation if the individual chooses to adopt it
5. Confirmation: Determining the benefits of the innovation and also learn and improve the implementation process

5.1.4 Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) (Davis, 1989) is a widely used model in the field of Information Systems. This model builds on the Theory of Reasoned Action and explains the actual use of a system based on two specific variables:

- Perceived Ease of Use which is defined as “the degree to which a person believes that using a particular system will be free of effort”
- Perceived Usefulness is defined as “the degree to which a person believes that using a particular system will enhance his or her job performance”

These two variables have significant influence on decisions to use technology. The model is widely used for studying user acceptance of a new technology. The framework of the model is given in Figure 22.

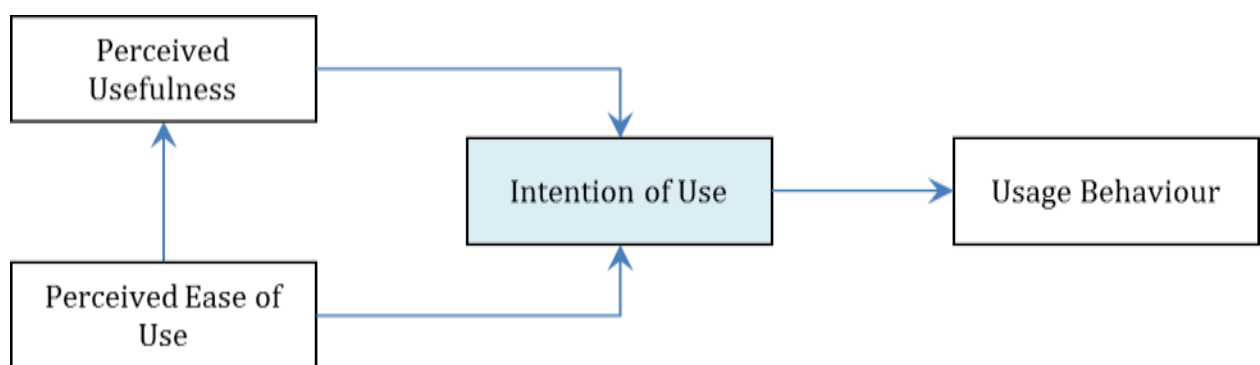


Figure 21: Framework of Technology Acceptance Model (Davis, 1989)

5.1.5 Extended Technology Acceptance Model (TAM2)

The Technology Acceptance Model was expanded by Venkatesh and Davis (Venkatesh

and Davis, 2000) into the Extended Technology Acceptance Model (TAM2). This modified model tried to explore the use of the factor "Subjective Norm" (introduced in the Theory of Reasoned Action) on the other two factors "Perceived Usefulness" and "Perceived Ease of Use". The authors tried to explain "Perceived Usefulness" and "Perceived ease of use" in terms of social influence (subjective norms, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, perceived ease of use). Figure 23 portrays the framework of TAM2.

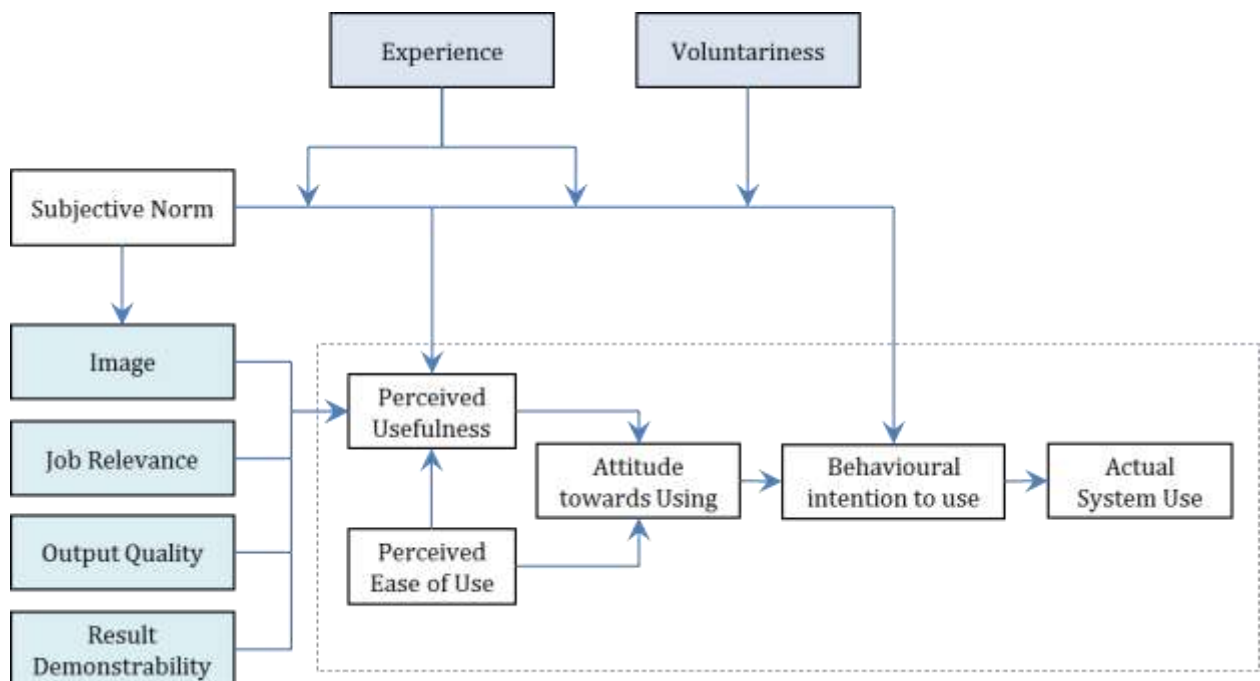


Figure 22: Framework of Extended Technology Acceptance Model (TAM2) (Venkatesh and Davis, 2000)

5.1.6 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology Model (Venkatesh et al., 2003), one of the most prominent technology acceptance models, was formulated by Venkatesh, Morris and Davis after reviewing and comparing eight models of user acceptance and their extensions, namely: Theory of Reasoned Action (Ajzen and Fishbein, 1980), Theory of Planned behavior (Ajzen, 1985), Technology Acceptance Model (Davis, 1989), Extension of the Technology Acceptance Model (TAM2), Motivational Model of Computer Usage (MM) (Igarria et al., 1996), Model of PC Utilization (Thompson et al., 1991), Diffusion of

Innovation Model(Rogers, 2003) and Social Cognitive Theory (SCT)(Bandura, 1986). This model integrates seven constructs that appeared to be significant determinants of usage or behavior intention in one or more of the eight models. These constructs include:

- **Performance Expectancy:** the degree to which an individual believes that using the system will help him or her to attain gains in job performance
- **Effort Expectancy:** the degree of ease associated with the use of a system
- **Social Influence:** the degree to which an individual perceives that important others believe he or she should use the new system
- **Facilitating Conditions:** the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the new technology
- **Attitude:** Individual's positive or negative feeling about performing the target behavior (e.g., using the smartphone application for quitting smoking)
-
- **Self-efficacy:** the degree to which an individual beliefs that he or she has the ability to perform a specific task using the new technology
- **Anxiety:** The degree of an individual's apprehension, or even fear, when she/he is faced with the possibility of using the new technology

Four of these constructs namely 'Performance Expectancy', 'Effort Expectancy', 'Social Influence', 'Facilitating Conditions' have been found to be direct determinants of user acceptance and user behavior (Venkatesh et al., 2003). The other three constructs have not yet been recognized as direct determinants of user acceptance. Figure 24 presents the framework of the UTAUT model.

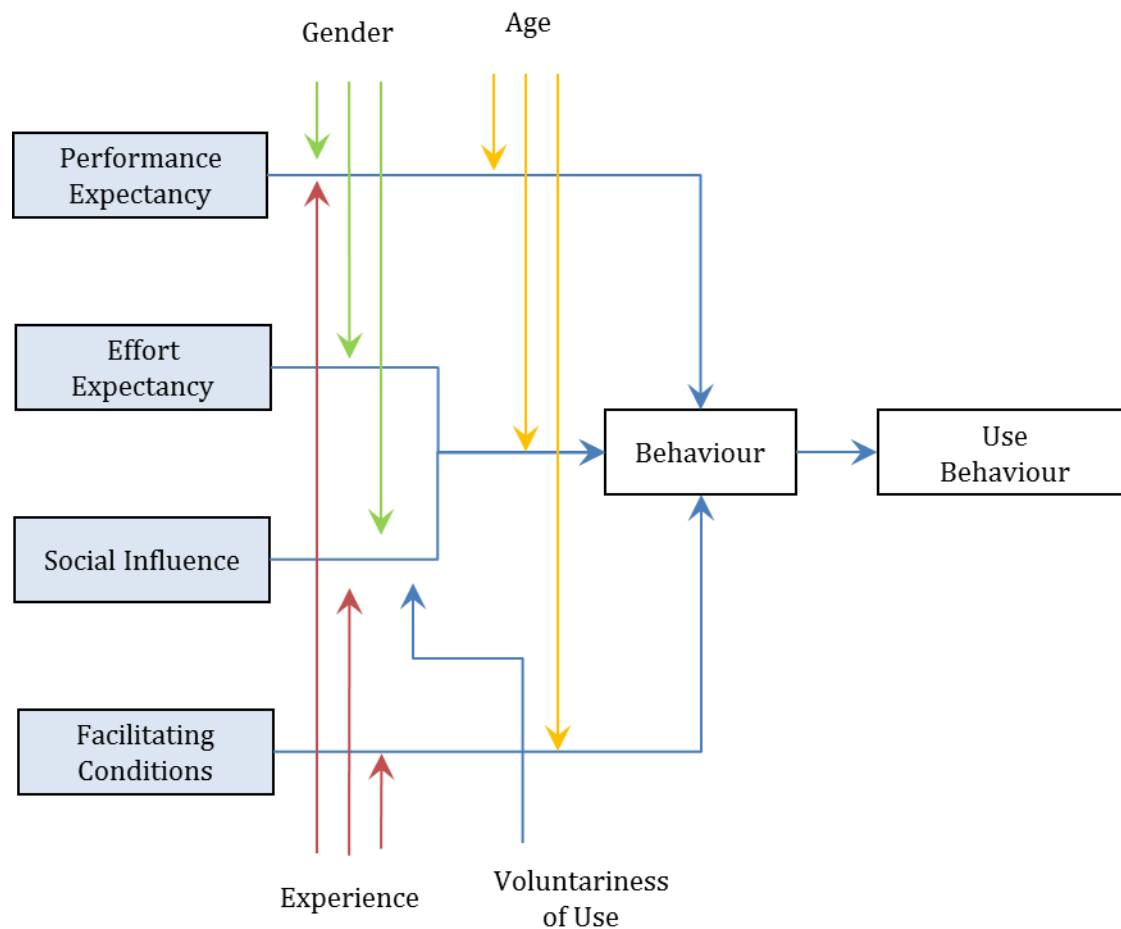


Figure 23: UTAUT framework by (Venkatesh et al., 2003)

Table 14 depicts the determinants, its sub determinants and the theoretical source of the same.

Table 14: Four major determinants of UTAUT Model

Sr. No.	UTAUT Determinant	Sub-determinant	Source of Integrated model
1	Performance Expectancy	Perceived Usefulness	Technology acceptance model (Davis, 1989), extended Technology acceptance model (Venkatesh and Davis, 2000), Theory of Planned behavior (Ajzen, 1991)
		Extrinsic motivation	Motivational Model of Computer Usage (Igbaria et al., 1996)
		Job fit	Model of PC Utilization (Thompson et al.,

Sr. No.	UTAUT Determinant	Sub-determinant	Source of Integrated model
			1991)
		Relative advantage	Diffusion of Innovation Model (Rogers, 2003)
		Outcome expectations	Social Cognitive Theory (Bandura, 1986)
2	Effort Expectancy	Perceived ease of use	Technology acceptance model and extended Technology acceptance model (Davis, 1989) (Venkatesh and Davis, 2000)
		Complexity	Model of PC Utilization (Thompson et al., 1991)
		Ease of use	Diffusion of Innovation Model (Rogers, 2003)
3	Social Influence	Subjective norm	Theory of Reasoned Action (Ajzen and Fishbein, 1980), Extension of the Technology Acceptance Model (Venkatesh and Davis, 2000), Theory of Planned behavior (Ajzen, 1991)
		Social factors	Model of PC Utilization (Thompson et al., 1991)
		Image	Diffusion of Innovation Model (Rogers, 2003)
4	Facilitating Conditions	Perceived behavior control	Theory of Planned behavior (Ajzen, 1991), Technology Acceptance Model (Davis, 1989)
		Facilitating conditions	Model of PC Utilization (Thompson et al., 1991)
		Compatibility	Diffusion of Innovation Model (Rogers, 2003)

The UTAUT model was found to outperform the eight individual models when tested empirically (Venkatesh et al., 2003). The model proved to be a very good tool for testing user acceptance of new technology. Thus, the ***UTAUT model was selected*** for evaluating the user acceptance of the multi-intervention service for smoking cessation.

5.2 Research Model

UTAUT model has been widely used for user acceptance studies in the context of using information system for behavior change as well as technology adoption (Karahanna et al., 1999). Studies have shown that behavior intention will have a positive and direct influence on user behavior (Venkatesh et al., 2003) and that adoption of a technology is directly influenced by user behavior (Ajzen, 1991). Prior studies have well established the relation between behavior intention, use of technology and the actual usage (Taylor and Todd, 1995, Venkatesh et al., 2003). In this study, behavior intention has been used to measure the actual usage of the Smartphone based multi intervention service and the use behavior. The research model is given in figure 5.7.

As mentioned at the end of the previous section, the Unified Theory of Acceptance and Use of Technology Model (Venkatesh et al., 2003) was selected for evaluating, finding key factors and exploring their implication on designing the multi-intervention service for smoking cessation. UTAUT model proposes four key constructs for determining the behavior intention of an individual and these constructs along with the hypotheses will be explored in depth in this section. Figure 25 presents the research model for this study. The four constructs of the research model are as discussed below.

Figure 24: Adjusted UTAUT model for multi-intervention service for smoking cessation

5.2.1 Components of research model

Performance Expectancy

Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. In the context of smoking cessation, it is the degree to which an individual believes that he or she will be able to quit smoking using the multi-intervention service. A study by Naenna et al. (Naenna and Phichitchaisopa, 2013) found that performance expectancy affected behavior intention in adoption of healthcare information technology. In the case of a multi-intervention service, the hypothesized relation for direct effect is:

H1: Performance expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation

Effort Expectancy

Effort expectancy is the degree of ease associated with the use of a system (Venkatesh et al., 2003). According to four user acceptance models (Davis, 1989, Thompson et al., 1991), (Venkatesh and Davis, 2000, Ajzen, 1991), there are three sub determinants of Effort Expectancy, namely, Perceived Ease of Use, Complexity and Ease of use. Effort expectancy is considered to be directly associated with Expected Ease of use. In a study by Pai (Pai and Huang, 2011), it was found that Effort Expectancy has a positive influence on intention to use healthcare information systems. In case of multi-intervention service, if the service is easy for users to use, then they will find it less tedious to use. It will therefore be more likely to be accepted by users. Thus the second hypothesis of the study is:

H2: Effort expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation

Social Influence

Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new technology or service. This means that individuals would be more interested in a service or technology if the people who are important to them think it would help them. For example, if a person is suggested to use a

healthcare application by a friend, he will be more willing to try the application based on the suggestion. This paves way for the third hypothesis which states that:

H3: Social influence will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation

Facilitating Conditions

"Facilitating Conditions" is the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the new technology. "Perceived behavior control", 'facilitating conditions', and 'compatibility' are the three sub-determinants of "Facilitating Conditions". All these constructs measure the perception of user regarding the removal of barriers of use. For example, a person using a new technology or service will feel more comfortable if he believes that there is technical or organizational support. Thus, the fourth hypothesis is:

H4: Facilitating conditions will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation

Use behavior

The original UTAUT model posits that behavior Intention will have a significant influence on Use behavior which is the degree of technology acceptance or usage by the user. Thus the fifth hypothesis of the study is:

H5: Behavior Intention will have a positive influence on Use behavior.

Overview of the research model constructs

The constructs discussed above are expected to have influence on the behavior intention of user for using the multi-intervention service. "Use experience" is a specific construct that has been used in the context of a multi-intervention service. Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions have been used as the independent variables. Behavior Intention and Use behavior, also referred to as Actual Usage, has been considered as the dependent variables in the model. The determinants are shown in figure 5.7 above.

5.2.2 Summary of Research Hypothesis

The study proposed five hypotheses to investigate the association between four independent variables namely performance expectancy, effort expectancy, social influence, facilitating conditions and the dependent variables behavior intention and Use behavior. The hypotheses are summarized in Table 15.2 below.

Table 15: Research Hypotheses

Hypothesis	Study assumption
H1	Performance expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation
H2	Effort expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation
H3	Social influence will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation
H4	Facilitating conditions will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation
H5	Behavior Intention will have a positive influence on Use behavior.

5.3 Survey Design

The evaluation of the multi-intervention service revolves around an explorative research through a survey based on the UTAUT framework, involving the following steps:

- Questions and statements in the survey are related to smoking experience and smoking cessation using a smartphone based multi-intervention service. The survey has been divided into four sections. The first section confirms the fitment of participants to the selection criteria.
- This is followed by the introduction of the smartphone application through a link to an online video description:

(https://www.youtube.com/watch?v=1a_KyQSvNcg&feature=youtu.be).

The smokers are then asked to try out the application on their smartphones by registering on the application "QuitPuff" <http://quitpuff.com/public/app.html>. This is the smartphone based smoking cessation service.

- The second section of the survey examines the constructs used in the research model. The questions in this section aim to gather answers for analyzing the theoretical model and the influence of the constructs and moderators on the acceptance of the service.
- The third section includes questions on demography, smoking pattern as well as experience with smartphones. Most of the questions on theoretical model use a 5-point Likert scale for collecting the answers which range from "1" ("Totally Disagree") to "5" ("Totally Agree"). Option 3 allows participants to select a neutral answer.
- The final questionnaire has 50 questions, out of which 30 questions are on theoretical constructs. Survey questionnaire is given under appendix B.

5.4 Data collection:

An online survey was conducted for this study. The survey was built using qualtrics (www.qualtrics.com). The questionnaire is based on the pre-tested questions presented in the original UTAUT model. Questionnaires were distributed to a database of online participants through "Mechanical turk" which is an online tool for organizing web based surveys.

Participants were recruited through online social network (facebook quit smoking pages), market research customer database like mechanical Turk. The respondents needed to fulfil the following criteria for participating in the survey

1. Are current smokers
2. Are 18 years and above and can provide informed consent
3. Are a Smartphone user
4. Want to quit smoking

225 smokers completed the survey. The questionnaire had a consent form at the beginning of the survey. The form explained the purpose of the study and contact details of the study team. Participants could go ahead with the survey only if they consented to fulfilling the criteria by clicking on the accept button on the online consent form.

The reason behind selecting smokers for this study is because they can understand the multi-intervention service better and this will help in acquiring better insights into the needs and perceptions of the potential users of the service.

5.5 Data Analysis: Results and Discussion

This section discusses in details the procedure followed for the analysis of the data collected through the web based survey using the instrument described in the previous chapter and also discusses the findings.

Statistical Package for Social Sciences (SPSS) version 21 was used to for descriptive statistics of the variables. PLS was the statistical tool used for measuring the research model. Structural Equation Modelling (SEM) technique was used for evaluating the relationships in the UTAUT model and also for testing the hypotheses among the variables. The reason for selecting Structural Equation Modelling (SEM) is because this statistical methodology allows a hypothesis testing (confirmatory) approach to structural analysis of data that represents a phenomenon(Kline, 2011).

In order to understand the smokers' intention/ behavior, and then use Smartphone based multi-intervention service for smoking cessation, this study used a questionnaire method for examining the framework of this study. The statements used in the questionnaire were based on pretested questionnaires by (Venkatesh et al., 2003) in his paper on UTAUT. The variables were measured with a 5-point Likert scale as compared to the 7-point scale used in the original UTAUT since a 5-point scale proved to be more robust for this survey. According to the scale, 1 equalled the negative end (strongly disagree) and 5 equalled the positive end (strongly agree). The questionnaire was divided into ten sections, including the questions for external variables, behavior intention, user behavior as well as demography.

5.5.1 Respondent Characteristics

The online survey was carried out through Qualtrics survey software and respondents were contacted through Mechanical Turk, an online survey platform with respondent database. Out of the 240 surveys that were collected, 225 were usable completed surveys for analysis. A snapshot of the demographic information of the respondents has been

given in table 5.3. Most of the respondents belonged to the age categories 18-25, 26 - 34 and 35 - 54. Only 6 of the participants were aged 55 and above. Around 70% of the respondents were male and 30% female.

Table 16: Demographic information of respondents

Variable	Scale	Frequency	Percent	Cumulative Percent
Age	18-25	58	25.8	25.8
	26-34	116	51.6	77.3
	35-54	45	20.0	97.3
	55-64	4	1.8	99.1
	65 or over	2	0.9	100.0
	Total	225	100.0	
Gender	Male	158	70.2	70.2
	Female	67	29.8	100.0
	Total	225	100.0	
Education	Less than high school	2	0.9	0.9
	High school/GED	14	6.2	7.1
	Some college	37	16.4	23.6
	2 year college degree	27	12.0	35.6
	4 year college degree	84	37.3	72.9
	Masters degree	59	26.2	99.1
	Doctoral Degree	1	0.4	99.6
	Professional Degree (JD,MD)	1	0.4	100.0
	Total	225	100.0	
Earlier quit Attempts	Yes	180	80.0	80.0
	No	45	20.0	100.0
	Total	225	100.0	
Years of smartphone use	Less than 6 months	5	2.2	2.2
	6 to 12 months	28	12.4	14.7
	1 to 3 years	144	64.0	78.7
	4 years or more	48	21.3	100.0
	Total	225	100.0	
Use of mobile internet	Yes	222	98.7	98.7
	No	3	1.3	100.0
	Total	225	100.0	
Mobile for smoking cessation	Yes	197	87.6	87.6
	No	28	12.4	100.0
	Total	225	100.0	

In the survey, respondents were also asked about their personal experiences regarding

their smoking behavior and smartphone usage. From the survey, it was found that:

- 80% of the smokers had attempted to quit earlier
- Almost 88% of smokers were willing to use mobile phones for smoking cessation interventions
- Questions regarding smartphone usage revealed that almost 99% of the respondents used internet on their mobile phones
- Majority of the respondents, (~64%) had been using a smartphone for more than 1 year

All respondents in this study were selected because they were active smokers, had a smartphone, wanted to quit smoking and were aged 18 years or above.

5.5.2 Reliability Verification:

Reliability verification was conducted to check the degree to which the instrument is free of random error. This helped in checking the consistency and stability of the measurement. The individual item loading is given in table 5.4.

All items except two sub-constructs of Facilitating conditions had item loading less than 0.40. Loading for rest of the items range from 0.720 to 0.959. Reliability analysis was conducted through exploring the Cronbach's alpha of the five factors, which exceeded the cut-off value of 0.70. The Cronbach's Alpha should be greater than 0.70 for demonstrating construct reliability (Nunnally, 2010). Thus two items (FC1 and FC4) were removed from the instrument for further analysis. According to the above-mentioned establishment of UTAUT-based framework, "performance expectancy", "effort expectancy", "social influence", and "facilitating conditions" are the independent variables or exogenous variables, whereas "behavior intention" and "use behavior" are the dependent variables or endogenous variables, and the "behavior intention" is also the intermediary variable.

Table 17: Individual Loadings, composite reliabilities (CR) and AVE

Construct	Individual Items	Item Loading	Cronbach Alpha	Construct Composite Reliability CR	Construct Average Variance Extracted AVE
Performance Expectancy	PE1	0.846	0.889	0.923	0.751
	PE2	0.860			
	PE3	0.835			
	PE4	0.922			
Effort Expectancy	EE1	0.768	0.818	0.879	0.647
	EE2	0.818			
	EE3	0.901			
	EE4	0.720			
Social Influence	SI1	0.859	0.840	0.893	0.677
	SI2	0.884			
	SI3	0.811			
	SI4	0.729			
Facilitating Conditions	FC2	0.777	0.723	0.863	0.761
	FC3	0.959			
behavior Intention	BI1	0.921	0.920	0.950	0.863
	BI2	0.947			
	BI3	0.918			

5.5.3 Validity Testing:

Construct validity is used for finding the degree to which an operational measure correlates with a theoretical concept. A confirmatory factor analysis was conducted for assessing the overall model and also to examining the convergent and discriminant validity.

Convergent Validity:

Convergent validity is a function of the association between two different measurement scales which are supposed to measure the same concept, and is achieved when multiple indicators operate in a consistent manner (Gefen and Straub, 2005). In the confirmatory factor analysis, the average variance extracted (AVE) was considered as a base for convergent validity. AVE was used to calculate the explanatory power of all variables of the dimension to the average variations. Constructs have convergent validity when the

composite reliability exceeds the criterion of 0.70 and the average variance extracted is above 0.50. According to table 5.4, the composite reliability of the variables was between 0.863 and 0.923 (that is >0.70) and AVE is between 0.647 and 0.863. Thus, all the constructs of the model have convergent validity.

5.5.4 Model & Hypothesis Testing:

Hypothesis testing helped in determining the independent variables that provide meaningful contribution to the explanation of the dependent variables (Hair, 2009). Hypothesis testing was conducted using SmartPLS which is a SEM (Structural Equation Model) software. The overall model fitting focussed on each determinant. The change of each variable path was according to the modification indicators recommended by SEM regard to the data analysis. All variables were adjusted so as to lift the explanation ability of the model for the use behavior.

The path diagram of the model fitted well with the actual observed data. The results of the hypotheses verification is summarized in table 5.5.

The structural model with the path coefficients and the R square for the dependent variables are given in figure 5.7. According to the figure, R square of the dependent variables behavior Intention is 0.529 and that Use behavior is 0.340. This means that the model explains 52.9% of variance of behavior Intention and 34% of variance of Use behavior. The statistical significance of the path coefficients were calculated through the bootstrap method.

With respect to the key determinants of the multi-intervention service, Performance Expectancy has the most significant influence on behavior intention, Effort Expectancy, Social Influence and Facilitating Conditions. Thus hypothesis 1 (H1) which states that performance expectancy, or the degree to which a user believes that the multi-intervention service will improve performance for smoking cessation, has a positive effect on behavior Intention a multi-intervention service ($\beta=0.374$, $p>0.1$) is hence proved. Similarly, Effort Expectancy, or the degree of ease of use, has a positive influence

on behavior intention ($\beta=0.326$ $p>0.01$). Hence, hypothesis H2 is verified. Again, social influence, or the degree to which a user perceives the importance of others' opinion with respect to using a new service, has a positive effect on behavior intention to use a multi-intervention service ($\beta=0.291$ $p>0.05$). Hence, hypothesis H3 is verified. Facilitating conditions also has a significant influence on the behavior Intention of user to use the multi-intervention service ($\beta=0.285$ $p>0.1$). Hypothesis H4 is verified. For hypothesis 5 (H5), from Figure 26 it can be stated that behavior Intention has a significant influence on actual usage ($\beta=0.368$ $p>0.001$).

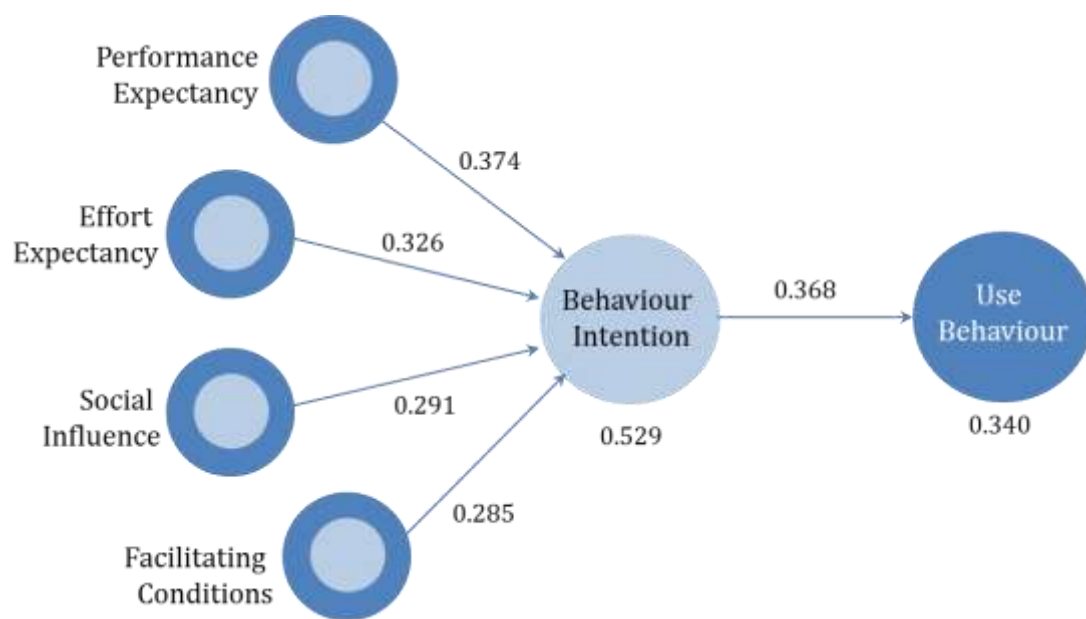


Figure 25: Model Testing result

The coefficient Beta value was extracted for the hypothesis testing. Coefficient Beta value was compared against $p<0.05$, $p<0.01$ and $p<0.001$. Thus based on the hypothesis testing we were able to find the factors affect the acceptance of a Smartphone based multi intervention service for smoking cessation. (Hair, 2009)

Table 18: Results of the hypotheses verification are summarized below

Sr. No.	Hypothesis	Study assumption	Verified result
1	H1	Performance expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation	Verified
2	H2	Effort expectancy will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation	Verified
3	H3	Social influence will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation	Verified
4	H4	Facilitating conditions will have a positive influence on behavior intentions to use Smartphone based multi intervention service for smoking cessation	Verified
5	H5	behavior intention will have a positive influence on "Use behavior"	Not Verified

Among the 5 hypotheses, four (H1, H2, H3 and H4) were verified. The fifth hypothesis H5 could not be verified as the study could not collect data whether the users were able to quit smoking using the application. Thus, for users of the Smartphone based multi-intervention smoking cessation app, performance expectancy, effort expectancy, social influence and facilitating conditions were found to have a significant influence on the behavior intention. This implies that all the factors contribute significantly in attracting the user to use the smoking cessation application. Although, the impact of behaviour intention on Use Behaviour could not be verified. This would require at least a 6 months to 1 year long randomized control trial.

5.6 Summary

According to the results of this study, "performance expectancy", "facilitating conditions", "effort expectancy" and "Social influence" will lift the "behavior intention" which in turn will lift the "use behavior" of the Smartphone based multi-intervention service. Again, "Effort Expectancy" was proven to be significantly influencing the "behavior intention". This implied that Information system designers and developers should focus on the aspects of technology and service to make them effortless and easy to use to increase the intention to use the Smartphone based service for disease management. With increasing costs of healthcare services, easily available and low cost services are the need of the hour. With the various options that consumers have these days, focusing on service quality and customer requirements is the only way to ensure acceptability and mass scale use of healthcare services.

This research is a multidisciplinary approach to designing and evaluating a multi-intervention service for smoking cessation. The research provides a framework for designing multi-intervention healthcare service from the perspective of Information systems, marketing as well as social psychology.

Chapter 6: Discussion and Conclusions

The purpose of this thesis is to develop an mHealth based multi-intervention technology that would cater to the needs of a broader range of consumers, especially smokers, for smoking cessation. The technology is based on a framework that is adopted from Persuasive Systems Model and brings together interventions like motivational messaging, progress tracking, instant gratification, social support and distraction through games, videos and instant chat. This provides users with increased options of selecting the intervention or a combination of interventions that suits their needs and interests. This new framework has the potential to improve the effectiveness of mHealth applications and services for behavior change, compared to single intervention applications. The development of the framework (discussed in details in chapter 4) answers the first research question: *Q1. How to develop a Persuasive Technology framework and design a Smartphone based multi-intervention mhealth service for smoking cessation using the framework?* The same chapter also discusses the development of the multi-intervention service in the form of a smartphone application using the various interventions according to the framework.

The thesis also explores the perception of users, especially smokers, towards using a smartphone based multi-intervention service for smoking cessation. Mobile based healthcare applications (apps) have taken the public health sector by storm. Every few days new health applications and services are being developed and shared with users and patients. Organisations working relentlessly on providing cheaper, better healthcare services must consider the factors that influence the adoption and uptake of these healthcare services by customers who are willing to accept and use these services according to their needs.

The study uses a well-established UTAUT model for measuring the influence of user's experience towards each potential determinant of behavior intention for Smartphone based Multi-intervention service for smoking cessation. The UTAUT model is a very robust model for technology acceptance prediction and can be used for predicting user acceptance of healthcare services for behavior change. According to the results of this

study, "performance expectancy", "facilitating conditions", "effort expectancy" and "Social influence" will lift the "behavior intention" which in turn will lift the "use behavior" of the Smartphone based multi-intervention service. Again, "Effort Expectancy" was proven to be significantly influencing the "behavior intention" - this implies that Information system designers and developers should focus on the aspects of technology and service to make them effortless and easy to use for the users to increase the intention to use the Smartphone based service for disease management. With increasing costs of healthcare services, easily available and low cost services are the need of the hour. With the various options that consumers have these days, focusing on service quality and customer requirements is the only way to ensure acceptability and mass scale use of healthcare services.

6.1 Contribution

The contributions of this study are in terms of theory, methodology and practice..

Contribution to theory

Theoretically, the study extends the Persuasive system design framework by combining the features of the PSD model with that of the Social Cognitive Theory in the context of a multi-intervention service for smoking cessation. Methodologically, the study validates that PLS path modelling can be used to estimate the impact of factors affecting the user acceptance of a multi intervention service framework and its association with other variables of the model.

Contribution to practice

Health management through behaviour change has received attention from health researchers and health policy makers. One of the major studies in disease management through behaviour change, the Lancet (Lancet study Group, 2009) 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study, shows that burden for diseases is changing from infectious diseases to lifestyle diseases and chronic illnesses like diabetes, hypertension, cardiovascular diseases etc. For managing lifestyle diseases, change in behaviour is of utmost importance. Although various social and psychological interventions have been implemented for behaviour

change, however, a technology based multi-intervention model might be the most prolific way to bring about behaviour change with the widest reach. The framework has been evaluated on a sample size of 225 smokers for smoking cessation in chapter 5 of this study and the user acceptance study has been conducted, showing that the multi-intervention service is acceptable to users.

mHealth service is an important way of offering mHealth technological intervention in healthcare. It brings together multi-disciplinary knowledge from information technologies, service science, multimedia content technologies and marketing for the a sustainable healthcare intervention. The study provides a smartphone based multi-intervention service for smoking cessation through behaviour change and this service will be easily accepted and adopted by users if certain factors, as mentioned above, are taken into consideration while designing the service. The evaluation showed that users would like and accept a smoking cessation service better for four major factors: (a) if they believe that the use of the service is beneficial (performance expectancy); (b) if the service is easy to use (effort expectancy); (c) if others believe they should use the service (social influence); and (d) if they believe there is sufficient technical support for the service. These factors, if incorporated effectively in the healthcare services, can improve the acceptance of mobile based healthcare application adoption. Overall, the study provides significant contribution to developing a multi-intervention service framework that can be used in healthcare and public health programmes for various disease prevention and management like hypertension, diabetes, obesity, depression to name a few. It is a step forward for healthcare service designers for designing behaviour change interventions.

6.2 Limitations

The study has some limitations.

1. This thesis has focussed on the mHealth based multi-intervention technology development and its acceptance by potential users, such as smokers wanting to quit smoking. However, this research has not investigated the effectiveness of the mHealth based multi-intervention technology in making people quit smoking. This would require a

larger scale randomised controlled trial (RCT) with preferably more than 1000 smokers over a period of one year.

2. The sample represents participants mainly from USA and India. There can be limitations in the generalizability of findings to other participants in countries, other than these two.

3. The multi-intervention service (smartphone app) designed in chapter 4 is compatible with only smartphone that has a screen size of 3 inches or above. This provides a technological limitation regarding the use of the service for users with lower screen specifications.

4. Users with a non Smartphone cannot access all the interventions of the service. Non smartphones or the basic mobiles phones do not provide users the options of playing online games or streaming videos from the internet. This restricts the full utilization of the service.

5. The motivational messages at present have been developed only in English language. This can be later modified to other languages to cater to participants in countries where local languages other than are preferred.

6. The research was conducted within a specific domain of healthcare, that is smoking cessation. Although similar persuasive system approach will be useful for behaviour change in other public health problems, such as hypertension, diabetes and obesity, these application areas have not been evaluated in the study and would be suitable for future work.

7. Verification of homogeneity of samples: The study did not include verification of the homogeneity of samples, especially with the familiarity with the application. Since it was an online survey, the time participants spent familiarizing with the application could not be monitored. It might be likely that some participants used the application longer than the others and thus expressed different opinions. Sample homogeneity test needs to be carried out in future studies. There can be other biases like late vs early responders or gender difference.

6.3 Future Directions

Future work can involve testing the multi intervention service with users over a longer period of time for smoking cessation. In the current study, the users were asked to use the multi-intervention service on their smartphones for a limited period of time (less than a day). In case of longer usage of the service, there might be different repercussions of the moderators like "experience with the service" which can have a direct impact on the "use behavior". Other moderators that can be included in future studies are number of cigarettes smoked per day, smoking pattern, location, quit attempts (number of times a person has tried to quit in the past), use of other mobile based applications and demography.

Secondly, in the study only 225 samples were collected. This might lead to problems of multicollinearity due to high correlations between different constructs. Future work can involve studying the combined effects of the constructs on the independent variables. Increasing the sample size in future studies might reduce problems created due to multicollinearity.

Thirdly, the service can be further developed by allowing language choice for users. At present, online mobile applications and services are globally accessible by one and all, thanks to Information Communication Technology (ICT). The multi-intervention service can be developed for users from different countries by modifying language options.

Fourthly, the research model did not test the effect of moderators like age, gender and voluntariness of use on the use behaviour. In future studies, these moderators can be looked into in details to find their impact on the acceptance of the service in a randomized control trial.

Additionally, the multi-intervention framework can be developed for prevention or control of other non-communicable diseases like obesity, Hypertension and Type-2

Diabetes. A full paper titled "Mobile Phone Including Smartphone based Persuasive System Design for controlling Hypertension and Diabetes in Bangladesh" has already been accepted for publication in IJBET (Journal). This framework can be used for programmes involving health behavior change as the main outcome.

Finally, future research can look into the practical application like carrying out a large scale randomised controlled trial (RCT) of the mHealth based multi-intervention service for the desired benefit of behaviour change (e.g., smoking cessation). Uptake of smartphones by the mass population in developing countries, irrespective of their economic conditions, has increased drastically. This is due to low costs of the technology and services among others. This allows more flexibility in trying out smartphone based multi-intervention health programmes in developing countries like India and Bangladesh. A comparative study of the multi-intervention service between developing countries and developed countries can be included within the scope of future research.

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Appendices

Appendix A: Precompiled message list

Index	Messages
1	I quit because my family loves me (= cigarettes.smoked.today), because (= person.name.first) is awesome
2	Feel the incredible personal power of knowing U kicked the habit U had for so long!!
3	What's the result of smoking too much?? Coffin!
4	Be cool, Done be a smoking fool!
5	If you smoke, you are a joke.
6	Nicotine addiction is like an itch. If you itch, it's nice to scratch it. But better to have no itch at all! - Dalai Lama
7	One thousand Americans stop smoking everyday... By Dying
8	Nicotine patches are great! Stick one on each eye and you can't find your cigarettes
9	You smoke. You die early! You end up saving Government money.
10	Seven out of 10 people don't smoke and of those who do, seven out of 10 want to give up. Smoking kills half of all lifetime smokers
11	Habit is stronger than reason. Don't let your habit of smoking win over reason.
12	If you maintain a positive attitude, it will help U succeed
13	The key is focusing on the positive. Build up the good things in your life and the smoking will go away by itself.
14	You are so close! Becoming a Non-Smoker is the best thing you can do for your life!
15	Smoking is not an art and smoking is never cool.
16	(= person.name), you don't actually smoke. The cigarette does all the smoking. You are just the sucker.
17	Lung cancer might cure smoking. Which one do you want (= person.name.first)?
18	Feel the incredible self-confidence U gain from becoming this brand new U! A healthy, happy, non-smoking U!
19	Smoking kills 1 in 4 smokers in middle age. This is when your kids are still growing up. Quitting now will increase your chances of being there as your children become adults.
20	Cigarettes are killers that travel in packs
21	Smoking can lead on to other drugs. The lucky ones graduate to Marijuana and the unlucky ones end up on chemo therapy
22	Your immune system begins to show signs of recovery within a month of quitting
23	U will no longer be producing extra phlegm caused by smoking after 2 smoke free months. Blood flow to your hands and feet will also improve.
24	Your blood pressure returns to normal after 12 smoke free months.

Index	Messages
25	Your sense of taste and smell will slowly improve over time
26	In 10 years your risk of lung cancer is markedly lower than that of a continuing smoker and continues to decline (provided the disease is not already present)
27	In 15 years your risk of heart attack and stroke is close to that of a person who has never smoked.
28	Smoking is like paying someone to kill you. They are rich, you are DEAD!
29	I quit because my kids love me. Can you quit for someone you care about?
30	Smoking makes no cents. A pack a day for 10 years coasts about \$44000 - easily enough to buy a new car or put a deposit on a house.
31	Who's going to retire on your hard earned dollars? You or some tobacco company executives?
32	Imagine you are able to effortlessly run around the block without getting short of breath! Won't that be AWESOME!!
33	Imagine you no longer have to worry about when you are going to be 'free' to get that next fix
34	Smoking addiction is caused by a combination of nicotine dependence + habit + negative emotions. Start with the factor that you have most control over.
35	From the moment you stop smoking, you are a non-smoker!
36	You have been a non-smoker for a while now. Keep your guard up and remember that one puff is all it takes to start smoking again!
37	Thinking of yourself as a non-smoker is really important! Non-smokers don't test themselves by having just a puff
38	Smoke away your worries, not your lungs
39	Smoking cigarettes is so yesterday.
40	Time is ticking...Quit while you still can!
41	Be smart, don't start.
42	Too much smoke will leave you broke.
43	If you can't stop smoking, cancer will.
44	There are cooler ways to die than smoking.
45	Smokers don't get to smoke, they have to smoke. Don't be one of them.
46	Everyone has a right to clean air. Quit smoking!
47	Breathe healthily, live happily.
48	Put it out for ever before it puts you out forever!
49	Smoking is very glamorous, if you like deep wrinkles
50	When u bump into someone, u apologies. When your smoke hits someone's face do you apologize?
51	Smoking is stupid habit for really stupid people.

Index	Messages
52	Get a friend, colleague or family member to be a quit buddy to help you deal with tough times and bad days.
53	Let people and members of your household know and get their support.
54	When you start something new like quitting smoking, friends and family pay more attention.
55	Talked to somebody who has quit? Join the chat group and get your queries answered!
56	Change is difficult at the start, as the first step is often the hardest. Practice makes perfect.
57	Quitting smoking can be hard. It is a good idea to think about, and plan for stressful situations that might tempt you to have a smoke.
58	Make a list of all the reasons why you are quitting smoking, then make copies and put them around home and work. This list helps in tough times to remind you why you are now smoke free!
59	Have a plan to manage your appetite and weight. More exercise and less fat are the best ways to beat cravings!
60	Have a plan and prepare for the quit process! This will increase your chances of succeeding manifold!
61	Remember to reward yourself for your hard work during the quit process.
62	Great work! Think about how much money you saved so far from not smoking. You can afford a luxury weekend in the south coast soon!
63	Cravings can be caused by unexpected stress occurring in your life. Talk to non-smoking friends and family about how they cope with stress and changes in their lives.
64	Remember the 4 D's to beat a craving! DELAY, DEEP BREATHS, DO SOMETHING ELSE AND DRINK WATER
65	Remember: Delay for at least 5 minutes, the urge will pass
66	Remember: Deep Breathe, slowly and deeply
67	Remember: Do something else. Keep your hands busy. You not play a game.
68	Remember: Drink water, take time out and sip slowly
69	Becoming a non smoker is a process, not an overnight event. And you are very much capable of accomplishing the goal!
70	You might be feeling sad but you have not failed in your quit attempt!
71	Imagine, not worrying about smelling like an old dirty ashtray everywhere you go.
72	Trash the ash.
73	Smoke away your worries, not your lungs.
74	Arsenic kills if you swallow it. Tobacco kills if you smoke it.
75	Make your choices, it's your life.
76	If God had wanted us to smoke, he would have given us a separate hole for it.

Index	Messages
77	Live it, or burn it!
78	Stop smoking, or you was croaking.
79	You take my breath away.
80	When you smoke, you are not cool. In the end, however, you are extinct.
81	Be smart don't start.
82	Breathe healthily, live happily.
83	Did you know your mouth is on fire?
84	Don't be a butthead. Smoking kills.
85	Don't puff your life away.
86	Don't smoke you will choke!
87	Don't smoke - there are cooler ways to die.
88	Hang Tough, Don't Puff!
89	I like smoking. It kills off a lot of stupid people.
90	Smoke can cause a slow and painful death.
91	The Marlboro Man Died of Lung Cancer.
92	Cigarettes- Weapons of mass destruction.
93	When you smoke, everyone can smell you coming.
94	Your Money Going Up in Smoke
95	Smoking INJURES your Health, No-Smoking INSURES your health
96	Smoking BATTERS your Health, No-Smoking BETTERS your health
97	"Fortunately, there's more than one way to quit smoking . . . the catch is you must choose wisely to become smoke-free." - Arthur A. Hawkins II
98	"Even at the hardest times I never doubted the whole thing was going to be a totally positive experience."
99	"If people don't love themselves enough to cut down on their smoking, they may love someone else enough to do it."
100	"Sometimes I just sit in front of a mirror and watch myself inhaling that poison gas. If I was in a concentration camp and someone tried to make me do that, I'd want to kill them."
101	"Even with the best preplanning quitting is an extremely unsettling experience. It may feel as if somebody dropped a bomb on your life."
102	"Cigarette smoking is clearly identified as the chief, preventable cause of death in our society." - C. Everett Koop, former Surgeon General
103	"Smoking kills. If you're killed, you've lost a very important part of your life." -- Brook Shields
104	The best way to stop smoking is to carry wet matches.

Appendix B: Web Based Questionnaire

Q1. Do you smoke? ☐ Yes ☐ No

Q2. If Yes, How many cigarettes do you smoke each day? _____

Q3. How old are you?

- 18-25
- 26-34
- 35-54
- 55-64
- 65 or over

Q4. Do you use a Smartphone? ☐ Yes ☐ No

Q5. Do you want to quit smoking? ☐ Yes ☐ No

<CONTD.>

For the following questions please click on one of the five options for EACH feature.

Performance Expectancy

Q6. I will find the service useful for quitting smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q7. Using the service will enable me to accomplish my goal of quitting smoking easily and in a planned manner

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q8. Using the service increases **(can increase)** my chances to quit smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q9. If I use the, it will make it easier for me to quit smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Effort Expectancy

Q10. My interaction with the service is clear and understandable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q11. It would be easy for me to become skilful at using the service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q12. I would find the service easy to use

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q13. Learning to operate the service was easy for me

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Attitude toward using the service

Q14. Using the service is a good idea for quitting smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q15. The service makes the process of quitting more interesting

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q16. Using the service can be fun

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q17. I will like using the service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Social Influence

Q18. People who influence my behaviour would think that I should use the service for quitting smoking.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q19 People who are important to me would think that I should use the service as it would help me to quit smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q20. I will use the service if my friends used it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q21. In general, the use of the service will be accepted by people

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Facilitating Conditions

Q22. I have the resources that is a Smartphone which is necessary to use the service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q23. I have the knowledge necessary to use the service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q24. I think using the service fits well with my life style

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q25. Assistance for the multi intervention service is available in case of service difficulties

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Self-Efficacy

26. If there was no one around to tell me what to do as I go, I could use the service to quit smoking

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q27. I was able to reach my goal of quitting smoking if I could get support if I got stuck

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q28. I was able to reach my goal if I had adequate time to use the Smartphone based service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q29. I was able to reach my goal of quitting smoking if I had just the built in help facility for assistance.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Anxiety

Q30. I feel apprehensive about using the service

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q31. It scares me to think that I could lose a lot of information using the service by hitting the wrong button

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q32. I hesitate to use the service for fear of making mistakes I cannot correct.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q33. The service is somewhat intimidating to me

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Behaviour intention to use the system

Q34. I intend to use the service in the next 6 months

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q35. I predict I would use the following feature of the service in the next 6 months

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Q36. I plan to use the service in the next 6 months

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Demography Questions

Q37. Where do you currently reside: _____

Q38. Gender ☐ Male ☐ Female

Q39. What is the highest level of education you have completed?

Q40. For how long have you been using your Smartphone?

- ☐ Never used it
- ☐ Less than 6 months
- ☐ 6 to 12 months
- ☐ 1 to 3 years
- ☐ 4 years or more

Q41. Do you access the web from your Smartphone?

- ☐ Yes ☐ No

Q42. What operating system do you have in your Smartphone?

- ☐ iOS (for iPhone) ☐ Android ☐ Windows ☐ Others

Q43. Do you use your Smartphone for any other purpose other than calling or messaging?

- ☐ Yes ☐ No

Q44. Have you tried quitting smoking before?

- ☐ Yes ☐ No

Q45. Would you prefer using a mobile application for quitting smoking?

- ☐ Yes ☐ No

Appendix C: Final set of items used

Indicators	Questionnaire items
Performance Expectancy indicators:	PE questionnaire items
PE1	Q6. I will find the service useful for quitting smoking
PE2	Q7. Using the service will enable me to accomplish my goal of quitting smoking easily and in a planned manner
PE3	Q8. Using the service increases (can increase) my chances to quit smoking
PE4	Q9. If I use the, it will make it easier for me to quit smoking
Effort Expectancy indicators:	EE questionnaire items
EE1	Q10. My interaction with the service is clear and understandable.
EE2	Q11. It would be easy for me to become skilful at using the service
EE3	Q12. I would find the service easy to use
EE4	Q13. Learning to operate the service was easy for me
Social Influence indicators:	SI questionnaire items
SI1	Q18. People who influence my behaviour would think that I should use the service for quitting smoking.
SI2	Q19 People who are important to me would think that I should use the service as it would help me to quit smoking
SI3	Q20. I will use the service if my friends used it
SI4	Q21. In general, the use of the service will be accepted by people
Facilitating Conditions indicators:	FC questionnaire items
FC2	Q23. I have the knowledge necessary to use the service
FC3	Q24. I think using the service fits well with my life style
USE Behaviour indicator	USE questionnaire item
UB1	Q40. For how long have you been using your Smartphone

Appendix D: Final selection of papers for literature review

Paper	No of patients	Age	Age (Mean)	Gender Female (%)	No of cigarettes smoked	Inclusion criteria	Study Duration
Riley, W et al, 2008	31	18-24	21	53.20%	smoking \geq 28 cigarettes/week	Smoking \geq 28 cigarettes/week, Smoking \geq 6 days/week, Desire to quit within 30 days, No current other tobacco use, No past-month nicotine replacement or bupropion use, No past-year substance abuse treatment.	6 weeks
Brendryen et al [5]	396	36.15 +- 10.25	36.15	50.30%	18.2 +- 5.85	willingness to quit smoking, Being aged 18 years or older, At least 10 cigarettes daily	54 weeks
Free et al [6]	5800	16 and above		45%		Smokers aged 16 years or older, Willing to make an attempt to quit smoking in the next month, owned a mobile phone, Gave informed consent.	31 weeks
Obermayer et al [10]	46	18-25	21.5	46%	At least 28 cigarettes per week	Age 18 to 25 and current college students, Own and use cell phones with text messaging capabilities, Smoked minimum of 28 cigarettes per week, smokes 6 to 7 days a week, Desire to quit smoking in the next 30 days, No current use of other tobacco products, No current use of nicotine replacement treatment of bupropion in the past month, Not in treatment in any substance abuse disorder within the past year	6 weeks
Whittaker et al, 2011	226	16 - 25	20.5	47%		Participants had to be 16 years of age or over, Be current daily smokers, Be ready to quit, Have a video message-capable phone	6 months
Rodgers, et al, 2005	1705	19 - 30	25	58%	15 (10 to 20) per day	who wanted to quit, were aged over 15 years, owned a mobile phone	26 weeks

Paper	No of patients	Age	Age (Mean)	Gender Female (%)	No of cigarettes smoked	Inclusion criteria	Study Duration
Bramley, et al, 2005	1705	19 - 30	22	58.50%	15 (10 to 20) per day	who wanted to quit, were aged over 15 years, owned a mobile phone	26 weeks
Vidrine et al, 2006	77		42.8	22.1	>5 cigarettes per day	HIV positive, 18 years of age, current smoker [i.e., smoking > 5 cigarettes/day and expired carbon monoxide (CO) of > 7 ppm], and willing to set a quit date within the next 7 days	3 months
Ybarra et al, 2013	164	18-25	21.5	44%	12.15	18- to 25-year-old daily smokers, who were seriously thinking about quitting in the next 30 days	3 months
Naughton et al, 2012	207			100%		Pregnant smokers	3 months
Brendryen et al, 2008	290	39.6+-10.9	39.6	50%		willingness to quit on a prescribed day without using nicotine replacement and being aged 18 years or older	12 months
Strecher, et al, 2005	1978		41	70%	>5 cigarettes per day	Use English as primary language, was 18 years or older, smoke at least 5 cigarettes per day, interested in quitting smoking, Not involved in any cessation program at that time, no undergoing or planning cancer treatment	12 months
Abroms, et al, 2012	23		20.9	43.50%	>5 cigarettes per day	Being a university student (full or part time), Smoking five or more cigarettes a day, having an e-mail address for personal use, Having a cell phone for personal use with an unlimited text messaging plan Having an interest in quitting in the next month, Not being pregnant	3 months
Peterson, et al, 2009	2151		16.5	47.30%	At least 1 every month	School students who were smokers, Currently smoking at least monthly or had smoked in the past 30 days	6 months