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DESIGN FOR LONG-TERM BEHAVIOUR CHANGE: AN EXPLORATORY STUDY IN PERSUASIVE INTERACTIVE SYSTEMS FOR PEOPLE WITH DIABETES IN SELF-MANAGEMENT

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Design for Long-Term Behaviour Change:
An Exploratory Study in Persuasive Interactive
Systems for People with Diabetes in Self-Management

Barbara Shuk-Kwan Wong

A thesis submitted in partial fulfilment of
the requirements for the
degree of Doctor of Philosophy

December 2014
Certificate of Originality

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Abstract

People with diabetes mellitus and many other chronic diseases are growing globally and they can cause heavy burdens to the individuals as well as the social and healthcare systems. Many people with chronic diseases require lifestyle change and adherence to the treatments for long term, which could be a challenge for them. A great amount of studies in the past decade have been starting to study different means to tackle the issues such as how technologies, especially digital technology to help to encourage more healthy behaviour and serve as an intervention in the self-care process.

Persuasive design is one of the concepts of design for behaviour change using design and technology to influence attitudes or behaviour in certain ways. However, the persuasive and long term effects of different persuasive strategies including narrative and statistical form of persuasive systems are mixed and not well understood. Moreover, the experiential aspects, the user values, as well as the contextual factors are seldom considered in many of these systems. Nevertheless, these factors could affect the motivation and persuasive effects for long-term behaviour change.

This study is to explore how persuasive interactive systems could help to motivate and persuade people with diabetes to engage in self-management and perform more healthy behaviour over time. It involves a comprehensive literature review from multi-disciplines including health psychology, communication theories, and human-computer-interaction; and a systematic research design using interviews,
contextual inquiry, system evaluations and a design prototype with mixed research methods to gain a more holistic understanding of the issues.

The findings discovered several challenges in diabetes management including diet control and physical exercises, which were influenced by internal and external resources of the patients. It was also found that narrative form of persuasion was more effective than the graphical and statistical form which was mainly due to the usability problems of the systems. Several system attributes were noticed to affect the user experience, and in turn they influenced the persuasion effects and user engagement. The user needs and values of the systems were also identified for user motivation over long term system use. Finally, the study also recognized several user contexts and contexts of use could affect the effectiveness of motivation and persuasion strategies.

The study proposes that adapting the theories in positive psychology and well-being could help to sustain motivation in the long term. Several models and frameworks of design for maintaining behaviour change are proposed, and design principles and guidelines for developing and evaluation for these kinds of systems are also suggested.

As an exploratory study, this study enriches the knowledge of the design concepts and provides insights for future development of persuasive design, not only in chronic care, but also other design interventions for sustained behaviour change.
Publications and Presentations


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I - OVERVIEW

1. Introduction of the Study

1.1. Introduction

Design as rhetorical communication can influence social and individual behaviours. According to Buchanan (1985), one of the central roles in design is communication, not only in graphic design but also a larger sense of design artefacts including product design, architecture and even urban planning. Design objects and technologies possess some forms of rhetorical power to influence and be influenced by the human value, which can help to improve or enhance the quality of people's lives.

Rhetoric is the “art of making persuasive speeches” that can be traced back from the ancient Greek (Joost & Scheuermann, p. 3). The characteristic of rhetoric is that actions are intentional, that is, the actions are designed to achieve certain objectives through rhetoric means. Nowadays, rhetoric refers more than just the form of language and speech, but it is also formulated in many different artistic forms and genres such as paintings, buildings, and pieces of music (Joost & Scheuermann, p. 3). In fact, every communication can be rhetorical, and it serves some purposes to influence whether it is for educating public, arousing emotions or promoting a concept. In this regard, design as a creative act which is always embodied with certain intention using rhetoric means such as forms, colours, or images to achieve a goal, whether it is to design an advertising poster, a chair, or a surgical room. Hence, design has a rhetorical power that can be served as interventions to change undesirable individual or social behaviours to more desirable ones such as quitting smoking or food waste reduction.

Design for behaviour change is a new design approach which has been growing in the last several years. Although the practice of design for behaviour change is not new, the term and approach are only recognized in recent years (Niedderer, 2013). The design concept has been used in many different areas such as design for sustainability (Bhamra, Lilley & Tang, 2011), design against crimes (Press, Erol, Cooper & Thomas,
Niedderer (2013) identifies that design for behaviour change has different approaches and perspectives. Some design approaches for behaviour change are mainly through the design of physical objects, environment, or product features to guide users to behave in an intended behaviour, where users are mostly unconscious or unintentional in their behaviours, for example, encouraging the users to do more exercise through climbing more stairs instead of using the lift by placing the lift in a less accessible location or eliminating the lift altogether. However, this kind of design allows no choice for the users and may also cause problems for people who have disabilities. This kind of design for behaviour change is also unethical since it violates the will of the users, and the effect is only short-term for it depends largely on particular context.

Persuasive technology is a kind of design for behaviour change concept developed by BJ Fogg (1998, 1999, 2003) as an interactive technology that changes a person’s attitudes or behaviours. Persuasion is “an attempt to shape, reinforce, or change behaviours, feelings, or thoughts about an issue, object, or action” (Fogg, 1998) without using force or coercion. It is regarded that the change of attitudes is more important for sustaining a behaviour over time (Petty & Cacioppo, 1986; Crano & Prislin, 2005). Fogg (1998) regards that technology can be created and adopted with an intent to affect human attitudes and behaviours. Persuasive technology and design focus on understanding human behaviours and communication for designing interactive systems to achieve intended outcomes.

Persuasive communication strategies in behaviour change have been widely used and studied, especially in the field of advertising, marketing, and health communication in the last decades. However, it is still an initial stage to understand how persuasive communication strategies are applied in interactive products or systems to achieve long-term behaviour change. This study investigates the above issues and the effectiveness of these strategies in interaction systems. It can enrich the knowledge in this area and inspire for future study.
1.2. Background of the Study

Diabetes mellitus is chronic disease requiring not only regular medication but also adapting to healthy lifestyle such as diet control and doing exercise, which is particularly challenging for many people with diabetes. In fact, the problem involves motivation and lifestyle issues that go beyond the medical system (Burns, Cottam, Vanstone, & Winhall, 2006). The main objectives of diabetes care are not only focusing on health management but more importantly on promoting and supporting health behaviour change.

Digital technology and mobile technology such as the Internet and smart phones have been widely available. These kinds of technologies provide almost unlimited opportunities for new solutions in human’s lives, including the areas such as waste reduction, fitness and healthcare. M-health and telemedicine are emerging concepts that use digital technology to facilitate more effective healthcare, which could not only help to ease the burdens of the healthcare services but also empower patients to control their health (WHO, 2010, 2011). The use of digital technology for diabetes self-management has been studied abundantly in the western countries in the past several years with mixed results. However, these concepts are in its infancy, and more studies are still needed particularly in the Asian context since diabetes mellitus is one of the most prevalent chronic diseases among the Asian population (WHO, 2004; Morrow, 2010).

This study is exploratory in nature to examine the concept of persuasion design and technology for diabetes management and health behaviour change in the Hong Kong context. Since diabetes management requires a behaviour change over the long term, and a sustainable behaviour change demands a change of attitude; therefore, to adapt the concept of persuasion design is more appropriate for this kind of system design. This study adopts the theories from health psychology, persuasive communication, as well as human-computer-interaction to understand the concept of behaviour change and how persuasive design can be applied for diabetes management and health
promotion. The study is intended to examine how different persuasive communication strategies, mainly in narrative or graphic presentation, could promote self-reflection, which is essential for attitude change. Moreover, how content information, user experience and contextual factors would affect the persuasion and motivation effects of diabetes systems for health behaviour change are investigated.

The values of this study are not only enriching the body of knowledge in the persuasive design and the design for behaviour change concept, but they are also providing valuable insights of designing systems for health promotion and chronic care.

1.3. Research Gaps

Studies about using information and communication technologies (ICT) and mobile applications in smart phones or mobile devices in chronic disease management have found to have a positive effect, for example, managing diabetes (Mukhtar, Ali, Belaid, & Lee, 2012; Vargas-Lombardo et al, 2012), improving health (Blanson Henkemans, 2009; Xu et al, 2011), encouraging physical activities (Albania et al, 2009; Brox and Hernandez, 2011; Rodriguez et al, 2012) and controlling calorie intake (Kirman et al, 2010; Tsai et al, 2007). However, several research gaps of these kinds of studies are identified.

Firstly, there are numerous health behaviour change theories, but a comprehensive understanding of how behaviour change occurs and particularly to maintaining behaviour change over time is lacking.

Secondly, the concepts of persuasive technologies tend to focus on changing people's behaviour without considering a wider human needs of the users. Many of these kinds of technologies also tend to 'fix' or 'correct' people behave in certain ways (Larsson & Larsson, 2008; Parker et al, 2011) and the effects of long-term behaviour change are not certain. Moreover, what kind of system attributes that are important for motivating and engaging users, and the user values for persuasive system for chronic diseases, diabetes mellitus, are lacking in this case.
Thirdly, most studies in persuasive technologies seldom consider the content as one of the important factors in influencing behaviour change, since content is regarded as implicit in design, and it is assumed as “someone else's responsibility” in many design practices (Jones, 2011, p.583). However, Jones (2011) argues that content, including text, image, audio and video, is critical in interactive and persuasive experience. Content can affect a user's attitude and behaviour of an action, as well as provide motivation and guidance of the action. Without the support of adequate content, it could initiate negative effects to the users who may feel pressured or confused. It would also miss an opportunity for designers to create more influential designs. Finally, if it is missing the evaluation of content in designs or systems, it could also be difficult to assess a persuasive experience accurately.

Fourthly, there is a lack of understanding of the connection among the users, the contexts (for example, physical, psychological and social), and the persuasive strategies these systems use. Many of these kinds of studies see patients as an abstract and homogeneous targeted group. Although diabetes patients are sharing some common characteristics, they are not homogeneous and different individual context can affect their self-management significantly (Schechter & Walker, 2002; Audulv, Asplund, & Norbergh, 2012). The effectiveness of using different persuasive strategies for different user groups is also not well defined.

Finally, there is also only a limited research about the use of these kinds of persuasive systems targeting the Asian population where the social cultures, the perspective of health, lifestyle and food culture are different from the western counterparts.

1.4. Research Questions

In response to the research gaps, several research questions are proposed, which serve as the goals of this study and the research design is developed to answer those questions in systematic ways. The research questions in this study are mainly divided into three areas:
1. Diabetes management and health behaviour change:

- In diabetes self-management, what are the biggest perceived challenges for people with diabetes in self-management in the Hong Kong context?
- What are the determining factors affecting behaviour change?
- What are the current approaches used to sustain behaviour change over the long term?

2. Persuasive and motivational effects in diabetes system design:

- What persuasive strategies could be used for long-term behaviour change?
- Which kinds of persuasive communication strategies, particularly when comparing the narrative and graphic presentation formats, are the most effective for behaviour change and why?
- Content can affect persuasive effects but many persuasive designs ignored it in their study, is content information important for persuasive systems?
- What kind of system attributes are essential for a persuasive system to motivate behaviour change particularly in diabetes systems?
- How does user experience of the persuasive systems affect persuasion and motivation?
- What are the user needs and values for diabetes management systems?

3. Contextual factors in persuasive design:

- Will user context and context of use affect persuasive and motivation effects, if yes, what are they?
- What are the most important user contexts when developing persuasive interactive systems for behaviour change over time?

The research inquiry of this study takes a holistic approach from an understanding the design context, to analyse the design strategies of the persuasive systems, and then
study the effects of the users’ interaction of the systems, identify critical issues, and suggest design guidelines to inform the future design of these kinds of systems. This approach focuses on the interaction of the users and the artifacts, with the purposes of understanding both the user, the context, the design artifacts and their interaction to gain a holistic perspective of the subject matter.

1.5. Research Objectives

This study is exploratory in nature with an intention to inform, inspire, explain and propose models for further development of the design concepts. The primary goals of this study are to contribute knowledge of the field of design and healthcare, in both theoretic concepts and design practices. The main objectives of this study are therefore included in the following:

- To understand the design context and identify the critical issues that affects the subject of concern.
- To develop theoretical models for sustainable behaviour change based on the literature from multi-disciplines.
- To examine the theoretical models and identify the effectiveness of different persuasive strategies for behaviour change.
- To understand if different user context affects the effectiveness of these strategies.
- To identify the user values and meaning for diabetes persuasive systems.
- To develop design principles and guidelines for designing effective interactive tools and self-management systems, as well as to propose an evaluation method of the applications that help to persuade, motivate and support the behaviour change and the long-term self-management engagement.

1.6. Scope of the Study

This study focuses on the persuasion and motivation effects of people with diabetes to conduct in self-management. Hence, it concerns how the use of different persuasive communication strategies in interactive technology would motivate them to engage
self-management and sustain healthy behaviour change over time, as well as what contextual factors affect the system in use rather than focusing on the result of the blood sugar level after the system use. Nonetheless, the researcher believes that a more engaging chronic management system could help to improve the health outcomes in the long run.

**1.7. Research Significance**

As the aging population and growing cases of chronic disease in Hong Kong, China as well as in many parts of the world, the promotion of healthy lifestyles and the participation in active chronic management are important. Design has a rhetorical nature, which can act as intervention to help disease prevention and support positive behaviour change.

This study provides valuable and in-depth knowledge and understanding for designers and healthcare providers about the patient experience in self-care. It provides insights for creating innovative design and technological solutions to improve healthcare products, services and systems. Furthermore, the focus on patients’ well-being in healthcare design can enhance the quality of care and provide more desirable and successful patient experience, which could also improve the engagement in self-management. Finally, the theoretical concepts developed in this thesis could also be applied to other interventions that require a sustainable behaviour change.

**1.8. Overview of the Thesis**

This study is structured into five parts. Part I is an *Introduction* to the study, which is an overview of the study discussing the background, the research gaps and research questions, as well as the significance of the research.

Part II is *Literature Review*, which includes four chapters from chapter 2 - 5. Chapter 2 is a basic knowledge of diabetes and the importance of self-management; it discusses the challenges and special issues in diabetes management, particularly related to
motivational problems. Then it discusses the concepts of design as rhetoric which serves as an intervention for behaviour change. The notion of persuasive technology and Design for Intent (Dwl) is compared and how persuasive technology can be used for diabetes management is discussed. Chapter 3 is a review of the psychological theories of well-being and health behaviour change. It provides a comprehensive understanding of the determining factors affecting behaviour change and an integrated model is developed to illustrate the behaviour change processes and identify the key determinants in each stage. Chapter 4 is about persuasive communication strategies for behaviour change. It reviews the effects of persuasion through different kinds of communication strategies, particularly focusing on narratives and statistical form of persuasion, as they could promote self-reflection for maintaining behaviour change. Chapter 5 discusses the concepts of user experience and how they affect motivation and persuasive effects in system interaction.

Part III is Research Proposition that explains the research methodologies in the study and describes the research methods in each phase of research.

Part IV is Research Findings and Evaluation, which includes Chapter 7 – 11. Chapter 7 mainly describes the results and findings from the phase 2 of research, which provides a general understanding of the diabetes management of Chinese adults, as well as more in-depth insights on some particular challenges in diabetes management for them. Chapter 8 is a system analysis of two different types of persuasive systems including a narrative and a statistical format. Their use of persuasive strategies and techniques are discussed and compared. Chapter 9 – 11 are the findings from the phase 4 research. It discusses in detail about the motivation factors, the user needs and values of these kinds of systems, as well as what kinds of user context and context in use might affect the persuasive effects of the systems. Several models and design guidelines are proposed for these kinds of systems.

Part V is the Conclusion part. It answers the research questions raised in the introduction and elaborates the theoretical framework based on the research and literature review. It shows the significance of the study by contributing new knowledge
to the field and provides guidance for designers and healthcare providers to develop innovative and more satisfactory healthcare products and services to support behaviour change. Finally, the limitation of the study is discussed, and some recommendations for further study are proposed.
II - LITERATURE REVIEW

2. Diabetes Self-Management and Persuasive Systems

2.1. Introduction

This chapter is to set forth the background of the research about health behavior change. It reviews the basic understanding of diabetes self-management and its challenges, and the reason why it is important for people with diabetes to adopt health behavior change. Then it will discuss the current design concepts and some design approaches for using technologies to promote behavior change.

This chapter is divided into two parts. The first part is to review the importance of self-management for people with diabetes and identify some challenges and issues in chronic management. It introduces the nature of diabetes mellitus and its treatment, and the challenges and main issues in diabetic self-management.

The second part introduces the recent technologies and design approaches especially the concepts of persuasive technologies and systems design for behavior change. It presents some major concepts and models in persuasive technologies and their criticisms. Through the literature review, some research gaps are identified and discussed.

2.2. Pandemic of Chronic Diseases and Diabetes Mellitus in Hong Kong and China

2.2.1. Definition and trends in chronic diseases

Chronic diseases can be defined as "long-term (three to six months or longer) complex illnesses that can be controlled but not cured" (Ragin, 2011, p.82). Chronic diseases have been found to be the major causes of deaths worldwide. According to statistics from World Health Organization (WHO, 2005), chronic diseases contributed for about
60% of 58 millions total deaths worldwide in 2005. Considering as the main health concerns for developed counties (Murray & Lopez, 1996; Ragin, 2011), chronic diseases are growing rapidly in the developing countries as well, counting 80% of all deaths that are contributing to chronic diseases worldwide. It is predicted that by 2020, chronic diseases will become the main cause of morbidity and mortality globally and contributing about two third of the illness burden (Murray & Lopez, 1996).

Chronic diseases have great impacts on many areas and bring huge burdens on the individuals, their families and the society, including that it: has major adverse effects on the quality of life of affected individuals; causes premature death; creates large adverse – and underappreciated – economic effects on families, communities and societies in general (WHO, 2005, p.5).

According to WHO, the major causes of chronic diseases are due to unhealthy diet, physical inactivity and tobacco use (WHO, 2005). As the changing lifestyle and diet habit, overweight and obesity have already becoming prevalence all over the world, and they contribute to many chronic diseases like diabetes and heart diseases. Hence, to promote healthy lifestyle and support people with chronic diseases to manage their health effectively are important tasks to prevent chronic diseases and the risks that may cause.

2.2.2. Diabetes Mellitus

Diabetes Mellitus is one of the chronic disease occurred either by inadequate secretion of insulin or the body does not effectively use the insulin it produced resulting in raised blood glucose. Insulin is a hormone produced by our pancreas to regulate our blood glucose. It moves our blood glucose into cells, where it is stored and turned into energy for our body use later. However, if there is insufficient of insulin, the blood glucose levels will increase in our blood, the condition called hyperglycemia. Persistently excess of blood glucose levels can cause many problems including coronary artery disease, and eye and kidney damage.
There are two types of diabetes. Type 1 diabetes is due to the body does not produce insulin and it is usually occurred in younger people before the age of 40. The cause of type 1 diabetes is not well known and it is not possible to prevent or reverse. Type 2 diabetes is due to either insensitivity of body cells to insulin or inadequate secretion of insulin. It is the most common form of diabetes and is accounted for about 80 - 90% of all cases of diabetes. Type 2 diabetes can be caused by genetic and environmental factors such as excess calories intake, poor diet, and low physical activity. Therefore, most people with type 2 diabetes, except elderly people, are usually overweight.

2.2.3. Diabetes Mellitus in Hong Kong, China and Worldwide

In Hong Kong, diabetes mellitus is the second most common types of chronic diseases (Hong Kong Monthly Digest of Statistics, 2009) and it is the tenth commonest cause of deaths (Centre for Health Protection, 2010). According to the Diabetes Hong Kong (2008), nearly 10% of the total population (700,000) are affected by the disease but half of them are being undiagnosed. The elderly people who aged 65 or above have the highest population of diabetes, with about 20% to 30% of them are suffering from the disease; however, it shows a growing trend among the younger populations (Gu et al, 2003).

In other parts of the world, World Health Organization showed that China, India, and the United States are amongst the highest population of diabetes (WHO, 2004). It is estimated that the number of people with diabetes will rapidly climb in the coming future. By 2030, the population of diabetes will be double worldwide and the three countries will remain the highest number of people with diabetes. In particularly, China will has the highest diabetes population and the diabetes cases will increase from 20.8 millions in 2000 to 42.3 millions in 2030 (WHO, 2004; HIVE Healthmedia, 2010), indicating necessary measures to prevent and care of diabetes in Hong Kong as well as in China are significant.
2.3. Diabetes Mellitus and Self-Management

2.3.1. Treatments and care

Treatment of diabetes involves lowering blood glucose levels and prevention of other risk factors by taking medication and insulin injection if needed. The patients need to check their blood glucose and blood pressure daily to decide how much medication or if insulin injection is required. They also need to check and care regularly with their eyes and feet to detect any complications that may occur.

Diabetes self-management is essential to maintain health and prevent complications such as high blood pressure and cholesterol, skin sores and eye problem. Diet control and exercise are important for diabetes patients because research has found that some people can stop taking medications after losing weight and under diet control, hence managing weight and eating a well-balanced diet are essential.
Self-care or self-management is important for diabetes patients and chronic disease patients (Anstiss, 2010) since it can reduce hospital readmissions, decrease the risks from developing complications, and achieve healthier outcomes while improving quality of life (Bodenheimer et al, 2002; Holman & Lorig, 2004).

### 2.3.2. Definition of self-management

There is no universal accepted definition of self-care, self-help or self-management. In fact, these terms are used interchangeably. For example, Audulv, Asplund, & Norbergh (2012) define self-management as:

*The strategies individuals undertake to promote health (e.g., healthy living, exercising), manage an illness (e.g., manage symptoms, medication, and lifestyle changes), and manage life with an illness (e.g., adapt leisure activities or deal with losses caused by illness). We defined self-management integration as a process in which self-management activities are assimilated into an individual's life (e.g., how the individual sustains and integrates exercise in his or her everyday life).*

On the other hand, Department of Health, London (DoH, 2005) defines self-care as:

*The actions people take for themselves, their children and their families to stay fit and maintain good physical and mental health; meet social and psychological needs; prevent illness or accidents; care for minor ailments and long-term conditions; and maintain health and well-being after an acute illness or discharge from hospital.*

At the same token, the World Health Organisation (WHO, 2009) refers self-care to:

*The ability of individuals, families and communities to promote health, prevent disease, and maintain health and to cope with illness and disability with or without the support of a health-care provider.*
The former definitions are focused on the individual level where the individuals take responsibility and employ strategies for managing and promoting their own health in a positive way. On the contrary, the latter have a broader perspective that self-care includes not only the individuals, but their families, healthcare providers, and the communities involve into activities that help to enhance health, prevent illness, and restore health, both physically and psychologically. Hence, it is suggesting that a new approach in chronic care with an integrated approach in the management of chronic illnesses is necessary.

2.3.3. Main issues and challenges in self-management

Self-management is essential for many chronic diseases but it is not easy to achieve. The following discusses the main issues and challenges in self-management.

2.3.3.1. Adherence problems

Self-management is very challenging since the patients need to change their lifestyles in many aspects over long period. For some patients, it is not an easy task and they encountered adherence and motivation problems (Delamater, 2006). Adherent problems in self-management such as not taking medications, diet control and doing regular exercise can hinder the healing process and effects, it may also detriments health such as developing complications.

Anderson (1990) has summarized two major areas of adherent problems of older diabetic patients including: firstly, the features of the regimen such as complexity, duration, and extent of behavioral change can adversely affect patient adherence; secondly, psychosocial and environmental barriers also contribute to adherent problems. A major area to affect patient adherence was found to be the relationships between the patients and healthcare providers, especially the patients and the healthcare providers' attitudes, beliefs, communication processes and subsequent reactions to the consultation. Anderson (1990) suggests enhancing the communication
skills of the patients and healthcare providers, and providing training to promote professional and patient problem-solving skills.

Ilioudi et al (2010) also identified similar results. They found that the major barriers to effective self-management include: the lack of support from families; lack of continuity and poor communication with physicians; psychological and physical issues; transportation problems; insurance issues and the cost of care; and lack of awareness.

Some studies also found that life satisfaction and self-esteem also related to self-care behaviour. For example, Backman and Hentinen (2001) studied the self-care of home-dwelling elderly and identified strong connection between self-care and self-concept and between self-concept and functional capacity. They found that self-esteem is related to well-being for the elderly and those who cared for themselves independently in responsible way felt higher self-esteem and life satisfaction.

On the other hand, a recent study found that poor health literacy affects the diabetes patients from taking medications (Permanente, 2013). The study followed 1,400 patients for 12 months after they were being prescribed of antidepressants and found that 43 percent failed to refill the prescription and almost two third of the participants discontinued the medication completely. The researchers found that patients who have difficulty to understand the health instructions, which they called "limited health literacy", have higher attrition rate than the patients with good literacy (Permanente, 2013). They regarded that patients with limited health literacy are poorly control their chronic health conditions and they proposed to improve people's health literacy, provide simplify information and treatment options, as well as monitor if the patients' have taken medication regularly.

2.3.3.2. Diversity of user context

Studies have also found that self-management is complex and different user context can affect the self-management behaviour. From the literature, three issues are identified:
Patients differ in their health beliefs and personal role in health care.

Studies found there are differences between gender, age, and diabetes duration in self-care. For example, Austin et al (2011) realize that female adolescents with longer type 1 diabetes duration are more likely to have difficulty to maintain dietary self-care activities than male adolescents. The study also shows that contextual factors such as parental effects and practitioners have influence on their self-care behaviours and motivational factors.

Hörnsten and his colleagues (2011) noticed that in type 2 diabetic patients, the integration process and their self-management strategies were affected by psychological and emotional aspects such as their perceived seriousness and emotional response to the disease, as well as their personal goals, and so on.

Cultural issues also have significant impacts on diabetes self-care management (Chun & Chesla, 2004; Chun, Chesla, & Kwan, 2011). Studies by Chun and his colleagues (2004, 2011) about the acculturation experiences of Chinese American immigrants have found that cultural background has significant influence on their diabetes management and the perception of health in complex ways including the individual characteristics, repertoire of skills, acculturation goals and motives, copying resources, diet, exercise, and so on.

These studies indicated that the behaviour of self-care may not the same among different ages, genders, ethnic groups, as well as diabetes duration.

Patients differ in their self-management integration.

Studies discovered that during life challenges such as chronic disease, individuals experience a transition process to cope with their disease or adapt their lives according to the new situation to manage the changing situation (Telford, Kralik, & Koch, 2006). Moreover, people also differ in their coping strategies depending on their way of
thinking and how to deal with the problems (Weiten & Lloyd, 2008)

Audulv and her colleagues spent three years to follow their participants with various types of chronic diseases in order to understand the assimilation of self-management practices and sustained in their lives. They discovered that the integration of self-management involved four phases: (a) seeking effective self-management strategies, (b) considering the costs and benefits of the self-management strategies, (c) creating routines and plans of action, and (d) negotiating self-management that fits their life situations. (Audulv, Asplund, & Norbergh, 2012, p.336).

In the first phase, the participants perceived a need for self-management, seek information, and tried to adopt self-management strategies for themselves if they did not have prior knowledge about self-management. In the second phase, the participants evaluated the effectiveness of the self-management against the costs such as time and efforts. If they perceived the self-management beneficial and/or effective, they were more likely to continue. The third phase is to create routines and plans of action. When the self-management behaviours continued for a certain period, it became routines and it helped the participants to take the self-management actions into their daily lives so that they did not need to make conscious efforts every time they performed the actions. In the final phase, the participants tried to negotiate a balance between life goals and disease control. They tried to prioritize their different goals and adjusted self-management strategies accordingly to fit their lives and goals. In this phase, they weighted the positive and negative effects of self-management, for example, self-management may seen as inconvenient and time-consuming (negative effects) and if their efforts were worthy to better control their blood sugar level (positive effects). They were likely to sustain their behaviour when they experienced more positive effects from self-management activities.

Audulv and her colleagues found that the self-management integration is an on-going process and it can change when/if the individual's situation changes. For example, when the participants' health situation change or if they encountered new information about self-management strategies, they could shift back to phase one to seek new
self-management strategies. They concluded that two aspects are important for self-management integration including the individual's inner negotiation between self-management and life goals, and the individual's unique context such as availability of resources and social supports. These aspects will affect how an individual's capability and/or intention in the self-management integration process. Since there are different individual needs of self-management supports in each phase of self-management integration, they suggest tailoring the self-management supports and strategies to meet different individual needs (Audulv, Asplund, & Norbergh, 2012).

- People differ in their reception of persuasive message.

When receiving persuasive message, people are also different which are based on their ability to understand the message and their involvement level. According to the Elaboration Likelihood Model (ELM), people with higher involvement tend to be influenced by central route of persuasive message such as fact and figures, in contrast, people with lower involvement tend to be affected by peripheral route of message such as promotion or attractive images. More detailed discussion of this concept will be discussed in Chapter 4.

Hence, it should be aware that designing systems or products for self-management need to take into account the cultural and contextual factors as these factors could affect diet and lifestyle behaviours, as well as the attitudes and perception of care.

2.3.4. Interventions to improve adherence in self-management

By summarizing the studies of Haynes (1979) and Roter et al. (1998), Schechter and Walker (2002) propose that three intervention approaches can be used to improve patient adherence: educational, behavioral, and affective.

Educational interventions focus on providing information and/or skills to improve adherence. The aim of the intervention is to increase the knowledge of the disease and its health effects, and build up the skills to perform self-management behaviour. They
suggest the information may include the nature of the disease, the positive and negative effects of adopting health advices, and necessary self-management skills and techniques. They also suggest that the education can be provided in different formats, for example, writing or visual medium such as video, multimedia software, or internet, for groups or individuals. The key of successful education strategies is to provide simple and clear message, and tailor the message to the individual needs.

**Behavioural interventions** refer to using techniques from cognitive-behavioural psychology to motivate desirable behaviour. The use of techniques can be in a variety of forms such as reminders, memory aids, goal setting, self-monitoring, contracting, skill building and rewards. The long term success of the intervention and the change of intended behaviour also rely on the acceptance the new behaviour of the individual patients.

**Affective interventions** aim at providing emotional support and encouragement to enhance adherence. Studies have found that social supports such as family and peer group can affect diet and exercise interventions. Other strategies include using lifestyle 'coaches', patient self-help group, and virtual community to promote self-efficacy and enhance positive coping skills.

They stress that using a combination of several strategies from these categories have a higher chance of success than using single strategy alone to maintain long term adherence (Schechter & Walker, 2002). It also requires these strategies to be used in different degrees of intervention to achieve higher health impact and positive behaviour outcomes.

**2.3.5. Main objectives in Self-Management Systems**

According to Bodenheimer et al (2002), the major task of self-management is to promote patient empowerment and any self-management should provide self-efficacy. **Patient empowerment** refers to "patients accept responsibility to manage their own conditions and are encouraged to solve their own problems with information but not"
orders from professionals. The paradigm views internal motivation as more effective for life-style change than external motivation" (Bodenheimer et al, 2002, p.2470). Chronic disease patients should be encouraged and motivated to take care of their own health and perform positive health activities and behaviour with the assistance from their families and health care providers. **Self-efficacy**, defined as the "confidence to carry out a behaviour necessary to reach a desired goal" (Bodenheimer et al, 2002, p. 2469), it can allow the person a feeling of autonomy and mastery of the environment. Both self-efficacy and patient empowerment can promote autonomy and sense of control which are essential for well-being. Furthermore, self-management education and collaboration between the patient and physician as partnership are also important to support better self-management and enhance health outcomes.

The design of the self-management systems and interventions, therefore, requires a paradigm shift that focuses on promoting health and fostering patient empowerment and self-efficacy in self-care. Since active patient participation in self-management can allow more efficient secondary and tertiary invention and reduces hospital readmission (Visser, & Snoek, 2004). As Severson et al (2011) claimed that "health system design concepts should focus on the creation of health, not health care; foster simplicity; create nurturing relationships; eliminate user fear; and contain costs."

In summary, the self-management systems should focus on three main objectives: to **monitor health**, **manage health**, and **promote health**, with promoting health as the primary objective. **Monitoring health** is to allow patients self-monitoring their health conditions so to assist in medications and treatments. **Managing health** is to facilitate effective self-management tasks such as taking medication and following up with the clinical appointments. **Promoting health** is to persuade and motivate patients to engage and actively participate in healthy lifestyle such as diet control and physical exercise. These objectives can be achieved by providing patient education and training, behavioural intervention, as well as social supports and encouragement. The ultimate goal is to promote patient empowerment and self-efficacy so as to improve health and enhance patient well-being and quality of life. To achieve these goals, different design strategies should be employed such as provide education and training,
facilitate communication between the patients and their healthcare providers and caregivers, motivate health behaviour, and foster simplify tasks (Figure. 2.2). The detail consideration of design strategies particularly concerning to promote health is discussed in the following chapters.

![Diagram of main objectives in self-management systems]

**Figure 2.2. Main objectives in self-management systems**

### 2.4. Design for Behaviour Change

#### 2.4.1. Introduction

Healthcare monitoring technologies such as e-health, m-health, telemedicine, smart phones as well as wearable technologies have been developed rapidly in the last decades to help to improve health care and patient outcomes with digital, wireless and information technologies in many western countries. It has been regarded as providing a huge potential in healthcare in the coming future. For example, telemedicine, as a way to use of ICT to improve patient outcomes by increasing access to care and medical information, has been regarded to have "great potential for reducing the variability of diagnoses as well as improving clinical management and delivery of
health care services worldwide by enhancing access, quality, efficiency, and cost-effectiveness" (World Health Organization, 2010, p.8).

With the advanced of technologies, more sophisticated consumers and aging population, using technologies in chronic disease management will be promising. Coughlin and Pope (2008) conceive that these health services and technologies should not merely focus on the management of disease alone but should promote more active and healthy lifestyle, as well as enhance positive well-being. For example, Adidas was one of the companies developing wearable devices called miCoach Fit Smart for measuring heart rate, and many other non-biometric metrics such as calories burned, distance covered, and stride rate (Leswing, 2014). (Figure 2.3) Other popular ones include Fitbit (Figure 2.4) and Jawbone UP waistband, they also provided similar functions for promoting healthy lifestyle with ubiquitous sensor technology to track the wearer's activities such as steps, sleep and calories.

![Figure 2.3. The miCoach Fit Smart by Adidas](image-url)
Care should also be taken on disease prevention since the causes of many chronic diseases such as diabetes, hypertension, and heart disease are a large part related to sedentary and unhealthy lifestyles. It is also important for the people with chronic disease to adopt healthy lifestyle to eliminate the risks of complications, reduce hospital readmission and decrease the costs in healthcare. Hence, the goals and objectives in healthcare product and service development in the upcoming future should focus on promoting healthy lifestyle and enhance well-being. Design has a role to play in this process and this section is to discuss some design concepts related to health behaviour change and well-being.

2.4.2. Design as Rhetoric and New Design Thinking

Buchanan (1985, 2001) considers that design as rhetoric since the center of design studies is communication. The idea of communication is directly and indirectly applied in design practice, not only in graphic design, but also to the larger field of design ranging from industrial and product design, architecture and urban planning (p.4). Designers and the effects of design have an influence on the consumers or society at
large. As he put it, "Design is an art of thought directed to practical action through the persuasiveness objects and, therefore, design involves the vivid expression of competing ideas about social life" (p.7) The design works are reflected on and shaped by the designer's values and design philosophy, the design process, as well as the social world of design organization, management, and corporate policy (Buchanan, 1985).

Buchanan (2001a) regards that the focuses of design have changed since the early twentieth century and he recognizes four areas of focuses in design. In the past century, design was mainly focused on "symbols and images" (graphic design and communication design) which concern using words and images in effective communication, and "things" (industrial design and engineer) which are interested in the creation and production the physical artifacts in everyday life. With the development of digital technologies in the last few decades, it has caused a rethinking of the practices of all design professions, the processes of product development, as well as the role of design in the social and cultural life. It changes the focus of design from "thing" to "action" and "process", which leads to the concepts of interaction design. According to him:

*It shifts attention away from the product as a “thing” and focuses, instead, on the product as a locus of action or activity, where the human being is no longer regarded as a passive receiver of messages or an external entity caught in the workings of a product. In fact, when attention shifts to action, the designer is also concerned with the design of processes, services, and other structured activities, whether these activities are for practical action, art and entertainment, or education. The central issues in this area of design are temporal sequence and dynamic connection, which bear a close relationship to what McKeon refers to as the problem of deliberation, where the human being must consider the intelligible consequences or results of action. (Buchanan, 2001a, p.201)*

The attention of design for action leads to the concerns of the experiential aspects and the consequences of the action.
The latest of design focused on "environments or systems" within which the action takes place. The focus is not limited to material systems but on human systems where it involves in designing the system and action by integration of information, physical artifacts, and interactions of environments in every aspects of our lives. Designers create systems or environments in such a way that they also create symbols or representations that attempt to express the intended idea or thought. However, the idea is not a given fact but like a thesis that is formed in the processes of communication with all the stakeholders in the outcome. Therefore, designers working in this area of focus act as facilitators of organizational process and they organize discourses about the values of a community and to implement those values with desirable results. Designers in this process are adopting rhetoric to create a new form of dialectic that addresses certain value and principle (Buchanan, 2001a).

He contends that the four orders of design (symbols and images, things, actions, environments and systems) illustrating how design is constantly responding to the current and emerging issues of the culture life by establishing new fields of study and new professional practices. The role of rhetoric in design in this process can be either served as direct participation in design practice, or used to educate new generation of designers to be more sensitive of the influence of design and technologies (Buchanan, 2001a):

The four orders of design—manifested in symbols and images, physical artifacts, actions and activities, and environments or systems—represent new fields of cultural study as well as professional practice. They illustrate how the issue of cause and action leads us to dissolve the boundaries of old fields and disciplines and establish new ones that address current and emerging problems of cultural life. Rhetoricians may play a role in this process by clarifying the intellectual transformation that lies at its core. They may also be led to action, either participating directly in the practical exploration of design or educating new generations of men and women who are more sensitive to the marks and signs of innovation in design thinking and in the shape of emerging technology. (p.203)
Buchanan (2001a) has indicated one important aspect of design: that design has persuasive influence on human's life, both directly or indirectly, individually and socially. In this regard, designers have utmost responsibility in their design works and should utility their powers in the benefits of human beings. Moreover, the new role of designers is becoming as "advocators" and "facilitators" within a system to create ethical and socially responsible products and services for all the stakeholders involved (Papanek, 1971; Buchanan, 2001a). The new design thinking, according to Buchanan (2001a), should transform the design theme of "form and function" into the new design theme of "form and content". Designers should understand the significant content of the products they create to achieve the intended outcomes of their works or may lead to harmful results in our world. These concepts are the design theoretical base for this study - how design and technology can serve as intervention to persuade users to adopt health behaviour change and to enhance well-being?

2.5. Persuasive Technologies in Health Behaviour Change and Chronic Management

According to WHO (2005), the most important goals in chronic management is to promote health behaviour change and enhance well-being. However, designing for behaviour change is a challenge for designers. As Lockton and Harrison (2009) put it, "As consumer products become increasingly efficient technologically, human behaviour is often the weak link, at a societal level but also at the scale of interaction with individual products and services." (p.1) Human being's thinking and behaviour are complex, idiosyncratic as well as unpredictable, it is therefore not an easy task to design for certain behaviour as the designers intended.

The concepts of design for behaviour change is a new design approach, but these concepts have been fast growing in the past decade. This design approach is based on the concept that design and technologies are never neutral and that they always influence people's attitudes and behavior in one way or another (Oinas-Kukkonen & Harjumaa, 2008). Hence, design can be act as an intervention to tackle individual and social problems such as unhealthy habits or sustainability. Many studies in this field
have been examining to use design in areas such as crime prevention (Crowe, 2000), sustainability (Rodriguez & Boks, 2005; Bhamra, Lilley, & Tang, 2008; Fuad-Luke, 2009; Lilley, 2009), as well as healthy diet and lifestyle (Albaina, et al, 2009; Purpura et al, 2011; Orji, Vassileva, & Mandryk, 2013). Two of the most prominent design concepts in this field is *Persuasive Technology* and *Design for Intent (Dwl)*.

**2.5.1. Persuasive technology**

Tscheligi and Reitberger (2007) have discussed the use of information and communication technologies (ICTs) to solve societal problems. According to them, in the early era, technologies especially ICT were focused on the usability issues for people who were mainly using desktop computer in the working environment where efficient and ease of use were the main concerns. As the computer and mobile technologies have entering the public and private environment such as homes and shopping malls, the focus has shifted on a much wider spectrum to cover almost all aspects of user experience in people's daily lives. As Tscheligi and Reitberger (2007) state that "This diffusion of everyday life with ICTs spurs a renewed and growing interest in how these technologies can be used to address the complex and urgent societal problems that humankind is facing." (p.41) They content that one of the promising approaches to enhance human well-being and solve societal problems is persuasive technologies.

**Persuasive technology** was proposed by BJ Fogg, a professor at the Stanford University, who defines it as "any interactive computing system designed to change people's attitudes or behaviours" (Fogg, 2003). He argues that computer technologies can affect human's attitudes and behaviour so computer has persuasive effects. He proposes that today's computers have three basic functions: as **tools**, as **media**, and as **social actors**. Computers as tools since computers can allow people to do things that previously could not do, or to do things easier. Computers as medium as they can convey symbolic content such as texts or graphics, or sensory content such as simulations or videos. Computers as social actors since they can create relationship through the use of animate characteristics, play animate roles, or follow rules or
dynamics such as greetings and apologies (Fogg, 1998). He regards that these functions as functional triad which can change attitudes and behaviors through different means (Table 2.1.)

Table 2.1. The functional triad and their persuasive affordances
(Fogg, 1998, p.227)

<table>
<thead>
<tr>
<th>Function</th>
<th>Essence</th>
<th>Persuasive affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer as tool or instrument</td>
<td>Increases capabilities</td>
<td>• reduces barriers (time, effort, cost)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• increases self-efficacy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• provides information for better decision making</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• changes mental models</td>
</tr>
<tr>
<td>Computer as medium</td>
<td>Provides experiences</td>
<td>• provides first-hand learning, insight, visualization, resolve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• promotes understanding of cause/effect relationships</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• motivates through experience, sensation</td>
</tr>
<tr>
<td>Computer as social actor</td>
<td>Creates relationship</td>
<td>• establishes social norms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• invokes social rules and dynamics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• provides social support or sanction</td>
</tr>
</tbody>
</table>

Later, he develops a behaviour model for persuasive design called the FBM model (Fogg, 2009). The model is composed of three principle factors: motivation, ability, and triggers. He regards that if a person is to perform an intended behaviour, it should fulfill three factors that he or she must: 1) be sufficiently motivated; 2) have the ability to perform the behaviour; and 3) be triggered to perform the behaviour. All these three factors must be present simultaneously for the behaviour to occur (Fogg, 2009). He has provided a detailed explanation of these principle factors and their elements required in behaviour change. It is summarized in Table 2.2.
Table 2.2. The elements of the three principle factors of the FBM model
(Adopted from Fogg, 2009)

<table>
<thead>
<tr>
<th>Elements of Motivation</th>
<th>Elements of Ability</th>
<th>Three Types of Triggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Pleasure / Pain</td>
<td>● Time</td>
<td>● Spark Trigger - for people have low motivation.</td>
</tr>
<tr>
<td>● Hope / Fear</td>
<td>● Money</td>
<td>● Facilitator Trigger - for people have high motivation but lack ability.</td>
</tr>
<tr>
<td>● Social Acceptance / Rejection</td>
<td>● Physical Effort</td>
<td>● Signal Trigger - for people with high motivation and ability, as reminders.</td>
</tr>
<tr>
<td></td>
<td>● Brain Cycles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Social Deviance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Non-Routine</td>
<td></td>
</tr>
</tbody>
</table>

He suggests that this model can help researchers and designers to think more clearly about behaviour and use this model to identify the problems in persuasive design so as to improve the persuasive effects, for example, to increase motivation, simplify the design, and/or use strategies to trigger behaviour.

2.5.2. Design for Intent (Dwl)

A similar design approach is **Design for Intent (Dwl)** which was developed by Lockton and his colleagues (2009a, 2010) as "design intended to influence or result in certain user behaviour". It describes using design strategies in different types of products, services, interfaces or systems with an intention to influence how the behaviour of the users when using them (Lockton, Harrison & Stanton, 2008; Lockton, Harrison & Stanton, 2009a). The concept is mainly based on the ergonomic science and studies with the focus on influencing user behaviour when the user interacts with the product or system. The concept is that it is necessary to influence certain user behaviour due to safety, health and security reasons. For example, a ATM machine or a healthcare system needs to be designed in such a way to avoid user operation errors
that may caused detrimental results. Lockton and his colleagues have been applying this concept in several design for sustainable behaviour projects (Lockton, Harrison & Stanton, 2008; Lockton, Harrison & Stanton, 2009a; Lockton, Harrison, Holley, & Stanton, 2009b; Lockton, Harrison & Stanton, 2010).

Nevertheless, this approach is mainly focused on changing the users' 'behaviour' during an interaction with a particular product or system, for example, to reduce the environmental impact of products through economically consumption of resources during use; or to increase efficiency in the product and systems when use (Lockton et al., 2010). The design may change the user's behaviour in certain ways, for example, to reduce water consumption or energy use in the office. However, it does not change the attitude of the user, that is, the users may not understand why they need to reduce the water and energy consumption in the first place, or they do not perceive it is important to do so. Without the attitude change and understanding the reason to change, the behaviour change is only temporary. According to Crano and Prislin (2005), attitudes are the evaluative judgment that integrate and summarize cognitive and affective experience of an object. These evaluations can affect the persistence, resistance, and attitude-behaviour consistency. The dual-process model, which will be discussed in the following chapter, is also suggested that message that are processed and evaluated, if successfully, can influence attitude change and then behaviour change. As persuasion is the element in attitude change, that is, an attempt to change attitude and/or behaviour without using coercion or deception (Fogg, 2003), for long term and sustained behaviour change such as chronic management, therefore, the change of attitude is crucial and the approach of persuasion technologies is more appropriate.

2.6. Design for Different Types of Behaviour Change

From the literature review, two major design approaches are identified for behaviour change: the short-term and long term behaviour change. In this regards, the design goals and strategies for different types of behaviour change should be used differently. (Table 2.3)
2.6.1. Design for short term behaviour change

Short term behaviour change refers to the behaviour change that is unconscious and temporary. The users do not have the intention to change their behaviour; it is the intention of the designers or engineers in the product or system design to direct the user's behaviour in certain ways in order to avoid making errors, improve efficient, or reduce wastage, and so on. The design is not aimed at changing the user's attitude, so the behaviour is only occurred when the user is interacting with the product or system, no effect on the user's behaviour in other context is expected. Design for Intent (DwL) is fall into this approach.

2.6.2. Design for long term behaviour change

Long term behaviour change refers to the behaviour change that is conscious and intentional, and the new behaviour can be maintained over time. The user has a conscious awareness of his/her own behaviour that is considered no longer appropriate in his/her life so a new behaviour is needed. In this sense, the behaviour change is more likely to sustain over longer period of time, even after the interaction with the product or system is completed. For example, if a user recognizes that physical exercise is good for health, then the behaviour change, that is, doing more physical exercise, is beyond using the system or product itself. It requires the design changing the user's attitude and behaviour. The aim of the design is therefore focused on changing user's attitude by persuasion and promoting the concept of behaviour change, as well as how to support the new behaviour over time. Persuasive technology is an example of this design approach.
Table 2.3. Comparison between design approach for short-term behaviour change and long-term behaviour change

<table>
<thead>
<tr>
<th>Goals</th>
<th>Design for short term behaviour change</th>
<th>Design for long term behaviour change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of change</td>
<td>Temporary, context specific</td>
<td>Longer term, can be extended to different context</td>
</tr>
<tr>
<td>User's intention to change</td>
<td>No intention to change</td>
<td>Have intention to change</td>
</tr>
<tr>
<td>Theoretical background</td>
<td>Cognitive science, ergonomics</td>
<td>Health psychology, social psychology, communication theories.</td>
</tr>
<tr>
<td>Design approach</td>
<td>Design for Intent (DwL)</td>
<td>Persuasive technology</td>
</tr>
<tr>
<td>Example</td>
<td>A medical device designed to direct appropriate behaviour in using the device in order to avoid errors.</td>
<td>A persuasive application to help users to stop smoking habit by promoting more healthy lifestyle.</td>
</tr>
</tbody>
</table>

2.6.3. Behaviour Change Support Systems (BCSS)

Oinas-Kukkonen (2010) has developed a conceptual model called Behaviour Change Support Systems (BCSS) to study persuasive technology. The BCSS is defined as "an information system designed to form, alter or reinforce attitudes, behaviors or an act of complying without using deception, coercion or inducements." (p.6)

According to Oinas-Kukkonen (2010), the BCSS is an object of study within the field of persuasive technology. The research topics in BCSSs are not limited to human-computer interaction and computer-mediated communication, but also included a wide spectrum of topics such as "the approaches, methodologies, processes and tools to develop such systems and ways for studying the organizational, social, and end-user impacts of them." (Oinas-Kukkonen, 2010, p.6) In other words, the research focuses the qualities and characteristics of the software, analysis and design of the systems or applications, as well as the behaviour and perceptions of the end-users. It
examines the purposes of the persuasive design, the design and software features, in different socio-technical platforms, systems or services.

Oinas-Kukkonen (2010, 2013) identifies three types of behaviour change: a change in an act of complying, a behaviour change, and an attitude change (C-, B- or A-Change). He suggests that different persuasive goals and strategies including using formation, alteration, or reinforcement (F-, A- or R-Outcome) are necessary for the systems or applications to support different types of changes. (Table 2.4)

<table>
<thead>
<tr>
<th></th>
<th>C-Change</th>
<th>B-Change</th>
<th>A-Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F-Outcome</strong></td>
<td>Forming an act of complying (F/C)</td>
<td>Forming a behavior (F/B)</td>
<td>Forming an attitude (F/A)</td>
</tr>
<tr>
<td><strong>A-Outcome</strong></td>
<td>Altering an act of complying (A/C)</td>
<td>Altering a behavior (A/B)</td>
<td>Altering an attitude (A/A)</td>
</tr>
<tr>
<td><strong>R-Outcome</strong></td>
<td>Reinforcing an act of complying (R/C)</td>
<td>Reinforcing a behavior (R/B)</td>
<td>Reinforcing an attitude (R/A)</td>
</tr>
</tbody>
</table>

In this model, C-change refers to the goal of the behaviour change is simply to make sure the end-user complies with the requests of the system such as taking blood sugar tests. The users may or may not have right motivation to do so the purpose in this approach is to provide triggers for inducing users' action and their complying with the requests of the application. Oinas-Kukkonen (2010) regards that achieving a C-Change first may help achieve a B-Change subsequently.

B-Change refers to the goal of the systems in this type of change, it is aimed at eliciting a more enduring change than simple compliance once or a few time. It may be easy to achieve a one-time behaviour change but achieving long-term behaviour change is more difficult. Oinas-Kukkonen (2013) conceives that schedule for performing a desired behaviour that is repeated over a period of time on predictable schedule may lead to longer term behaviour change.
The goal of systems to achieve A-Change is to influence the end-users' attitudes rather than behaviour only. Long term behaviour change requires an attitude change to take place, then it can help to sustain behaviour change. Therefore, a sustainable B-Change occurs only through an A-Change. The goal of achieving both A-Change and B-Change simultaneously in a behaviour change support system may be used in some behaviour interventions especially for risky behaviour, which requires long term behaviour change. For example, addictive behaviour such as drug abuse, smoking, and gambling; or health behaviour such as diabetes, heart disease or kidney disease. Since the users are not only required to have their attitude change (A-Change), but they also need to acquire proper knowledge and skills (B-Change) to increase their motivation and strengthen their self-efficacy to perform the new behaviour.

The contribution of the BCSS is the identification of different types of behaviour change and different goals of the system to achieve the change outcomes. It provides a framework of initially understanding the relationships between types of change and types of outcomes in persuasive design systems. However, it does not clearly explain the relationships of the types of change and the outcomes. Most importantly, it does not provide any guidelines about what types of persuasive strategies and tactics can be used to achieve these outcomes, for example, what kinds of strategies are appropriated to alter a behaviour change, or form and reinforce an attitude, and so on.

According to Oinas-Kukkonen (2013), most of the current research involved with systems supporting health behavioural change, including those in the healthcare and human-computer-interaction fields, seem to be interested in C- or B-Change, whereas the social psychology field involving the health BCSSs contributes more research on A-Change. He suggests that more research about A-Change rather than C- or B-Change should be devoted in the future.

As the management of diabetes as well as of many other chronic illnesses requires a long term behaviour change, then research about how technologies or design can promote behaviour change and support and help maintain new behaviours is essential. Research is also important in these areas in how to create methodologies for
promotion and support of behavior change that can be developed from, and grounded on empirical and clinical studies. Finally, study is also needed in providing a theoretical models for sustainable behaviour change and for creating the design guidelines that can help health care professionals realize successful tools for helping patients manage their conditions.

2.7. Review Some Existing Persuasive Design Models

Many persuasive design models and frameworks have been developed in the past several years ever since the concept was launched. This section is focused on discussing the most widely used models: Fogg’s Seven Principles of Persuasion and the Persuasive Systems Design Model (PSD Model).

2.7.1. Fogg’s seven Principles of Persuasion

Fogg (2003) proposes seven principle strategies in persuasion technologies to change attitudes and behaviour. They include: Reduction, Tailoring, Tunneling, Suggestion, Self-monitoring, Surveillance and Conditioning. Reduction means to simplify tasks for easy to use. Tailoring is to provide tailored information to meet individual needs, interests, personality, usage context and other factors relevant to the individual. Tunneling refers to the designs that guide the user through a process or an experience in an interactive system. Suggestion is to suggest a behaviour to a user in appropriate time. Self-monitoring is to help users to achieve their goals and facilitate them to track their performance in more easy way. Surveillance refers to the concept that the automatic observing and recording of a certain behaviour can increase the chance of achieving a desirable result. Conditioning means to use reinforcement to help shaping the intended behaviour and transforming the existing behaviour into habits.

2.7.2. Persuasive Systems Design Model (PSD Model)

Based on the Fogg’s model, Oinas-Kukkonen and his colleagues (Oinas-Kukkonen &
Harjumaa, 2008; Torning & Oinas-Kukkonen, 2009) develop a comprehensive framework - the **Persuasive Systems Design Model (PSD Model)** for designing and developing BCSSs. They define a persuasive system as "a computerized software or information system designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception." (Oinas-Kukkonen & Harjumaa, 2008). The model provides a framework and conceptualization of technology-mediated persuasion to provide guidelines and as evaluation of persuasive systems.

The PSD Model adopts many principles from Fogg but modified some of the features. It has been used for analysing many persuasive systems such as weight loss websites (Lehto & Oinas-Kukkonen, 2010), heart rate monitor (Harjumaa, Segerståhl, & Oinas-Kukkonen, 2009), and drinking and smoking problems (Lehto, & Oinas-Kukkonen, 2011).

The PSD model consists of twenty-eight design guidelines which are divided into four main categories: 1) **Primary task support**; 2) **Dialogue support**; 3) **System credibility**; 4) **Social support**. The **Primary task support** category consists of design principles that support the carrying out the user's primary task, they include: reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. The **Dialogue support** category is the design principles for facilitating computer-human dialogue support to assist users in accomplishing their goals or target behaviour, they are praise, rewards, reminders, suggestion, similarity, liking, and social role. The **System credibility** related to the design principles for creating a more credible system since it is more persuasive. The principles include trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. Finally, **Social support** are the techniques for motivating users by leveraging social influence, they are social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition (Oinas-Kukkonen & Harjumaa, 2008). The detail of the principles is in Appendix A.

Moreover, Oinas-Kukkonen and his colleagues (Oinas-Kukkonen & Harjumaa, 2008; Torning & Oinas-Kukkonen, 2009) perceive that analysing the **persuasive context** are
essential to understand the persuasive process in the system design. The PSD Model divides the persuasion context into three main parts: Intent, event and strategy.

**Intent** comprises the persuader and the type of change. The persuader is the system designer or organization who has an intention to persuade its users. The type of change refers to the intended or deliberated attitude and/or behaviour that the system is designed for a change to take place.

**Event** includes the use context, the user context and the technology context. The use context refers to the information processing event that affects the persuasion, it includes the roles of persuader, persuadee, message, channel, and context. The user context refers to the information of the target use. It requires to see the user context in a holistic manner to understand the "user's needs, interests, motivations, abilities, pre-existing attitudes, persistence of change, cultural factors, deep-seated attitudes, social anchors and perhaps even the whole personality." (Torning & Oinas-Kukkonen, 2009). The technology context is the features of the technological platform. Since some technology has its own configuration which may affect the persuasion effect, for example, the persuasion between desktop computers and mobile phones may be different due to different setting, configuration, speech and writing, context of use, and so on.

**Strategy** consists of the message and the route of persuasion. The message refers to the selected form and/or content by the persuader to deliver the deliberated information to persuade the user for an intended attitude or behaviour change. The content could be any type of information such as statistical data or information about a particular disease, but it can be delivered in different kind of forms such as text, numbers, graphs, narrative or games. The route of persuasion can be either direct, indirect or both. The direct route refers to the persuasion using solid arguments, whereas indirect route employing a number of facts instead of just a few convincing arguments. It can also use both routes simultaneously in a system.

Oinas-Kukkonen and his colleagues (Oinas-Kukkonen & Harjumaa, 2008; Torning &
Oinas-Kukkonen, 2009) contend that analysing the use and user contexts are essential since ignoring them will be difficult for designers to understand the inconsistencies in user's thinking, recognize the appropriate moment in messages delivery, and to use persuasion techniques effectively. Furthermore, analysing the persuasion message and the persuader are also necessary to comprehend the complexity and potentially controversial nature of the message and the use history of the persuasive system.

Nevertheless, Torning and Oinas-Kukkonen (2009) examined 51 papers about persuasive technologies which were published on three International conferences during 2006 - 2008. They found that only about half (54.9%) of these papers described the use context and in a coarse manner; and only 23.5% mentioned the level of actual users and their individual context. They argue that oversimplified the user context could be a problem for designing effective persuasion and it may be difficult to generalize the results of the research. They propose that in the future study, it requires developing conceptual models for a clearer measurement of successful persuasive design, and models with empirical understanding would be even valuable for the field.

2.8. Examples of Persuasive Technologies in Healthcare and Self-Management

The use of persuasive technologies has been applied in a broad spectrum of behaviour change such as sustainability behaviour (Bhamra, Lilley, & Tang, 2011), drinking and smoking problems (Lehto, & Oinas-Kukkonen, 2011), healthy diet (Resnico, 2008), fitness and physical exercise (Consolvo et al, 2006; Purpura et al, 2011).

There are many studies related to diabetes and self-management. For example, Nachman et al (2010) developed an end-to-end diabetes system called Jog Falls which blends together various functions including activity and energy expenditure monitoring and diet-logging to provide data for patients and physicians so that the physicians can analyse the data and give suggestion if needed. The system includes a body wearable sensor for recording health data such as heart rate and accelerometer, which automatically combines the information from the activities of the patients to
estimate energy expenditure. To encourage patients to constantly engage with the system the GUI shows the activity goals, current and past activity states and dietary records along with nutrition values. At the same time the activities of the patients, including food intake trends, health data, and physical activity, could be viewed by their physicians allowing for more effective coaching.

In its design, Jog Falls adopted several persuasive strategies—such as goal-setting, positive feedback, reduction, tunneling, tailoring, self-monitoring, surveillance, and conditioning—based on Fogg's model (2003), as well as just-in-time suggestions to encourage behaviour change. In a study of its use fifteen participants including 14 males and 1 female with the age between 18 - 60 in Manipal, India, were involved in this study. They used the system for 63 days. During this period, the participants met with the co-PI (project in-charge) every week to discuss the issues, track their progress and provide the feedback about the system. Nachman et al (2010) claimed that the results showed a significant positive correlation between weight loss and hours of system use.

Blanson Henkemans et al (2009) designed a persuasive computer assistant for self-management. The assistant was an online lifestyle diary called DieetInzicht which was represented by an animated iCat. The iCat showed different facial expressions and provided cooperative feedback, which is based on the principles from the motivational interviewing method. Their research involved 118 overweight Dutch adults in a randomized controlled trial for over a period of four weeks and tested the diary use differences between with and without computer assistant feedback. Their results demonstrated that in general, the participants filled in the diary more frequently, they also increased a motivation in self-management, reduced BMI and improved usability, as well as enhanced knowledge of maintaining a healthy lifestyle. However, their research also found that variance in personal characteristics such as age, gender, education level, computer experience, locus of control, and so on, affected the diary use and its outcome.

Kima and Kimb (2008) study whether the use of SMS by personal cellular phone and
internet would improve the blood glucose level of obese type 2 diabetes patients. The participants were recruited from a tertiary care hospital in an urban city of South Korea. Eighteen patients were randomly assigned to the intervention group while 16 in the control group. The intervention was aimed at reducing body weight and maintaining a closer to normal range of blood glucose level. Patients in the intervention group were requested to record their blood glucose level weekly in their personal cellular phone or computer internet. The researcher received the data and then sent personal recommendation through both the cellular phone and Internet to the patients weekly. The intervention took 12 months and during these period, the patients were provided continuous education and reinforcement of diet, exercise, medication adjustment and self-monitoring of blood glucose levels. If a patient failed to forward a blood glucose level for more than 1 week, a warning message was sent. They concluded that after 1 year, the blood glucose level of the intervention group were significantly lower than the control group.

Many of these studies claimed that the use of their persuasive techniques were successfully achieved the goals, that is, reduced blood sugar level or increased motivation in self-management. Nevertheless, either these studies were short-term, for example, 4 weeks (Blanson Henkemans et al, 2009), or most of them involved external influences, for example, the participants needed to meet their healthcare provider once a week to track their progress (Nachman et al, 2010), or the healthcare provider sent a personal recommendation to the participants weekly (Kima & Kimb, 2008). It is not knowing that if the persuasive effects were caused largely by the external forces such as human intervention or the system, and how important are these factors affecting the persuasive effects. Further study is needed to understand more about the persuasive effects in persuasive design and especially in related to chronic management.

2.9. Criticism of Persuasive Technologies and Systems

Although using technologies in behaviour change is regarded as a huge potential, it is also received several criticisms. The first type of criticism is related to the effectiveness of the persuasive effect. Many critics regard that the effectiveness of these systems are
not confirmed and the success are only short-term without achieving long-term behaviour change over the course of intervention (Lustria, et al, 2009; Neville, O’Hara & Milat, 2009).

Secondly, others argued that these kinds of systems are imposing too much control of the users (Gao, 2012). For example, Mamykina et al (2008) comment that many applications are focused only on the novelty techniques on the sensing side in capturing data. Moreover, systems are only focused on the actual behaviour or people are provision to change behaviour, rather than to promote the analytical and reflective skills of the users. They regard that reflective analysis of past experience as the important skills in diabetes management.

Thirdly, some others criticize that one of the reasons of high attrition rate of these systems is because many of them often lack an in-depth understanding the interdependent relationships between the user, the system, and the contexts (for example, the socio-economic, cultural, physical and psychological) in which they are used and adopted (van Gemert-Pijnen, et al, 2011). Many of them view users as a homogeneous group with similar needs and user patterns without considering the diverse user context. Furthermore, many of these systems do not meet the needs of the targeted users and they are not able to build relationships with them resulting in system abandonment due to stress and frustration in using them (Nijland et al, 2010; Riley et al, 2011).

Fourthly, in many studies of persuasive technologies, content is always being ignored or disregarded as a constitution of design principles of the systems. Jones (2011) argues that content has impact on digital experience to inform, instruct and even influence, so it should be considered during the system development. According to him, "To improve the results of a persuasive experience, content can and must have a central role in planning, executing, and evaluating the experience." Moreover, Chomutare and his colleagues (2011) studied the literatures of mobile diabetes applications and they discovered that the educational feature, as one of the top functional features in diabetes management, is largely missing in these studies.
For example in PSD, although Oinas-Kukkonen and his colleagues (Oinas-Kukkonen & Harjumaa, 2008; Torning & Oinas-Kukkonen, 2009) perceive that providing meaningful content is important for the user, they merge content in the Primary task support category which is mainly related to usability and utility issues such as reducing, tunneling, self-monitoring, and so on. However, I argue that the analysis of content information should be considered as an essential part of the system and analysed separately since content can be in varies forms and these forms and the quality of information can affect the persuasive effects. It is also easier and useful to understand how and what factors of the content information influencing the results.

Finally, many of the systems of behaviour change are mainly concerned about how different features produce the persuasive effects. I argue that the user experience could also influence how the persuasion is successful since a digital system without a pleasurable experience in use would not be able to change behaviour and maintain it over time. The user experience of the system is beyond usability and utility, but includes affective experience such as fun and aesthetics. More will be discussed in the following chapter.

2.10. Summary of the Chapter

In summary, this chapter reviews two streams of knowledge about health behaviour change - diabetes management and persuasive technologies. The first part reviews the issues in diabetes mellitus and the challenges in self-management. It identifies that one of the most challenging issues is how to help the patients to adhere in the treatment and self-care, and to adopt healthier lifestyle. The other challenge is the diversity of user context including differences in the health belief and personal role in health care, the self-management integration, as well as the reception of persuasive message. It recognizes that three intervention approaches can be employed to improve patient adherence, they are: educational, behavioral, and affective supports. Moreover, it highlights that the goals in self-management is to achieve patient empowerment and self-efficacy, which should be considered when developing the
self-management systems. Finally, it proposes three main objectives of the self-management system design: to monitor health, manage health, and promote health, with promoting health as the principal goal of these systems. A model is drawn based on these concepts.

The second part discusses some current design approaches especially design as rhetoric and persuasive technologies as intervention for promoting health behaviour change. It raises some issues about e-health and the recent studies about using technologies and design in healthcare, self-management and promotion of healthy behaviour. The concepts of Persuasive technology and Design for Intend (DwI) are discussed as design approaches in design for behaviour change. The study recognizes the differences between these approaches and suggests that Design for Intend (DwI) is more suitable for short-term behaviour change; in contrast, persuasive technology is more effective for long-term behaviour change. Moreover, Fogg’s seven Principles of Persuasion and the Persuasive System Design Model (PSD) to design persuasive systems are discussed. The PSD model suggests that understanding the persuasion context, including: Intent, event and strategy, are essential to develop effective persuasive systems. This chapter reviews some examples of persuasive design in healthcare and self-management, and recognizes some research issues of these studies. Finally, some criticisms of persuasive systems and technologies are considered.

Persuasive technology is a new design approach which could be especially useful to design for people with chronic disease or promote healthy behaviour. However, this design approach has received criticisms such as too much control and try to fix people, lack of long term effects and high attrition rate over time. Although Fogg’s Seven Principles of Persuasion and the Persuasive System Design Model (PSD) are the most widely adopted models in design for behaviour change, they ignore the persuasive role of content in these systems. Moreover, most of these studies neglect the experiential aspect of these systems, which could influence the persuasive and motivation effects. Many studies also focus only on how to change users’ behaviour without attempting to understand what the users' needs and wants leading to a mismatch between the users
and the systems. Finally, many systems see users are a homogeneous group with similar needs and use patterns; however, as the literature indicates that there may be differences between different users, which could also affect the persuasive effects and motivation to use.

In this regards, this study is set to fill these gaps by answering the following research questions:

- What are the theoretical concepts of behaviour change, especially for long term behaviour change?
- What persuasive strategies could be used for long term behaviour change? Which strategies are more effective?
- How can design help to sustain behaviour change?
- As education and information is important for self-management, how important is the informational content in a persuasive system?
- How can user experience of the systems affect the persuasion and motivation?
- What are the real user needs and values for these kinds of systems?
- Will user- and use- context affect persuasive effects of these systems? If yes, what attributes of the context are important?

In the coming chapters, I will review the literature from different disciplines including health psychology and persuasive communication, as well as human-computer-interaction, to understand the related knowledge about behaviour change and persuasive strategies that can be used in designing digital systems and technologies.
3. Understanding Motivation and Health Behaviour Change

3.1. Introduction

This part introduces and discusses the concepts of motivation and behaviour change, particularly how behaviour change can be maintained over longer period of time. By reviewing social and psychological theories, it can provide a conceptual understanding of how human changes behaviour. First, it discusses the theories of motivation and well-being and why psychological well-being is important in healthcare for chronic disease patients. Second, it reviews the health behaviour change theories and provides an understanding of health behaviour change processes and identifies the key determinants in each stage of behaviour change. Third, from reviewing the above theories, an integrated model is drawn as basic model for behaviour change.

3. 2. Concepts in Health Behaviour Change

To design for behaviour change, it is essential to understand the psychology of behaviour change. In the last decades, the studies of motivation and behaviour change have been well-studied subjects in psychology and communication, and a wide range of studies from varied disciplines such as rehabilitation, nursing, social work, and even business and marketing have been using behavioural and social psychological theories for behaviour intervention. It is just an emergent trend in the field of design and Human-Computer-Interaction but the trend is growing rapidly in the past decade.

To employ behavioural and social psychological theories in behaviour change research can provide an understanding of human behaviour in a more comprehensive way, and they are important tools for the development of effective behaviour interventions and communication strategies (Fishbein & Yzer, 2006; Foshbein & Cappelia, 2006a, 2006b; Lippke & Ziegelmann, 2008; Consolvo, McDonald & Landay, 2009 ). However, many of these studies are quite similar or identical to each other with only different
terminology used (Noar & Zimmerman, 2005). Moreover, these studies did not provide a clear understanding of how these theories are interrelated, and especially what determinants contribute to maintain behaviour change, particularly in design and information technologies literature. It is necessary, therefore, to develop thorough understanding so that effective strategies can be developed.

Three most important concepts in health psychology and behaviour change are identified, they include: motivation, persuasion and well-being. These three concepts are distinct but are also closely interrelated to each other. This section is to review some most prominent psychological theories that explain well-being, the motivation and behaviour change. An integrated model is then developed to fill the gap in the previous studies.

3.3. Health and Theories of Well-being

It is a growing concern in healthcare design to achieve well-being for patients, which is considered as one of the important goals to improve the quality of healthcare design. However, the concept of well-being is vague and it seems not well understood how and why it is important in healthcare. This section is to review literature especially from positive psychology and draw a more comprehensive understanding of psychological well-being for healthcare design.

3.3.1. Theories of psychological well-being

World Health Organization (WHO, 1992) defines health is "a state of complete, physical, mental, and social well-being and not merely the absence of disease and infirmity." Hence, health includes physical status, psychological, and social well-being, not just a lack of disease. Many evidences have shown that many people with physical disability still have a positive life view and live life to the full. We also see many people with terminated illness still strive their best to engage in activities that they find meaningful and significant. As Friedman (2002) discovers:
Ironically, for most people, their feelings or subjective state of health and well-being are most important. Most people are more concerned with being involved and self-fulfilled than they are with whether they will spend three months in the hospital before they die, or whether they will die at age 83 rather than 80. (Friedman, 2002, p.165)

Numerous studies have found that positive psychological well-being can help to restore health and reduce the risk of incidence of many chronic diseases and mortality (Boehm, Peterson, Kivimaki, & Kubzansky, 2011). Well-being may be associated with positive health behaviour such as improved diet and increased physical activity (Boehm et al, 2011). Moreover, researches also suggest that focusing on positive well-being and functioning can increase a person's ability to handle with challenges (Rozanski & Kubzansky, 2005), focus on prevention of illness activities (Friedman, 2002), and enhance general health-related outcomes (Charlson et al, 2007).

Friedman (2002, p.67) states, "wellness seekers are actively responsible for matters relating to their health, with a special emphasis on prevention of illness. This view is quite different from the traditional view in which medicine is seen primarily as a curing or repair system needed when medical problems strike." Furthermore, "The wellness seeker builds stamina and fitness, thus expanding the range of what is to be considered "normal", and may also developed added flexibility in dealing with life" (Friedman, 2002).

Hence, to achieve the highest level of well-being and maximize function in everyday life are the pivotal goal in healthcare for persons with chronic diseases since self motivation and management are vital for them (Stewart et al, 1989). To achieve these goals could help to reduce healthcare costs and provide overall benefits to the patients, their caregivers and healthcare providers, as well as the healthcare systems as a whole.

However, the term 'well-being' is still not easy to define and come to a consent. According to Cambridge Advanced Learner's Dictionary, the term 'well-being' is defined as "the state of feeling healthy and happy". Ragin (2011, p.15) defines
well-being as “one's overall state of health’ including both mental, emotional, spiritual and physical health”. Ryan and Deci (2001) consider that well-being is a contented state of being happy, alive and prosperous, which includes both the hedonic concepts of happiness and the concept of eudaimonia of meaningfulness. Hence, well-being can be referred to as a contented state where a person's being in the world, both physically and psychologically, in the interactions with one's environment, which produces an experience fulfilling one's sense of self and purpose in life.

One of the most comprehensive models in psychological well-being was developed by Ryff and Keyes (1995, p.720) as six dimensions of model in psychological well-being. The model is a combination of a broad spectrum of positive psychological functioning which includes six dimensions: Self-acceptance, Positive relations with others, Autonomy, Environmental mastery, Purpose in life, and Personal growth. These dimensions are developed from varies social and psychological theories and they are interrelated. Based on these dimensions, some of the main psychological theories of these concepts are discussed in more details in the following.

3.3.1.1. Self-acceptance

The self-acceptance is related to Maslow's Need Theory. Maslow's hierarchy of needs (1943) is one of the most widely quoted theories in psychological well-being. The theory suggests that human beings have different kinds of needs and he represents these needs in hierarchy as a shape of the pyramid. He considers that only the needs of the first level are fulfilled before they moving to the upper level. The basic needs in the bottom are physiological needs such as food and warmth. When these needs are satisfied, people can move to the next levels of needs which are safety and security needs. As these needs have been met, people look for social and psychological needs such as love, friendship and intimacy. As moving up the pyramid the needs of self-esteem and the feeling of accomplishment become more prominent. On the top level are the needs for personal growth and to achieve individual potential as self-actualization.
Maslow believes that these needs play a major role in motivation behavior. He defines the physiological, security, social and esteem needs as deficiency needs where these needs arise due to deprivation. It is vital to satisfy these needs in order to avoid unpleasant feelings or consequences. In the highest level of needs he calls them growth needs that are not about missing something but about the desires to learn and grow as a person. Maslow considers that these needs are most important in human beings.

He later modifies the model by adding cognitive needs (knowledge, meaning, etc.), aesthetics needs (appreciation and search for beauty, balance, etc.), and transcendence needs (helping others to achieve self actualization), these kinds of needs are included in the top level as needs for self-actualization. He contends that as the basic functional and physiological needs are fulfilled, people look for knowledge, beauty, justice and meanings, as well as the needs for creativity and self expression. When people become more self-actualized, they become more ethical and to seek a more harmonized relationships with others by helping others and devoting into charity works.

Maslow’s hierarchy of needs model indicates that human needs include physiological, social, and psychological needs. The higher the hierarchy the more vital the social and psychological needs are. When the physiological needs are satisfied, people want to seek social psychological needs such as security, loved, belonging, esteem, identity and social status, and the ultimate level is to achieve self-actualization by growing oneself and helping others.

### 3.3.1.2. Personal growth

Carl Rogers (1961) was the pioneer to accent to the theory of personal growth and life fulfillment. He develops a person-centered therapy which emphasizes the concept of "self-actualization". He believes people have inherent tendency to understand themselves, fully develop their capacities and talents, and resolve their own problems. The central motivation of a person is to learn and grow that help to discover his or her potential and use of any talents. People grow when they encounter
problems and find a way to master them. Through this process, they develop new skills and knowledge which induce positive inner feelings and a sense of self-worth. Rogers believes that the needs of self growth is a life-time process to keep a person's alive and feel more satisfactory in life. In addition, Rogers regards a fully functioning person tends to have a growing openness to experience, increasingly existential lifestyle, increasing organismic trust, freedom of choice, creativity, reliability and constructiveness, and live a rich full life.

Roger's theory is also related to Maslow's hierarchy of needs to emphasize the importance of self-actualization which allows a person to develop and achieve individual potential as human beings. Both of these theories emphasize the positive and growth-oriented aspects of human beings. People have a sense of growth are more lively, resistant to stress, and have a stronger will and flexibility to cope with their problems. Studies have showed that there is a positive relationship between perceived growth and positive well-being of people with chronic diseases such as cancer (Stanton, 2006) and arthritis (Evers et al, 2001). Moreover, studies of sickness people and patients in stressful situations also appeared that perception of growth can produce positive health consequences such as stronger immune systems and lower levels of mortality (Park, 2009).

3.3.1.3. Autonomy, environmental mastery, as well as positive relations with others relate to Self Determination

The dimensions of autonomy, environmental mastery, as well as positive relations with others, are based on the concepts from Self Determination Theory. In Self Determination Theory, Ryan and Deci (Deci & Ryan, 2008; Ryan, 2009) suggest that well-being is related to the satisfaction of three needs: competence (environmental mastery), relatedness (positive relations with others), and autonomy.

**Competence** refers to the desire to have an impact on the environment and capable to achieve desired outcomes. The feeling of competence is intrinsic motivation since it can satisfy psychological needs for competence and mastery environment.
Relatedness is the desire to feel an interconnection with others who can care for and cared by others. Humans are naturally need positive relationships with others and feel belonging in groups.

Autonomy is the desire of the experience of freedom to perform self-organize behaviour and activities that congruous with the person's sense of self. They argue that the more autonomous motivation the person experience, the more persistence, adherence, performance, and well-being at an activity (Deci & Ryan, 2008; Ryan, 2009) They also argue these needs as universal and essential to one's psychological well-being.

The Self-Determination Theory also closely relates to the motivation and health behaviour change, which will be discussed in more details in the next section.

3.3.1.4. Purpose in life

This dimension relates to search for life meaning (Ryff & Singer, 2008). Two approaches of well-being theory - hedonic and eudaimonic, which are based on different views on human nature (Deci & Ryan, 2008). The distinction between these two views is rooted in ancient Greek philosophy. The hedonic view of well-being is related to pleasure or happiness as the goal of life. On the contrary, the eudaimonic view of well-being emphasizes self-realization, the attainment of meaning, and living in accordance with the true self. Research on these approaches found that, although both hedonic and eudaimonic can achieve well-being, eudaimonic behaviours are not only strongly related to well-being, but also more robust than hedonic behaviors (Ryff & Singer, 1998; Steger, Kashdan, & Oishi, 2008).

In the theory of Sense of Coherence (SOC), Antonovský’s (1987; 1993) has proposed that a person with a strong sense of coherence has a more confident and optimistic attitude towards the world and his/ her own life, he or she is also more resilient to stress and flexible to challenges. The SOC composes of three core
components including *comprehensibility, manageability* and *meaningfulness*. **Comprehensibility** refers to the extent of the events which are perceived as ordered and consistent that making logical sense. **Manageability** is the extent to which we perceive to possess adequate internal or external resources such as finances and social support to cope with the stressing situations. **Meaningfulness** refers to whether we perceive that life makes sense, and the challenges are worthy of emotional commitment and investment. According to Antonovsky (1979), a sense of coherence helps a person to cope with stress and challenges more successfully and maintain health and well-being. Studies have found that SOC has positive effects on coping and quality of life among people with chronic diseases (Motzer & Stewart, 1996; Shiu, 2004; He & Ann 2006).

Antonovsky considers that meaningfulness is the most important component of all. A person believes a life is meaningful has a motivation to understand and manage events, and he or she has greater strengths to resist and cope with stress. If a person loses the sense of meaningfulness, his or her will to live will also disappear. Hence, rather than medication, diet control or exercise, it could be more crucial to promote a sense of meaningfulness in a patient’s life so that he or she has stronger will to improve their health. Studies have found that meaning in life associated with health, positive well-being and life fulfillment (Chamberlain & Zika, 1988).

There are many concepts in **personal meaning of life**. For example, Baumeister (1991) consider that meaning of life consists of four components that meet basic needs:

1. **Purpose**: Present events draw meaning from their connection to future outcomes—objective goals and subjective fulfillment.
2. **Values**: Beliefs that can justify certain courses of action
3. **Efficacy**: The belief that one can make a difference
4. **Self-worth**: Reasons for believing that one is a good and worthy person

Reker and Wong (1988, p.221) consider personal meaning is defined as “cognizance of order, coherence and purpose in one’s existence, the pursuit and attainment of
worthwhile goals, and an accompanying sense of fulfillment". Wong (1998) regards that personal meaning is a combination of social and individual systems that are significant to the individual, they include: affective, motivational, cognitive, relational, and personal characteristics and status. Wong (2010) further argues that although positive emotions elicited by things or being in good process and immersed in activities that are enjoyable, engaging and successful can have positive effect on health, meaning is more important in retaining some level of well-being when people are encountering very challenging situations. Hence, to perceive meaningfulness is the major drive for an action.

3.3.1.5. Internal Locus of Control and Sense of Hope

Other related theories in health are Internal Locus of Control and Sense of Hope. A sense of internal locus of control is also an essential factor for a person to remain healthy. Friedman (2002) argues that people feel that they can control their own behaviour and environment is essential for healing and remain healthy. A personal feeling of control is a general sense that people believe that whatever happens to them is under their control. It is found that people with internal locus of control are healthier and more confident to deal with stress (Rotter, 1966); there is also a direct association with people engages in healthy behaviours (Friedman, 2002). Friedman (2002) contends that it is important to provide choices to bestow a sense of locus of control. The concept is similar to the autonomy and competency in Self-Determination Theory and the Sense of Coherence, all these theories emphasize the importance of promoting a sense of autonomy by providing choices and flexibility.

Promoting a sense of hope is equally important for chronic disease persons in the healing process so it is vital to inspire hope in the healthcare activities (Cutcliffe & Koehn, 2007). Hope, according to Snyder (2002, p.249), is "the perceived capability to derive pathways to desired goals, and motivate oneself via agency thinking to use those pathways." Hope can help the persons to endure difficulties and engage in positive self care and lifestyle change, so it aids recovery and restores health. Social supports, interpersonal connection, encourage positive sense of self and optimism can all help to
inspire hope. Furthermore, it is also essential for the healthcare providers and caregivers to provide the feeling of being cared for and respected (Cutcliffe & Grant, 2001).

In terms of the concepts of well-being in different cultures, Ingersoll-Dayton et al. (2004) discover that having harmonious relationships are more important for Asian people. In their research of Thai elderly, they identified that psychological well-being for the Thai elderly have two facets: *intrapersonal* and *interpersonal*. They assume it is due to the Buddhist beliefs about karma that doing good deeds bring good results in current and future incarnations, hence, it involves a blending of autonomous and interpersonal processes. Based on the findings, they created a five dimensions model that includes interpersonal and intrapersonal well-being indexes. The following is Ingersoll-Dayton et al’s Five dimensions of psychological well-being model.

<table>
<thead>
<tr>
<th>Interpersonal</th>
<th>Harmony</th>
<th>experiencing peaceful and happy interactions with others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interdependence</td>
<td>providing assistance to and receiving assistance from family members and other</td>
</tr>
<tr>
<td></td>
<td>Respect</td>
<td>feeling one’s advice is heeded and one’s wisdom is appreciated</td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>Acceptance</td>
<td>relinquishing upsetting thoughts and accepting life’s circumstances</td>
</tr>
<tr>
<td></td>
<td>Enjoyment</td>
<td>appreciating simple pleasures that involve others as well as solitary pursuits</td>
</tr>
</tbody>
</table>

Although their study has showed some distinguishing factors between the East and West, basically it consists of some common personal and social aspects such as happiness, positive sense of self, positive and harmony social relationships with others. Hence, it could be argued that these are the universally applied essential components for psychological well-being.

### 3.3.2. Summary of the Dimensions of Well-Being
In summary, the dimensions of well-being from Ryff and Keyes (1995) can be extended into **Hedonic, Self-acceptance, Positive relations with others, Autonomy, Environmental mastery, Purpose and meaningful in life, Personal growth, and Sense of hope.** Hedonic is more related to the positive affect and the rest of the dimensions are more on cognitive dimensions about the eudaimonic views of well-being. However, it is believed that both dimensions are interrelated to each other (Lent, 2004). The following table is to show the extension of dimensions of well-being and the related psychological theories.

**Table 3.2. The extension of dimensions of well-being**

<table>
<thead>
<tr>
<th>Dimensions of Well-being</th>
<th>Concepts</th>
<th>Psychological theories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hedonic</td>
<td>pleasure or happiness as the goal of life; positive affect</td>
<td>➢ Hedonic views of well-being</td>
</tr>
<tr>
<td>Self-acceptance</td>
<td>positive evaluations of oneself and one's past life - such as self-worth and self-actualization</td>
<td>➢ Hierarchy of needs - Maslow (1943)</td>
</tr>
<tr>
<td>Positive relations with others</td>
<td>the possession of quality relations with others - such as being respected, harmony relationships with others, and assessing supports to and from others</td>
<td>➢ Self Determination Theory</td>
</tr>
<tr>
<td>Autonomy</td>
<td>a sense of self-determination - freedom of choices</td>
<td>➢ Self Determination Theory</td>
</tr>
<tr>
<td>Environmental mastery</td>
<td>the capacity to manage effectively one's life and surrounding world - perceived competence</td>
<td>➢ Self Determination Theory ➢ Sense of Coherence (SOC) - Antonovsky's (1979) ➢ Locus of Control - Rotter (1966).</td>
</tr>
<tr>
<td>Purpose and meaningful in life</td>
<td>the belief that one's life is purposeful and meaningful</td>
<td>➢ Eudaimonic views of well-being ➢ Sense of Coherence (SOC) - Antonovsky's (1979)</td>
</tr>
<tr>
<td>Personal growth</td>
<td>a sense of continued growth and development as a person - such as learn new things, accomplishment and seek challenges and novelty</td>
<td>➢ Theory of personal growth and life fulfillmen - Rogers (1961) ➢ Hierarchy of needs - Maslow (1943)</td>
</tr>
<tr>
<td>Sense of hope</td>
<td>perceived capability to derive pathways to desired goals, and motivate oneself via agency thinking to use those pathways</td>
<td>➢ Hope Theory - Snyder (2002)</td>
</tr>
</tbody>
</table>
3.4. Motivation and Theories of Health Behaviour Change

There has been a huge body of theoretical studies attempted to explain the determinants of behaviour change. In literature about health behaviour, motivation and persuasion are identified as the most important factors for affecting behaviour change.

Motivation can be generally referred to a goal-directed behaviour people act towards to achieve a goal. In psychological term, it can be defined as ‘the psychological forces or energies that impel a person towards a specific goal’ (Sheldon et al 2003, p 45). Or, put simply, it refers to "what people desire, what they choose to do, and what they commit to do. In other words, investigations of motivation attempt to explain the deeply held concern among people as to why we do the things we do." (Keller, 2010, p.3). Motivation explains the goals people intend to pursue, in what way and how intensive they pursue them.

Motivation is closely related to well-being and behaviour change, and it is one of the most essential parts in chronic self-care and self-management since the patients take a key responsibility to take care of themselves over long term. It requires self-disciplined, perseverance, and positive coping strategies of the patients. Lifestyle change such as diet control and physical exercise are also needed for people with chronic diseases. Fail to compile in self-management, for example, take medication regularly, may cause serious consequences such as readmission to hospital or development of complications. However, to encourage in performing and sustaining motivation of intended behaviour are not easy for most people especially for uninteresting or difficult tasks. It requires effective persuasive strategies to motivate people to act on the new behaviour without force or coercion.

To understand the psychological concepts of motivation and health behaviour change theories can help designers to develop products or services to promote health and assist them to adhere in self-management. In the next section, I will first review some of the most relevant theories of health behaviour change and propose some key
3.4.1. Types of motivations in health behaviour change

The factors that affect behaviour change are complex. Although differ in their use of terms, the majority of theories consider that the most important influential factors on health behaviour rely on the attitudes and beliefs of the individuals, social influence, self-efficacy and the variables during different stages of change (Fishbein et al., 2001; Noar, 2006).

From those main theories of health behaviour change, they can be categorized as four major groups: *intrapersonal, interpersonal, ecological, and transitional.*

*Intrapersonal* refers to the individual's biological and psychological factors; *interpersonal* is about the social, cultural and environmental influence on behaviour; *ecological* refers to the ecological interaction between the person's inner and outer environment, it even includes a wider context such as organizational, community, and policy making; *transitional* regards the behaviour change is a process of change that involves distinct psychological considerations in different stages. The following is to review the different groups of health behaviour change theories.

3.4.1.1. Intraperisonal of Behaviour Change

The first group of theories are focusing on the individual level and they suggest that a person's behaviour change depends on the individual's psychological factors such as beliefs, attitudes, expectations and perceptions. They include the *Intrinsic and Extrinsic motivation, Health Belief Model (HBM), Theory of Reasoned Action (TPB), Theory of Planned Behaviour (TPB), and Goal Setting Theory.*

Ryan and Deci (2000; 2007; 2008) consider that behaviours are mainly driven by our
expectations. They propose that we have two types of motivation: *intrinsic* and *extrinsic*. **Intrinsic motivation** is defined as "the doing of an activity for its inherent satisfactions rather than for some separable consequence." (Deci & Ryan, 2000, p.56). It is an important form of motivation that inherent in every human from birth and throughout one's lifetime. Intrinsic motivation relates to instinctive satisfying goals such as personal growth and development, physical health, and relationships with others. They refer to doing things that are inherently interesting, fun, creative, and enjoyable, since these are the natural motivations for a person to grow and develop as a human being. On the other hand, **extrinsic motivation** refers to doing activity in order to attain some separable outcome (Deci & Ryan, 2000, p.60). In contrast to intrinsic motivation that people doing the activity for the pleasure of the activity itself, extrinsic motivated activities usually have instrumental value and people engage the tasks for the rewards by completing them, not for the pleasure of the tasks. Pursuing of wealth, fame, financial rewards are examples of extrinsic motivation.

According to the theory, extrinsic motivations can only achieve temporary effects, whereas intrinsic motivations are more durable. They contend that intrinsic motivation results in higher and more robust behaviour change (Kasser, & Ryan, 1996), since intrinsic motivation is what drive people to achieve their inner potential and interest, which lead to personal growth and psychological well-being. Studies have found that using external motivation such as financial rewards or punishment for intrinsic motivating tasks only gains short-term motivation (Williams, Cox, Hedberg,& Deci, 2000). It could in fact undermine intrinsic motivation and decrease the motivation of performing the tasks since people experience it as being controlled.

Intrinsic motivation is thus distinct from extrinsic motivation that the behaviour is acted because of the enjoyment of the activity itself rather than based on its instrumental value. Nevertheless, intrinsic and extrinsic motivation are not a dichotomy that either one of them occurs in a given situation, but more possibly that some of the elements of both types of motivation are intertwined in any situation. They suggest that extrinsic motivation, although driven by instrumental values, can have various degree of autonomous from the most extrinsic to the less extrinsic ones.
The Self-Determination Theory includes several layers of elaboration from amotivation, four types of extrinsic motivation and intrinsic motivation, to explain the complex phenomenon of motivation. Amotivation refers to the state where individual has no intention to act, it may be resulted from the lack of interest or perceived value of the action, or perceived a lack of competent to do so. The four types of extrinsic motivation include external regulation, introjected regulation, identification, integrated regulation. The most extrinsic motivation is external regulation which refers to the motivation of the actions are in a large degree regulated by extrinsic rewards such as financial rewards. Introjected regulation means that the action is performed due to the feeling of pressure to avoid guilt or to maintain or enhance self-esteem. It is extrinsic since the individual is not experienced the full part of the self.

Identification is more autonomous since the individual recognizes that the behaviour has personal significance so he/she accepts its regulation as his or her own. The least extrinsic is integrated regulation which is closer to intrinsic motivation, where the individual internalizes the values for an action and assimilated to the self through self-examination and self-regulation. The theory suggests that the extrinsic motivated actions become self-determined when the internalization of values for action and assimilation of self are high. However, it still extrinsic motivation since it is still based on instrumental value and expectation of certain outcome separated from behaviour (Deci & Ryan, 2000). Nevertheless, they suggest that the continuum of these extrinsic motivation types is not a developmental continuum. The internalization process can develop at each stage and an individual can take a new behaviour regulation at any point along these continuum depending on factors such as past experience or different circumstances.

The Health Belief Model (HBM) is one of the most commonly used psychological models to explain and predict long- and short-term health behaviours. It was developed by three U.S. social psychologists Hochbaum, Rosenstock and Kegels in the 1950s to explain the failure of a free tuberculosis (TB) health screening program. The concept is that the likelihood of a health behaviour change is determined by the beliefs and perceptions of the individuals regarding the disease and the strategies available to
reduce the occurrence. There are four decisive perceptions including perceived susceptibility (the chances of getting a condition), perceived severity (how serious of the condition and its consequences), perceived benefits (the possible benefit or effectiveness of an action to reduce the impact), and perceived barriers (the tangible and psychological costs of action). The combination of perceived susceptibility and severity can generate threat, and the combination of perceived benefits and barriers help to evaluate the course of action taken. According to this theory, these are the precondition for an individual's "readiness to act". However, whether the action is taken place depending on two conditions - the cues to action and self-efficacy. The cues to action refers to stimulations that activate the action. Self-efficacy means how confidence a person perceived to successfully perform the action (Glanz, Lewis, & Rimer, 1997). This theory suggests that both conditions should be presented or a change of action will not occur.

The Theory of Planned Behaviour (TPB) was developed by Ajzen (1991) as an extension of the Theory of Reasoned Action (TRA) proposed by Fishbein and Ajzen in 1975. According to the Theory of Reasoned Action, a person's behaviour is determined by the intention of the person to perform the behaviour. Intention is a result of the attitude (the beliefs about the object or the behaviour and the value evaluation of the possible outcomes) and subjective norm (how much they think the significant others want them to perform the behaviour). The Theory of Planned Behaviour (TPB) adds that perceived behavioural control is a motivational effect on intentions, that is, one's perceived ability to perform a behaviour. The concept contends that if the person's attitude is positive and the subjective norm is high, and he or she perceived a strong behaviour control, there is a higher intention or motivation for the person to perform the behaviour.

The Goal Setting Theory (Locke & Latham, 2002) suggests that setting goals can motivate behaviour change and individuals are motivated by different kinds of goals. It considers that the higher goals cause a higher level of efforts and performance than easy goals or goals that are vague or abstracted. According to the theory, goals are more effective when they are more specific, feasible, measurable, time-specified,
challenging while realistic. It is also more successful if it is set by the individual alone or with an expert, and they are important and meaningful to the individual (Locke & Latham, 2002). In addition, individuals with self-efficacy are more likely to set higher goals than individuals with lower self-efficacy and they are more committed to the designated goals.

3.4.1.2. Interpersonal of Behaviour Change

The interpersonal level of motivation suggests that behaviour change is influenced by different factors including the social and physical environment. The most important theory is Social Cognitive Theory (SCT) and the concepts of self-efficacy.

Social Cognitive Theory (SCT) is a theory that tries to explain health behaviour in a more holistic perspective by understanding the interactions between the individual, social and environment. Developed by Bandura (1977), SCT suggests that the environment, which consists of social and physical environment, can affect a person's behaviour. Social environment refers to the people with whom the individual interacts, they include family, friends and other people such as healthcare providers. Physical environment refers to the place, the facilities and equipment, the ambient temperature, or the availability of food. SCT considers that all these factors are constantly influencing each other. As Bandura (2001, p.15) states, "people are producers as well as products of social systems".

The fundamental principle of SCT is reciprocal determinism which refers to the dynamic interaction between the environment, the individuals, and their behaviour. Bandura (1997) considers that behaviour is not simply affected by the environment but also the perception of the person regarding: the expected outcomes of the behaviour, the barriers, and the confidence in his/her own ability to control over the outcome and carry out the behaviour. According to SCT, two conditions are required to help the behaviour change to take place: observational learning and behaviour capability. Observational learning means that the individual observes the actions of another person and he/she receives reinforcement during the process. Behavioural
**capability** refers to the individual understands the cause of the behaviour and he/her also possesses the skills to perform it. Although SCT regards that environment is important to shape behaviour, it emphasizes that human being have the potential capability to modify and create environment that meets their own needs and purposes.

Additionally, SCT also stresses that other than human's individual capacity, collective action is also an important human capacity to interact with their environment. People can work together in groups or organizations to achieve environmental change for the benefits of the whole group. Bandura (1997, 2001) proposes the importance of utilizing environmental and social factors to influence health behaviours and health outcomes. In effect, as cultural aspects have important influences on social and physical environments, it is also essential to take into consideration these factors when developing health programs and technologies.

**Self-efficacy** is one of the core concepts of SCT and also one of the most important theories to precondition for a behaviour change, it has been integrated into other models and theories such as TPB. Numerous studies have found that having self-efficacy is an essential factor in diverersive health behaviour change (Grembowski et al., 1993; Ajzen & Timko, 1986; Bandura, 1997). Self-efficacy refers to the belief in one's capability to perform a given behaviour or govern event that affects his/her life (Bandura, 1997). The concept explains that the expectation of a person's self-efficacy determines the person's ideas or actions intended to tackle a problem or situation, the efforts he/she is willing to spend on the actions, and the degree of persistence when he/she is facing obstacle or failure. The greater the self-efficacy, the greater chance of challenge pursuit, the stronger intention of goal striving, and the higher degree of persistence when failure or aversive experience occurs.

Bandura (1977) regards four major sources of information that personal efficacy can be expected: *performance accomplishments, vicarious experience, verbal persuasion,* and *physiological states* (p.195). **Performance accomplishment** is the most influential source as it is based on personal mastery experience, repeated successes of experience increase the mastery expectations. When the stronger mastery expectations
has been developed with repeated succeeded experience, the personal efficacy is
enhanced and it can lead to longer persistence of self-motivation. **Vicarious**
experience refers to watching other people perform the activities successfully can
improve the confidence or persistence of the action. **Verbal persuasion** means using
suggestions to led and influence people to believing that they can cope successfully
with the tasks. However, this source is weaker than performance accomplishment
since it lacks of authentic experience that the personal efficacy is based. **Emotional**
arousal (**physiological states**) refers to the aversive emotions such as stress or fear
have informative value that affect the perceived self-efficacy in coping threaten
situations. Since aversive arousals impede the success of performance, hence they
reduce the sense of self-efficacy. It is, therefore, necessary to provide training of coping
skills to help individuals to handle threaten situations more proficiently and effectively,
which can increase the sense of locus of control and then eliminate fear arousal.

Bandura (1977) considers that the cognitive processing of efficacy information is
influenced by the **enactive, vicarious, exhortative, and emotive sources**. These four
major sources can be developed as ways to increase self-efficacy (Bandura, 1997,
p.200), they include: providing mastery experience by enabling people to attain
success (**enactive**), promoting social modeling by demonstrating the similar others
can also achieve the task (**vicarious**), facilitating verbal persuasion by giving adequate
suggestions and encouragements (**exhortative**), as well as improving physical and
emotional states by developing positive emotions and reducing stress (**emotive
sources**). He regards that the experiential sources are the most influential factors in
perceived self-efficacy.

SCT emphasizes the human abilities to cope with the environment and life challenges.
Cognitive processing of efficacy information including **self-reflection**
**introspection** and **self-beliefs** are valuable and essential part in this process. These
cognitive processings enable individuals to make sense of their experiences, evaluate
their own actions, adjust their thinking, and then regulate their actions to response to
their environment and social systems. This process involves making sense of the
**symbolic meanings** of their experience in the process of interaction with the social
and physical environment, which serves as guidance for actions and communications with the others. It is, therefore, possible to manipulate symbolic means to communicate, persuade and motivate people toward more desirable behaviour. The central point is that the intended goal setting in behaviour change should be supported by sufficient perceived self-efficacy. People who perceived to have higher self-efficacy to pursue a goal will positively affect the motivation to engage in the change (Bandura, 1997).

3.4.1.3. Ecological of Behaviour Change

The ecological perspective of behaviour change emphasizes on the interaction between the individual, social, environment, as well the organization and policy.

Ecological Model of health behaviour stresses the multiple levels of interaction between human and the environment that behaviour is not only affected by psychological and social factors, but also influenced by environmental and contextual factors. The key concept of ecological models is that behaviour has multiple levels of influences including intrapersonal (biological, psychological), interpersonal (social, cultural), organizational, community, physical environmental, and policy (Sallis, Owen, & Fisher, 2008, p.466). It provides a comprehensive framework to study the interaction of multiple levels of influences on behaviour.

The model proposes four core principles of health behaviour (Sallis, Owen, & Fisher, 2008, p.466):

1. There are multiple influences on specific health behaviors, including factors at the intrapersonal, interpersonal, organizational, community, and public policy levels.
2. Influences on behaviors interact across these different levels.
3. Ecological models should be behavior-specific, identifying the most relevant potential influences at each level.
4. Multi-level interventions should be most effective in changing behavior.

According to the model, intervention of behaviour change is most effective when it
applies in multiple levels. The effect is weak and only short term if a motivated individual without giving the support from the environment. The purpose of the Ecological Model is to assist in developing a systematic and comprehensive intervention strategy that targets mechanism of change at different levels of influence. It suggests that the behaviour change is maximized when the environment and policies support healthy choices and behaviour; there are strong social norms and social supports, and people are motivated and educated of those choices (Sallis, Owen, & Fisher, 2008):

3.4.1.4. Transitional of Behaviour Change

The transitional or stages of behaviour change theories focus on understanding how behaviour changes over time. The theories consider that health behaviour change is a process that goes through different stages. One of the most widely adopted theories of this kind is Transtheoretical Model (TTM) (Prochaska, DiClemente, & Norcross, 1992; Prochaska & Velicer, 1997), which is an integrated model developed from different theories of psychotherapy (Prochaska & Norcross, 2010). Rothman and his colleagues also contribute their studies in understanding how behaviour can be maintained (Rothman, Sheeran, & Wood, 2009).

The model suggests a five-stage process of behaviour change including pre-contemplation, contemplation, preparation, action, and maintenance. Pre-contemplation refers to the situation where the individual has no intention to change or unaware of the problem. Contemplation refers to the individual realizing there is a problem and thinking about to change. Preparation is the stage where the individual commits to modify his behaviour; and in action stage the individual has modified his/her behaviour or environment to overcome the problem. If the individual engages in the new behaviour for more than 6 months, it can be said that the behaviour change is maintained and it could later turned into a habit. However, the new behaviour can be relapsed and returned back to the previous stages. This model emphasizes that behaviour change is a process that occurs over time, which could progress in a linear fashion, however, most of the time it is a cyclical process that could
relapse and recurrent during the progress. The time of change in each stage is also progressing in its own pace and is not consistent, some people may stay in one stage, for example, in the pre-contemplation stage for quite some times before moving to the next stage of change, for example, to take action to change.

The theory also considers three factors essential for the behaviour change, they include: decisional balance, self-efficacy, and processes of change. Decision balance refers to the evaluation of the pros and cons of changing, that is, the gain or loss results of the new behaviour. According to the theory, a change occurs when the cons outweigh the pros in the pre-contemplation stage, whereas the pros exceed the cons in the middle stages and action stage (Prochaska & Velicer, 1997; Hall & Ross, 2008). Self-efficacy refers to the confidence of a person perceived to have the ability to cope with high risk situations without turning back to the unhealthy behaviour. The person needs to possess adequate skills and has the incentives to initiate and maintain change. The processes of change involves ten covert and overt activities that people employ in the process of stages of change to attain desirable behaviour (Prochaska & Velicer, 1997). These processes can be divided into two groups: the cognitive and affective experiential processes and behavioural processes. The experiential processes include Consciousness raising, Dramatic relief, Environmental reevaluation, Self-reevaluation, and Social liberation, which are the internal experience such as cognitive evaluation and emotions of the problem behaviour and the effects of the individuals and the others. The behavioural processes consist of Reinforcement management, Helping relationships, Counter-conditioning, Stimulus control, and Self-liberation, they are the strategies that help the individuals to successfully attain behaviour change. According to Prochaska and Velicer (1997), these ten processes provide important guidance for developing of intervention programs as they can affect people to move from one stage to another.

The Transtheoretical Model (TTM) regards that diverse psychological processes are characterized in different stages. To progress through the early stages, people apply cognition, emotion and evaluation processes such as perspectives and reflections. In the Action and Maintenance stage, people reply more on commitments, conditioning,
contingencies, environmental controls and social support (Prochaska & Velicer, 1997).

From their study of smoking cessation interventions, Prochaska and his colleagues (1997) found that interventions to change behaviour that matches with the individuals' stage of change are more effective. Moreover, they also noticed that using interactive interventions (computer-generated expert systems) are more effective than noninteractive communications (for example, self-help manuals or newsletters) when controlling for number of intervention contacts. Hence, they consider that "the future of health promotion programs lies with stage-matched, proactive, and interactive interventions." (Prochaska & Velicer, 1997, p.47) They suggest a paradigm change is needed when developing intervention programs, for example, consider stage paradigm rather than action paradigm, and to match the needs of the participants rather than expecting them to match the needs to the programs.

Another similar stages of change concept was proposed by Rothman and his colleagues (Rothman, 2000; Rothman, Baldwin, & Hertel, 2004; Weinstein, Rothman, & Sutton, 2004). They consider that behaviour change is a process involves four distinct phases - initial response, continued response, maintenance, and habit. According to Rothman (2000; 2004), the determinants of behaviour change in the initiation phase and maintenance phase are not identical. Although self-efficacy and motivation are both essential factors in this process, each has significant role to play in each process - while self-efficacy plays a more crucial role in the initial and continued response stages, motivation is more important to maintain the new behaviour.

The initial response phase is similar to the pre-contemplation phase in TTM, where is an initial stage of behaviour change. The individual needs to acquire high enough motivation and confidence on his ability to perform the new behaviour, that is, self-efficacy, to move to the next phase. In the continued response phase, it has a tension between the individual's ability and motivation to execute the new behaviour and the obstacles that may hinder the continuity of the action. Self-efficacy is also vital in this stage since the individual needs to feel a sense of mastery over his/her new behaviour. When it moves to the maintenance phase, as the individual has built up
some skills and knowledge, the determinants of self-efficacy is less important than the perceived value, that is, the motive, to continuously engage in the new behaviour. As it transits to the habit phase, the individual has developed self-sustained pattern of behaviour, it is more critical of his/her motivation to sustain the behaviour (Angelo, Reid, & Pelletier, 2007).

These theories are useful to understand why some people are more ready to change than the others and they suggest that it should design different interventions or communication strategies for people in different stages to achieve better results. However, the determinants of behaviour change in different stages are still inconclusive.

The TTM and the phases of behaviour change theories both proposed that health behaviour change involves processes of change and different psychological as well as behavioural determinants in each stage. They both agree that self-efficacy and motivations are critical factors in the processes. However, TTM consider that self-efficacy is important throughout the processes, whereas Rothman (2000; 2004) regards that self-efficacy is more important at the initial and continuous stages and motivations are more vital during the maintenance and habit stages.

Many of the previously mentioned theories have explained what causes a behaviour change, however, the understanding of why the behaviour is relapsed and how to maintain the new behaviour in longer term is still not well-studied. Yet understanding the reason for maintaining or failing to maintain health behaviour change is important for designing sustained motivation and user engagement for health-related interactive systems. The next section is focused on understanding the maintenance of behaviour change.

**3.4.2. Maintaining behaviour change**

Why do people fail to sustain desirable behaviour change and what made people maintain them? To study behaviour change has been a subject of concern and some
designs in behaviour change have proved successful. However, many of these studies seem to only achieve short term effects. In fact, to understand how to maintain behaviour over time is critical particularly for people who need to engage in long term behaviour change such as people with diabetes or hypertension. Fail to adhere or compile with intended behaviour such as diet control or taking medication regularly could have adverse consequences, for example, developing glaucoma, foot gangrene, or kidney failures. However, studies about how to maintain behaviour over time are still insufficient.

This part is to provide an understanding of what causes the disruption of behaviour and how the intended behaviour can be maintained. In reviewing the literature, it has found that two theories are most relevant to describe behaviour maintenance: the **Self-Determination Theory** and **Rothman's theory of behaviour change maintenance**. It has found some concepts related to the maintenance of behaviour, including: reflection, motivation, self-efficacy, as well as self-determination. These concepts have been discussed above but their interrelation and how they relate to maintain behaviour change is not well-known. This part is to discuss how these concepts are related and to identify the determinants of behaviour maintenance.

### 3.4.2.1. Internalization of Motivation and Self-Determination

According to Self-Determination Theory, there are two critical conditions for maintenance of behaviour: **internalization of values and skills**, and **experience self-determination**. The theory contends that the patients need to understand clearly why they need to change by internalization; and they also possess the skills and abilities to change; and most importantly, they should be provided an experience of autonomy, competence, and a sense of positive relatedness with the others during the process or in the healthcare settings, as this kind of experience is essential for internalization and a new behaviour will be better sustained (Williams, Deci & Ryan, 1998).

The SDT argues that intrinsic motivation requires to foster the **internalization and**
integration of values and behavioural regulations (Deci & Ryan, 1985). Internalization refers to "a process of taking in a value or regulation" and integration is "the process by which individuals more fully transform the regulation into their own so that it will emanate from their sense of self." (Ryan & Deci, 2000, p. 60). That is to say, internalization relates to the sense of self and the motivation to regulate a person's behaviour. It can be regarded as a continuum process to describe the motivated behaviour of a person ranging from amotivation to passive compliance, and to active personal commitment, by the degree of internalizing the values of the intended behaviour. When more internalization a person gains, the greater the persistence and more positive self-perception one becomes, and the quality of engagement is also enhanced (Ryan & Deci, 2000, p. 60-61).

Internalization can be achieved by providing a sense of autonomy, perceived competence and positive relatedness. Autonomy can be supported by providing relevant information and meaningful rationale for change, but it is not by external control or pressure. They also need to have a confidence and the sense of competence to succeed at it. It requires the person to acquire relevant skills and experience the competence in performing the action. To provide training and feedbacks, assist with affordable skills and tools for change, as well as necessary supports when competence barriers or problems occur can all increases the sense of competence.

The feeling of relatedness is also important for internalization as people generally want to feel a positive connection with others. It is especially important for the extrinsically motivated behaviour that are not inherently interesting. Since people perform the behaviour may mainly because it is valued by significant others, for example, their family, peer group, or a society, for those they have or would like to have positive relationships with. It suggests that facilitating social connection and supports to fostering a sense of belongingness are essential.

SDT argues that if only provides competence and relatedness without autonomy support will not achieve self-determined. In effect, they propose that autonomy is the critical element to promote internalization for a regulated behaviour since it allows the
person to develop integration of his/her own action, that is, feeling that the action or behaviour is valuable and meaningful:

*Controlling contexts may yield introjected regulation if they support competence and relatedness, but only autonomy supportive contexts will yield integrated self-regulation. To fully internalize a regulation, and thus to become autonomous with respect to it, people must inwardly grasp its meaning and worth. It is these meanings that become internalized and integrated in environments that provide supports for the needs for competence, relatedness, and autonomy.* (Ryan & Deci, 2000, p. 64)

Some experimental studies have shown that if providing meaningful rationale for change and positive social supports for autonomy, it can promote internalization and integration of behaviour change even for uninteresting action (Deci, Eghrari, Patrick, & Leone, 1994). The SDT theory suggests that by providing autonomous motivation for people to internalize the values and meanings of the behaviour as well as environment supports are more effective than controlled motivation in behaviour change.

### 3.4.2.2. Rothman's theory of behaviour change maintenance

On the other hand, Rothman (2000) is focused on understanding the determinants in behaviour change processes and its maintenance. He considers that the failures of many intervention strategies over time is due to misconception about the health behaviour change process. He argues that there are distinct psychological processes in directing the initiation and maintenance stage of behaviour change, and that the determinants of behaviour shift from one stage to the other.

According to him, while the decision to initiate a behaviour change in the initiation stage is dependent on the favorable expectation regarding future outcomes, the decision on continue regulation of behaviour is dependent on perceived satisfaction with received outcomes. That is to say, "decisions about behavioral maintenance reflect a shift in focus as people become less concerned about what *will* happen and more

Although a behaviour change is generated by expected favourable outcome, it is the continuous satisfaction of the experience and received results that reinforces and maintains a behaviour. However, over time the feeling of satisfaction will decrease which may affect the maintenance of the behaviour unless the experience becomes habitual. The factors of satisfaction, according to Rothman, can be related to people's expectations about the outcome and the satisfaction in the particular classes of experience which is different individually. Moreover, behaviour change is sustained over time when it has become a habit by repetition the behaviour in a stable context.

In the study of diet behaviour change, he and his colleagues identify two different determinants, the *reflection system* and *automatic system*, in the initial and maintenance stage of behaviour change (Rothman, Sheeran, & Wood, 2009). **Reflection system** requires active cognition processes on logical thinking and reasoning that is based on even single experience, by contrast, **automatic system** is rather an accumulated set of experiences resulting in learning over time. He considers that several determinants are important in the initial behaviour change stages, they include: *attitudes, social norms, self-efficacy* and *intention*, which are the key predictors of behaviour change. Nevertheless, the strong intention and high self-efficacy alone may not guarantee that behaviour change will be successful if it lacks of adequate resources or social and environmental supports. He suggests the role of context is important and they should be considered in the behaviour change process especially in the maintenance stages.

Rothman argues that reflection processes are crucial at the beginning stages of new behaviour because it involves deliberation and intention formation, however, they do not guarantee the behaviour can be sustained over long term. Rather, he considers that autonomic is more vital in the maintenance stage since when the behaviour becomes habitual, it requires minimal cognitive resources and is permanently active. and the automatic response can be affected by environment cue. Reflection is important at the beginning stages since people evaluate the values of the behaviour and they should have confidence in their own ability to perform the behaviour. In this stage, health
message is crucial in attitude change and formation of intentions. However, when the behaviour becomes habitual by repeatedly respond in a stable context, it can be maintained without reflecting on their intentions or behaviour goals. In this stage, the behaviour becomes a habit that is sustained automatically and activated from memory or in a given context, for example, food package or healthy food menu. So the aim of the intervention for sustained behaviour change should assist people to form healthy habits.

3.4.2.3. Summary of Behaviour Change Maintenance

These theories both provide explanations on how the behaviour is changed and maintained. Although in different approaches, they both share some common indications in the behaviour change processes:
- there is a process of motivation of behaviour change;
- internalization and reflection is important to initiate behaviour change;
- maintenance of behaviour requires a continuous satisfaction of experience;
- context plays significant role in behaviour change.

The differences of these concepts are that, for Self-Determination Theory, satisfactory of experience comes from feeling autonomous, perceived competence and positive relatedness, where it is more focused on the internalization of values of intended behaviour and intrinsic motivation of the experience. For Rothman, the role of different determinants play in different stages of behaviour change; and reflection is more important in the initial stage, whereas automatic is essential in maintaining the behaviour. He emphasizes that the formation of habitual behaviour can be activated by memory response and context cue. He also considers that satisfactory is an expectation of the outcomes from performing the behaviour and it is also quite personal, since the feeling of satisfaction of the outcome experience justifies the value of the action that the initial decision to change behaviour is correct and worthwhile to sustain, which encourages more similar behaviour.

To sum up, behaviour change involves different stages and different determinants are
vital in each stage. The maintenance of behaviour over time requires several factors: firstly, it should achieve autonomy, competence, and relatedness experience since they are intrinsic motivation for psychological well-being. Secondly, the intended behaviour needs to meet the expected outcomes, however, the expectations may be quite different individually so an in-depth understanding is needed. Thirdly, it should provide contextual supports and develop different intervention strategies to target for the particular stage during the behaviour change processes.

3.5. An Integrated Model of Sustained Behavior Change

The model is developed from the above literature review with a convergence of motivation and well-being theories, as well as health behaviour change theories. This model highlights some key issues in behaviour change and motivation, particularly the key determinants of each stage of behaviour change and how the behaviour can be maintained over time. The model is shown in the following diagram (Figure 3.1).

![Figure 3.1 - Model of behaviour change process and sustained motivation](image-url)
First of all, persuasion and motivation are two different concepts although they are highly related and usually combined to use together. In behaviour change, these two concepts play two different roles and they support each other. For initiative behaviour change, persuasion plays more prominent role since it needs to persuade that there is a need to change. However, to make the change happens, the person needs to have a motivation to change. Persuasion strategies such as health messages are more significant in this stage to facilitate internalization of values and meaning of intended behaviour by self-reflection. Motivation requires stimulation and facilitation to fuse”l the behaviour to be changed and sustained.

Secondly, a person's behaviour change depends on his/her own's attitude and beliefs; the perception of his health, the risks and threats, the costs and benefits, and the expectations to engage in the action; and all of these could be shaped by his/her past experience and knowledge, as well as the messages he/she received and perceived.

Thirdly, in order to initiate a change, there are at least three elements take place, they include the motivation, the trigger and the ability of the person. The motivation means that the person has an intention to change, and the person should be confident to process the ability to perform the intended behaviour; and finally there is a trigger for the action. The trigger is a stimulation that initiates the change, it could be positive or negative, derive from internal and external sources. For example, it may be because of the influence of the peers (positive + external), or he/she wants to look good (positive + internal). Or, it could be he/she witnesses the suffering of other people that have the similar disease he/she has (negative + external), or some health warning signals he/she detects (negative + internal). It is usually the more urgent, more severe, and higher threats that the person perceives the stronger trigger of the change.

Fourthly, motivation and behaviour change is not static and it goes through different stages and could fluctuate from time to time. Individuals in different stage, or they possess different knowledge and in different involvement level have different needs, so the persuasive messages and motivation strategies should be tailored to their needs to
achieve the best effects. For example, for high involvement and/or high literacy people, the use of cognitive types of messages is more effective than affective types of messages.

Fifthly, intrinsic motivation, for example, to keep healthy, is found to be more robust and endured than extrinsic motivation, for example, monetary rewards, in behaviour change. Intrinsic motivation leads to well-being so understanding the concepts of well-being and to adopt it into design strategies should be able to motivate the person to engage in long-term behaviour change. On the other hand, to achieve intrinsic motivation requires internalization which is a process accomplished by reflection. Reflection is mainly a cognitive process that regulates behaviour.

Finally, the action and behaviour change will be maintained or withdrawn depending on the experience of the action which serves as a reinforcement. Positive reinforcement could influence the repetition and maintenance of the behaviour, and vice versa. The sustained behaviour change also involves self-efficacy and barriers of the action; if the person perceives that there is a barrier that he/she is not able to overcome during the process; or that there is negative feeling about it; or the action is no longer meaningful and valuable, the action or the behaviour will be terminated. It should also provide constant stimulation such as updated information to attract the users to revisit or repeat the behaviour. As repeated behaviour and experience can lead to the formation of habit which is more sustainable in the long term. Furthermore, a new behaviour can be formed is dependent also on the social and environmental supports of the person.

The key determinants and the purposes of the intervention of each stage of behaviour change is summarized below (Table 3.3). It shows that in different stages of behaviour change, it requires different key determinants in influencing behaviour, so intervention strategies should be designed and developed accordingly to tailor for different needs in the change process. Finally, it is argued that although the model is about the change of health behaviour, this model and intervention strategies should be equally adequate for general behaviour change situations.
### Table 3.3: The key determinants and the purposes of the intervention of each stage of behaviour change

<table>
<thead>
<tr>
<th>Stage of behaviour change</th>
<th>Key determinant</th>
<th>Purpose of the intervention</th>
<th>Design strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initiation</strong></td>
<td>Attitude and beliefs; Perception of risks, Costs and benefits, Past experience;</td>
<td>Provide values and meaning of the intended behaviour</td>
<td>Persuasive messages focus on the risks and benefits of the change</td>
</tr>
<tr>
<td><strong>Aware of the problem</strong></td>
<td>Expectation of benefits; Perceived outcomes expectation/ effectiveness Experience of internalization and self-reflection Gaining skills and knowledge</td>
<td>Provide values and meaning of the intended behaviour Facilitate internalization through self-reflection Promote self-efficacy through training of skills and knowledge</td>
<td>Focus on achieving internalization of values and skills. Persuasive messages and strategies using: - narratives - games - graphics and statistics - personal experience - social influence</td>
</tr>
<tr>
<td><strong>Intention to change</strong></td>
<td>Motivation, Trigger Self-efficacy Skills and Knowledge;</td>
<td>Promote self-efficacy through training of skills and knowledge Support competence and locus of control</td>
<td>Facilitate self-efficacy</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Dimensions of well-being such as Autonomy, Competence, Relatedness, Self-acceptance, Purpose and meaningful in life, Personal growth, Hedonic and Sense of hope</td>
<td>Provide valuable and meaningful experience Positive reinforcement Provide continuous stimulations and ultimate challenges</td>
<td>Reinforcement and rewards Facilitate self-determined and wellness user experience</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>Repeat behaviour Automatic response by context cue</td>
<td>Social and environmental supports</td>
<td>Environmental cues</td>
</tr>
</tbody>
</table>

### 3.6. Summary of the Chapter

This chapter discusses some major psychological theories related to well-being and
behaviour change. Firstly, it has discussed why well-being is important for healthcare and chronic management. Some key factors of well-being are identified including Hedonic, Self-acceptance, Positive relations with others, Autonomy, Environmental mastery, Purpose and meaningful in life, Personal growth, and Sense of hope.

Secondly, it reviews the theories of motivation and health behaviour change. It noticed that an individual’s behaviour is not only affected by internal motivation such as attitudes, beliefs, and perception, but also influenced by social, environmental and even institutional context.

Thirdly, an integrated model is developed based on the theories in the literature and it recognised that health behaviour change moves through different stages and there are key determinants in each stage. Three key determinants are recognized in the process of health behaviour change, they include: self-reflection, self-efficacy, and positive experience that leads to well-being. Self-reflection is crucial for the initial stages since the person needs to understand and internalize why a new behaviour is necessary and what kinds of skills and knowledge they require to possess in order to achieve the expected results. A greater internalization can lead to stronger persistent of the new behaviour. In this stage, persuasive communication strategies such as health messages or risk communication play an important role to assist self-reflection. Self-efficacy is important during the action process since the person believes himself/herself to possess knowledge and capability to achieve the new behaviour. Finally, a new behaviour can be sustained relies on the positive experience gained during the process in a stable and supportive context. That experience should include at least one or some of the psychological well-being such as hedonic, autonomy, meaning and values, positive relationship with others, and so on, since they are the intrinsic motivation of human being. These key determinants can serve as a basic concept for developing design strategies for behaviour change and persuasive systems.

With this regard, it should be identified what persuasive strategies could be employed to promote self-reflection and self-efficacy, and what attributes are essential to
produce positive experience in persuasive systems. They are the purposes of reviewing the literature in the next two chapters - the understanding of persuasion communication strategies and user experience in digital systems.
4. Risk Communication, Reflections, Persuasive Strategies

4.1. Introduction

In the previous chapter, it has identified three key determinants in different stages during the health behaviour change process: reflection, self-efficacy and positive experience. Reflection is the initial stage to facilitate individuals aware of the problem, self-efficacy is the motivator to encourage action to be taken, and positive experience reinforces the behaviours over longer term. As these determinants have different goals and psychological and behavioural factors, it requires using different design strategies and tactics, for example, persuasive strategies is more important for eliciting reflection, while motivation and enhancing positive experience of the systems and user behaviour are more essential for action-taking and maintenance of long term health behaviour change.

Self-Determination Theory (Deci & Ryan, 1985; Williams, Deci, & Ryan, 1998) suggests that internalization of values and skills, and experience self-determination are important in changing and sustaining of behaviour; so design strategies should be adopted to provide different experiences for behaviour change. Internalization of values and skills requires self-reflection experience to understand the values of change. Experience self-determination requires the systems to promote intrinsic motivation by developing a sense of autonomy, competence, and social relatedness (Deci & Ryan, 1985; Williams, Deci, & Ryan, 1998).

In studying behaviour change, to consider the experiential aspects of products and services are important. As John Dewey (1980, p. 50) puts it, "It is only through experience that man learns about the world and only by the use of his experience that man can maintain and better himself in the world." Experiences from interaction with the products have certain effects on us to understand ourselves and the world. According to Margolin (2002), experience has both operative and reflective
dimensions: "The operative dimension refers to the way we make use of products for our activities. The reflective dimension addresses the way we think about a product and give it meaning" (p. 42). Therefore, the experience of a product or system do not only refer to the way users using the products to perform certain activities, but it also creates meaning from that experience. Design for health behaviour change should aim for design experience for reflection and for meaning, as well as experience for transformation to support change.

This chapter reviews some of the persuasive communication theories for self-reflection. It discusses different kinds of persuasive strategies particularly focus on narrative, gamification or education entertainment, and graphical and statistical forms in communication for fostering self-reflection and self-efficacy. A comparison of these forms is discussed.

4.2. Theories of Persuasion

The previous section provides an understanding of the factors that affect behaviour change; however, they cannot explain why promoting the same message is effective for some people and not for the others. Moreover, it needs to understand what kinds of design strategies and tactics can be used to achieve behaviour change.

Persuasion, according to Perloff (2003), is defined as "...a symbolic process in which communicators try to convince other people to change their attitudes or behaviors regarding an issue through the transmission of a message in an atmosphere of free choice." So persuasion is a process of behaviour change that occurs not by force or coercion but provides free choices to the receivers through symbolic means or messages. O'Keefe (1990) argues that persuasion is communicational since it involves the goal and intention of the senders, through a means of message to achieve that goal, and the receivers must have free will to receive the message or not. Reardon (1991) regards that persuasion involves using reasoning and emotional appeals to guide and influence people to adopt certain attitudes, beliefs, or behaviours that are preferred by the sender/persuader.
On the other hand, a theory of persuasion, according to Borchers (2012, p.37), "is a set of statements designed to describe, explain, and/or predict persuasion communication." The persuasive theories can help us to understand why people behave in certain way and may assist us to predict the behaviour through the use of particular strategy.

Attitude is important to persuasion since attitude affects behaviour (Dainton & Zelley, 2010). An attitude is a “relatively enduring predisposition to respond favorably or unfavorably” toward something (Simons, 1976, p. 80). We have certain attitudes toward people, things, brands, products, and so on. These attitudes are learned from our beliefs and past experience and are more endurable. Attitudes affect our behaviour in longer term but change is also possible under certain effects or circumstances. For instance, our attitudes of certain things or people may change if we have a deeper understanding of them or have special experience that changes our thoughts.

4.2.1. Persuasion as rhetoric

Persuasion can be traced back to ancient Greece as the art of rhetoric, one of the arts of using language as a means to persuade. The Greek philosopher Aristole contended that there are three modes of persuasion: *ethos, logos, and pathos*. The first mode *ethos* is related to the word ethics or ethical which refers to the character or image of the persuader who possesses the charisma or credibility to convince the audience (Demirdogen, 2010). Aristole regarded that if the persuader is perceived to be honest, has good character, goodwill and good reputation, then the persuader is tended to be more persuasive. *Logos* refers to appealing to the intellect or to reason, and using logical appeal such as facts and figures to support the persuader's arguments. Finally, *pathos* means to appeal to the audience's emotions. According to Aristole, emotions such as anger, fears, pity, or positive moods have strong effects on people's decisions and rational judgments. Emotion appeals can be accomplished in various ways such as using images, metaphors, or storytelling.
4.2.2. Elaboration Likelihood Model (ELM)

In health psychology or persuasion communication theory, one of the most important as well as most widely recognized theory is the Elaboration Likelihood Model (ELM). Developed by Petty & Cacioppo (1986), Elaboration Likelihood Model (ELM) provides an extended conceptual framework for understanding the persuasive processes in relation to the message, the receiver and the contextual effects of persuasive communication. It indicates that the source, quality and characteristics of the message and how it relevant to the receiver can affect the effectiveness of the persuasion and then attitude change.

According to the theory, persuasion is a process in which the success of the influence is determined by how the persuasive message makes sense to the receiver (Dainton & Zelley, 2010). People are mainly influenced by two routes of persuasion, a central and a peripheral route. The central route of persuasion involves thinking about the content of the message, whereas the peripheral route relies more on autonomy response to stimuli for processing information. The central or elaborated route of persuasion is more complex and it relies more on cognitive efforts to evaluate the persuasive message based on rational information, arguments, facts and evidences to support a claim or conclusion. The peripheral route of persuasion, on the other hand, depends more on employing simple cues to affect a behaviour change.

An individual who has high level of involvement, that is, higher level of intention, is more influenced by central route since he/she tends to look for extensive information and would like to carefully evaluate the content information for decision making. In contrast, an individual who has lower level of involvement, that is, lower level of intention, tends to be affected by peripheral route of persuasion such as attractive images.

Petty and Cacioppo (1986) regard that central route of persuasive messages are more endurable for long term change than peripheral messages. They believe that attitude is more persistent if the audience has high motivation to carefully evaluate the
information. However, it requires to fulfill two conditions: the person's motivation must be high enough to process all the given information, and the person must be able to comprehend the message cognitively. For instance, an advertisement of motorcycle may not have the persuasive effect if the audience does not have the motivation to purchase and the time or knowledge to comprehend the promotional message.

ELM suggests that both motivation and ability of the receivers are essential factors for the elaborated message to be succeed. Hence, it stresses that effective persuasion requires to understanding the receiver when considering the appropriate route of persuasion, and tailoring the message for different kinds of receivers. Recent studies also regard that the route of direct and indirect persuasion processes may act simultaneously, so it can combine the persuasive elements of both routes.

4.2.3. Six Principles of Influence

Another influential persuasive communication theory is Cialdini’s Six Principles of Influence. Since not every receivers have the time, motivation and ability to evaluate the information cognitively, sometimes receivers will depend on the peripheral cues for decision making. Cialdini (1993) identifies six common cues for peripheral message that are possible to influence behaviour: authority, commitment and consistent, contrast, liking, reciprocity, scarcity, and social proof.

**Authority** refers to using the perception of authority to influence the audience to accept the beliefs or behaviours since people generally tend to obey the authority, such as doctors or supervisors, since they may have the pressure to act.

**Commitment and consistent** refer to a person's dedication to a product, social cause, political party, and so on. Cialdini (1993) regards that humans have desire to be consistent so when we commit on something, we tend to act consistent to the future. He contends that people are more committed to a cause if the commitment is announced publicly than in private.
Liking refers to the concept that people are usually influenced by someone they like. We generally like people who are familiar or similar to us, or give us compliments, or simply people we trust. Rapport in interaction is important for gaining liking since we like people who have something in common with us.

Reciprocity emphasizes a give-and-take relationship. People tend to return favors and treat others the same way they are treated. Since people feel obliged to do something in return for repaying the others' action for them. The same is true when we do something for others and expecting others will do the same way for us.

Scarcity means that people usually think that things are more appealing when their availability of time and quantity are limited. So scarcity of time and quantity generate a sense of urgency since people are worried of missing out on something, that push people to act quickly.

Social proof refers to use peer pressure to influence behaviour. People tend to follow the crowd especially when the crowd is large. Since we incline to think it is "safety in numbers" particularly when we are in uncertain situation, we are also more easily to be influenced by people who are seemed to be similar to us.

These are peripheral cues that mainly tackle to emotions and create some sense of emergency to influence behaviour. However, these tactics can only achieve short-term effect but not long lasting change. The use of these tools are also needed to be cautious since it may mislead or deceive people, which causes ethical problems.

4.3. Persuasive Strategies in Behaviour Change

A number of persuasive strategies have been used for promoting behaviour change. Some of the most commonly use in persuasive systems such as goal setting in assistance with giving feedback (Locke & Latham, 2002; Consolvo, Everitt, Smith, & Landay, 2006; Lin et al, 2006; Maitland et al, 2006), and rewarding mechanism (Berengueres, Alsuwairi, Zaki, Ng, 2013). However, there is still limited evidence of
their long term effects (Colineau & Paris, 2012). In particular, studies have showed that using external rewards, such as monetary or point rewards, on motivation can only achieve short term results. The intended behaviour may cease after a period of time or when the reward is removed, it may even undermine the performance (Gneezy & Rustichini, 2000). As Deci (1971) argues that rewards are extrinsic motivations, if they are used unrelated to the nature of the activity may even harmful to the intrinsic motivations towards the reinforcement of the behaviour.

On the other hand, behaviour theories such as Self-Determination Theory, Self-Cognitive Theory, and Rothman's maintenance of behaviour change consider that self-reflection introspection is an important process for generating behaviour change, and people who process the internalization of values and skills as well as experience self-determination are more likely to sustain the behaviour (Williams, Deci, & Ryan, 1998). Numerous studies have focused on promoting reflective thinking as persuasive strategies in behaviour change. For example, Brown et al (2006) used a food photo journey to help students' reflection of their diet and physical exercise habit, and Orji and her colleagues (2012) designed a slow-causal game for helping people to reflect their diet behaviour so as to promote long-term behaviour change.

Reflection can be achieved in many ways. This study is focused on understanding the use of persuasive communication strategies including narrative and games, graphics and statistics to trigger reflection and how they can motivate behaviour change. Content information is essential to elicit reflection and providing adequate information is important since the content message can help to change attitudes which is more lasting than just change behaviour. Moreover, increasing knowledge can increase the sense of self-efficacy through symbolic means to communicate, persuade and motivate for self-reflection and desirable behaviour change (Bandura, 1977).

**4.3.1. Reflection**

Encouraging reflection is an important process of behaviour change especially in the initial stages (Rothman, 2007). According to Self-Determination Theory (Deci & Ryan,
long term behaviour change requires internalization of values and skills where the individual reflect their behaviour and internalize the values and benefits of new behaviours, and they also need to perceive to possess the abilities to change.

Reflection, according to Boyd and Fales (1983, p.101), is defined as "the process of creating and clarifying the meaning of experience (present or past) in terms of self (self in relation to self and self in relation to the world). The outcome of the process is changed conceptual perspective. The experience that is explored and examined to create meaning focuses around or embodies a concern of central importance to the self."

So reflection is described a process in which an individual is aware of an experience that usually causes cognitive dissonance, it triggers an internal examination and exploration of the issue of concern, through creating and clarifying the meaning in terms of self, resulting in a change of perspective and possibly behaviour. While reflection is usually stimulated by external force, the reflection occurs internally and each individual may have different effects triggered by different strategies and experience, and different individuals are more or less conscious of their reflection (Boyd & Fales, 1983; Wood Daudelin, 1997).

According to Bandura (2001), human beings are not only "agents of action" but also self-examiners of their own behaviour, and they have the capability to regulate the accuracy of their thoughts and actions through self-reflection.

*Through reflective self-consciousness, people evaluate their motivation, values, and the meaning of their life pursuits. It is at this higher level of self-reflectiveness that individuals address conflicts in motivational inducements and choose to act in favor of one over another.* (Bandura, 2001, p.10)

It is in that process that people judge their own behaviour according to their expectation of the behaviour outcomes, the reactions and effects of others, deduction
from existing knowledge and the possible follow actions of it, to regulate their behaviour (Bandura, 2001). Bandura (2001) emphasizes that the new behaviour is taken place only when the person's perceived self-efficacy is strong, that is, the belief of one's capability to perform the new behaviour and overcome challenges.

Reflection is a kind of learning process (Wood Daudelin, 1997). Since reflection is a highly cognitive process requiring the individuals to take an experience from the outside world and connect it with their past experiences, carefully think and evaluate them with the meaning in terms of self. If this process leads to learning, the individuals develop inferences to approach the world in different manners than before (Wood Daudelin, 1997). It has been recognized that reflection is a key learning tool (Schon, 1991) that can initiate new behaviour since "learning is the creation of meaning from past or current events that serves as a guide for future behaviour."(Wood Daudelin, 1997, p.39).

On the other hand, reflection is also a healing process (Myss, 1996; Lauver, 2000). Healing, according to Myss (1996, p.48), is "an active and internal process that includes investigating one's attitudes, memories, and beliefs with the desire to release all negative patterns that prevent one's full emotional and spiritual recovery." The process of healing requires the individual actively reviews the external situations to examine and acknowledge the truths about one's life with the internal belief and desire to make efforts for the creation of one's love, self-esteem, and health (Myss, 1996, p. 48). The results of reflection may lead to a change of behaviour which is an important step for initiating a healing process.

From the above reviews, it can be defined that reflection is a process that involves the inner self, from the interaction with the outside world, through examination of the past and present, the learning of new information and knowledge, and expectation of the future, that causes a change of conceptual perspective and even behaviour.

4.3.1.1. Stages of Reflection
Some scholars consider reflection involves several stages or levels (Boyd & Fales 1983, Boud et al 1985, Schon 1991; Wood Daudelin, 1997). For instance, Boyd & Fales (1983) identify six components in reflection process from a sense of inner discomfort, to identify or clarify the concerns, to open to new information leading to resolution and integration, then establish continuity of self with past, present, and future, finally decide whether to act on the outcome of the reflection process. Wood Daudelin (1997) suggests that reflection process involves four distinct stages: articulation of a problem, analysis of that problem, formulation and testing of a tentative theory to explain the problem, and finally action. On the other hand, Schon (1991) identifies only three stages of reflection including: conscious reflection, criticism and action.

From reviewing the literature, Atkins and Murphy (1993) summarize three stages of reflection: awareness, critical analysis, and new perspective. Awareness is the first stage in reflection where it occurs when the individual recognizes a discomfort feelings or thoughts, and it arises since his or her existing knowledge is insufficient to explain the situation in concerns. It is also a need that is triggered by curiosity or excitement to understand and learn more about the situation. The second stage is critical analysis of the concept, event or situation where the individual examines his/her feelings or existing knowledge, with the attempt to provide an explanation or possibly generate new knowledge. The third stage is new perspective derived from the generation and application of the new knowledge, in which the individual gains deeper understanding of the concept, event or situation. The reflection process involves both cognitive and affective stimulation that lead to behavioural change. Atkins and Murphy (1993) consider certain cognitive and affective skills are required to engage in the reflection process, such as: self-awareness, description, critical analysis, synthesis and evaluation. They suggest to develop these crucial skills so as to increase the reflective abilities of the individuals.

4.3.1.2. Using reflection in persuasive design systems

Since reflection is important for behavioural change, a number of studies have been using various techniques to stimulate reflection. They include using questions,
narratives, games, graphics and statistics, as well as personal experience to elicit self-reflection in promoting health and desirable behaviour. For example, Wood Daudelin (1997) recognizes the power of questions and suggests to use questions for increasing the learning power of reflection. Since asking questions help to clarify meaning, and to structure the progression through different stages in the reflection process (Wood Daudelin, 1997, p.42). For instance, the posing and answering of questions in class discussion can stimulate debates, and guide case analyses; in counseling, therapists can use provocative questions to guide clients through the discovery process. The use of quizzes and tests can also reinforce learning and understanding. She proposes that it is most effective in enhancing reflection by asking different types of questions during different stages of reflection. Furthermore, she also suggests writing as one of the power tools for stimulating reflection. That is especially useful for the individual to reflect alone since it helps to produce insights during the reflection process.

Examples of studies that aim at facilitating reflection in health behaviour change are many, some of them include diabetes management (Mamykina et al, 2008), healthy diet (Rothman, Sheeran, & Wood, 2009; Gao, 2012; Orji,Vassileva, & Mandryk, 2012), healthy lifestyle (del Valle & Opalach, 2005; Nakajima, Lehdonvirta, Tokunaga, & Kimura, 2008; Colineau & Paris, 2012). They employed different strategies to elicit self-reflection. For instance, Mamykina et al (2008) developed a mobile health monitoring application MAHI for people with diabetes with the focus on using social scaffolding to develop their reflective thinking skills on diabetes care. They found that after using the system for 4 weeks, the attitudes and behaviours of the patients changed and the patients were more engaged in diabetes education. They also found that the patients had significant increase of a sense of locus of control over their disease and their perceived role in management than the control group.

4.3.1.3. Risk communication strategies for reflection

Perception of risk can also affect behaviour change since considering the harmful effects and consequences of adversed behaviour that might cause can motivate people
to take actions to reduce or control it (Julian-Reynier et al, 2003). Risk communication is regarded as an effective way to provoke self-reflection and then behaviour change. Risk communication, according to The US National Research Council (NRC), is defined as "an interactive process of exchange of information and opinion among individuals, groups, and institutions. It includes discussion about risk types and levels and about methods for managing risks. Specifically, this process is defined by levels of involvement in decisions, actions, or policies aimed at managing or controlling health or environmental risks." (Lum, & Tinker, 1995). Risk communication should provide information of the risks and also the methods for managing them. If individuals have high perception of risk but lack of self-efficacy or knowledge in proper methods to manage the risks, it can increase distress and cause behaviour inaction (Julian-Reynier et al, 2003).

According to Siaw (2009), persuasion is affected by various types of factors and they can be briefly classified as presentation, linguistic and content related factors. Presentation related factors refer to the information presented to the user in forms of modality type, message order and/or use of embodied conversational agents. Linguistic related factors related to how information is conveyed through linguistic formation, they include message type and language use. Content related factors are concerned about the type of message content embedded in the information, for example, the use of narratives or statistical information. The present study is focused on the presentation and content related factors since the use of narrative and statistic evidences are some of the most common strategies in risk communication.

The following sections are focused on discussing the persuasion effects of narrative, gamification, as well as graphics and statistics in risk communication and the related works in health behaviour change.

4.3.2. Narrative

A commonly used in persuasive communication is narrative. Narrative formats are many, including: entertainment education (such as games, soap operas, cartoons,
dramas), case histories, reportings and journalism, literatures, testimonials, and storytelling (Hinyard & Kreuter, 2007; Kreuter et al, 2007).

The definition of narrative or storytelling is varied. According to Hinyard and Kreuter (2007), “A narrative is any cohesive and coherent story with an identifiable beginning, middle, and end that provides information about scene, characters, and conflict; raises unanswered questions or unresolved conflict; and provides resolution.” (p.778).

Kreuter et al (2007), on the other hand, define narrative communication as “a representation of connected events and characters that has an identifiable structure, is bounded in space and time, and contains implicit or explicit messages about the topic being addressed.” (p.221).

From the above definition, the characteristic of narrative involves a sequence of connected events, scenes and characters, has an identifiable structure, and contains some sorts of messages through a story. Narrative is a powerful tool in persuasion (Hinyard & Kreuter, 2007) and it has been employed in health promotion and promoting behaviour change. For example, Igartua, Cheng and Lopes (2003) studied the persuasive effects of using short films on AIDS prevention; Kreuter et al (2007) studied the narrative communication in cancer prevention and control.

Narrative structure is often used in entertainment-education. Entertainment-education (E-E) is defined as “the intentional placement of educational content in entertainment messages” (Singhal & Rogers, 1997, p. 117). Thus, entertainment-education can be in various formats such as one education scene, episode, or storyline that are embedded in entertainment program or media to deliver prosocial messages with an intention to positively influence awareness, knowledge, attitudes and/or behaviour (Moyer-Guse, 2008). E-E has been used for diverse health intervention programmes and it is considered as an effective way to convey prosocial and health messages (Moyer-Guse, 2008; Murphy et al, 2011). It is especially useful in situations where the involvement of the receivers is low (Kreuter et al, 2007).
Why narrative is effective in persuasion? Kreuter and his colleagues (Hinyard & Kreuter, 2007; Kreuter et al, 2007) conducted comprehensive reviews of narrative communication. From reviewing theories of health behaviour and communication, they identify several distinctive characteristics of narrative in persuasive communication:

- Narratives help overcome resistance to a message by reducing counterarguing;
- Narratives facilitate information processing and learning;
- Identification and perceived similarity with characters in a narrative influence perception

I summarize their findings in the following in addition with the other studies by different scholars and researchers regarding narrative communication in persuasion.

1. **Narratives help overcome resistance to a message by reducing counterarguing**

According to Kreuter et al (2007), resistance to change behaviours may involve many reasons, some of the reasons include fear and a lack of perceived self-efficacy, that is, people are not confident to perform the behaviour successfully. Studies have found that the use of modeling technique, which means seeing the other to perform the behaviour successfully, can be an effective way to influence people. Using narrative format in modeling by telling a successful story of similar other can provide example for people to follow and they know what to expect from the behaviour, therefore they are more willing to change.

On the other hand, not everyone exposes to persuasive communication will accept the message's claims. People who resist to persuasive messages may counterarguing the message claims, ignoring the messages altogether, or denying the validity of the message because they may not trust the message source (Kreuter et al, 2007, p.223). Using narrative may reduce the counterarguing because of several reasons:
The first is **Transportation**, the effect when individuals are immersed or transported in a story. "Transportation is an experience of cognitive, emotional, and imagery involvement in a narrative." (Green, Brock, & Kaufman, 2004). As Kreuter et al (2007) state,

> **Transportation may reduce individuals’ ability to counterargue story assertions, because the reader’s mental capacity is devoted to imaging story events. It may also be more difficult to counterargue conclusions that are implied by the story rather than stated directly as arguments. Transportation may also reduce individuals’ motivation to counterargue, because interrupting the narrative flow to dispute the author’s claims or descriptions would likely destroy the pleasure of the experience.** (p.224)

Study has found that transportation can affect beliefs (Green & Brock, 2000).

Secondly, narratives tend to be concrete as they describing the lived experience of others, which are interesting and more plausible.

Thirdly, narratives are a subtle form of persuasion since individuals may be attracted by the plot, interest, characters, or entertainment value of the narrative and then be influenced by the information in the story. Kreuter et al (2007) consider that it is more effective in the prediagnosis state since after diagnosis, people may more likely to actively seeking information. However, they suggest that the narrative health messages should not be too subtle that people may miss the intended messages.

Other reasons include reducing resistance due to fear such as to convey cancer-related message, since stories are less threatening; or due to distrust the healthcare providers; or lack of perceived message relevance (Kreuter et al, 2007).

2. **Narratives facilitate information processing and learning**

According to Kreuter et al (2007), storytelling is representation of social information
and social experience that human beings have innate ability to process this kind of information without education and training (p.225). Hence, the use of stories and other forms of narrative can enhance attention, comprehension, memory and recall of information. Narratives are particularly significant for those who have low motivation or lack the education and experience to process complex and didactic information: "for other audiences, including people with limited numeracy skills, lower health literacy, lower self-efficacy for understanding information, those who mistrust medical authorities because of their cultural or economic difference from themselves, and those from cultures that define knowledge or wisdom primarily as that which is gained through lived experience, narratives may be of particular utility." (Kreuter et al, 2007, p.225)

Furthermore, they also consider that the use of narratives is particularly valuable during the diagnosis and treatment stages since individuals, regardless of education or motivation, may experience overwhelming emotions that it is difficult for them to focus on complex didactic information (Kreuter et al, 2007).

Narratives, therefore, may be more useful and effective in the situations where the intended audiences have limited ability, motivation, or interest in processing didactic messages (Kreuter et al, 2007).

3. Identification and perceived similarity with characters in a narrative influent perception

The effectiveness of the narrative persuasion also depends on the perception of the similarity of narrative source or messenger, the perceived similarity, identification, as well as para-social interaction of the characters (Kreuter et al, 2007). The greater perception of similarity, the more effectiveness of the persuasion.

The perceived source of narrative affects how people trust the message, it may depend on two variables, the perceived similarity and the credibility of the source, of the messenger or characters. In the former one, the attributes and characteristics of
the messenger, such as demographics, socioeconomic status, group membership, place of residence, life experience, or attitudes, beliefs, and values, could affect the perceived similarity of the messengers, either they are actual or perceived ones (Simons, Berkowitz and Moyer, 1970; Kreuter et al, 2007). When the perceived similarity between the source and the receiver increases, so as the increase of trust, respect and attractiveness in a source (Kreuter & McClure, 2004). The reason is that people tend to like others who are similar to them based on the concept of social attractiveness (Kreuter et al, 2007). In the latter one, it refers to the trustworthiness of the messenger or characters in a narrative. It may be established by the character's lived experience, for example, a diabetic patient, and/or the experts or professionals such as healthcare providers. According to Kreuter et al (2001), the perceived of similarity and expertise of the sources and characters are peripheral cues that the effect is greater when the audience is less absorbed in a narrative or they have low attitude-relevant knowledge.

Another explanation is the concept of **identification** with characters in narratives. According to Cohen (2001), identifying with characters is a process “through which audience members experience reception and interpretation of the text from the inside, as if the events were happening to them” (Cohen, 2001, p. 245) Identification with characters requires audience's cognitive and emotional empathy, as well as a sense of merging with the character in the narratives (Cohen, 2001). The greater identification leads to affection inductive and greater enjoyment of the messages, so it has significantly influence on the attitudes and beliefs regarding the topics presented in the narratives (Cohen, 2001; Igartua, 2010).

The third concept is **para-social interaction** which refers to "the bond that develops between a viewer and a liked character." (Moyer-Gusé & Nabi, 2010, p.30) According to the theory, individuals develop relationships with fictional characters or celebrities in the media and see them as part of their social world (Horton & Wohl, 1956).The relationship is built based on social attraction and perceived similarity of the attitudes and background of the characters (Rubin & McHugh, 1987; Moyer-Gusé & Nabi, 2010). Identification with a character in a narrative who is similar to the individual is a kind of para-social interaction that can provide a sense of social support.
from others in identical situations (Kreuter et al, 2007). Furthermore, perceived similarity of narrative characters in persuasive communication may also due to social norms of people with a desire of feeling a sense of belonging, trust others and be trusted, and conformity (Kreuter et al, 2007).

The concepts of transportation, identification, perceived of similarity and para-social interaction are some of narrative characteristics that help to overcome different resistance to change, and improve the persuasive effects. Although these concepts are very similar and often confused, they are distinct conceptually and empirically (Moyer-Gusé & Nabi, 2010). As only identification refers to a state where the loss of self-awareness when the viewer or audience takes over the feelings, perceptions and goals of the character (Cohen, 2001; Moyer-Gusé & Nabi, 2010). Transportation, although similar as identification that both refer to a state of absorption in the narrative world, it does not require the viewer to take over the particular character's feeling, perceptions and goals; the viewer can enter into a narrative world as an observer and still remains self-awareness (Moyer-Gusé & Nabi, 2010).

Furthermore, adding imageries and sounds in narratives enhances the persuasion effects (Adaval & Wyer, 1998) and strengthen attitude formation (Lee & Gretzel, 2012). The addition of pictures in a narrative text can enrich the vivid effects of verbal event description, facilitate the perception connection between the sequence of events, and enhance the coherence of the story (Adaval & Wyer, 1998; Adaval, Isbell, & Wyer, 2007; Lee and Gretzel, 2012). On the other hand, stories presented in multimedia format accompanying with sounds, musics and videos are found to have greater ability in recall (Lukosius, 2004) and persuasion (Mayer, 1997; Verhallen, Bus, & De Jong, 2006). Since it can attract readers' focus attention, help to gain a deeper understanding of the story, and foster immersion into the content, hence, it makes the story more meaningful (Lee & Gretzel, 2012). In their study of the persuasive effects of tourist website features, Lee and Gretzel (2012) have found that imagery-eliciting web site features can lead to stronger and greater confidence in attitudes.

Other factors affect the persuasion including the attributes of the narratives such as
sequence, characters, space and time, location, production techniques, and so on. The quality of the attributes, the organization and representation of these attributes, and how they match with the objectives of the audiences are all factors that affect the narrative experience and narrative effects (Kreuter et al, 2007). Hence, the consideration of the source, message, channel, and receiver of narratives is essential to understand and enhance the narrative outcomes (Hinyard & Kreuter, 2007).

Finally, narratives can promote self-reflection, and studies have used narratives or storytelling for health promotion (Synder & Rouse, 1995; Igartua, Cheng, & Lopes, 2003), learning and education (Jenkins, & Lonsdale, 2007) and professional practices (Brady, Corbie-Smith, & Branch, 2002; McKillop, 2004). For instance, Grimes and his colleagues (2008) developed EatWell, a voice memory system for people to record their stories about eating healthfully in their neighborhoods and share the stories and experience with others in the community. The sharing of memories and stories helped to induce reflection and facilitate a sense of community empowerment in promoting healthy diet.

Synder and Rouse (1995) used entertainment program to promotion AIDS prevention and it could increase perception of risk for acquiring AIDS. Since fictional stories or films, for example, can convey information and stimulate reflection on certain issues that may be unaware of by the public (Igartua & Pa´ez, 1997; Igartua, Cheng, & Lopes, 2003). It is particularly a good mean for situations when the involvement is low.

4.3.3. Gamification

Games are a kind of entertainment-education and the term "Gamification" is "the use of game design elements in non-game contexts." (Deterding, Dixon, Khaled, & Lennart, 2011, p.10) Game is different to play since "play" is referred to a broader and looser category, and is a more free-form and expressive behaviour; while games are playing by rules with structural content and competing toward certain goals (Deterding, Dixon, Khaled, & Lennart, 2011). In recent years, gamification has been widely used in the areas of health care (Kato & Beale, 2006), education and learning (Van Eck, 2006), as
well as promoting sustainable behaviour (Bång, Svahn, & Gustafsson, 2009). Numerous studies have been using gamification in persuasive technologies for health behaviour change such as games for exercise (Consolvo et al, 2008; Albaina et al, 2009; Brox et al, 2011), healthy diet and nutrition (Mansour et al, 2009; Grimes, Kantroo and Grinter, 2010; Orji, Vassileva and Mandryk, 2012), and diabetes management (Brown et al, 1997; Aoki et al. 2004; Looije, Neerincx, & Cnossen, 2010), to name a few.

Kahol (2011) suggests to use games for diabetes management. He regards that using games can address several unmet needs from clinical perspective, including: games can help to maintain compliance as they can be used for education and allow healthcare providers to monitor the patients' activities; games can encourage exercise as well as proper nutrition intake. A number of studies have attempted to use gamification for diabetes management (Blanson Henkemans et al, 2009; Nachman et al, 2010) and they reported a positive effects of the results.

According to Orji, Vassileva, and Mandryk (2012), persuasive health games can be classified as exergames, serious games, and casual games. **Exergames** are games that encourage physical exercise and fitness in game playing, where the players are required to use their energy from physical activities when playing, for example, Dance Dance Revolution (DDR) is such a game that requires the players to move their whole body when playing. Other forms of exergames using ubiquitous technologies to track the players' daily physical activities and energy consumption. For example, *Ubifit Garden* was a persuasive game that used reinforcement to encourage physical activity. It used sensor technologies to measure the users' physical activity and displays it of a virtual garden on smart phones. The virtual garden rewarded the user to show more flowers on it if he did sufficient physical activities (Consolvo et al, 2008). Other similar design is *Flowie*, a persuasive virtual coach aiming to motivate elderly to walk. The design adopted context-aware technology which included a pedometer with wireless connection to a touch-screen frame displaying of a virtual flower. The virtual flower showed happiness when the user was doing sufficient walking, and vice versa. It reported that it did engage the users in their walking since the state of happiness or unhappiness affects the users' emotional feeling (Albaina, Visser, van der Mast, &
Serious games are games that are served for educational purposes. The intention of these games is to modify the player's health behaviour through education, training and entertainment. For example, Thompson et al (2010) designed a nine-level action-adventure video game called DIAB to prevent Type 2 diabetes and obesity among teenagers. The video game had a sophisticated game structure which used storyline, characters, and game activities to immerse the players and educate them the knowledge of healthy diet and activities so as to facilitate behaviour change.

Casual games are similar to serious games but are shorter and simpler, and they can be played on different devices such as personal computers and mobile phones. For instance, Orji et al (2012) designed a slow-causal game "LunchTime" for healthy diet behaviour change. The game was a cross-platform application that can be played in any web-enabled devices such as desktops or smart phones. It used a combination of health behaviour theories including goal-setting, feedback, social influence, and rewards to encourage the players to learn and reflect on healthy diet that leading to positive attitude change toward healthy diet. Another causal mobile game OrderUP! also aimed at encouraging healthy lifestyles by helping users to rethink their habits through self-reflection and social discussion (Grimes, Kantroo, & Grinter, 2010).

Games have several capabilities to influence players' behaviours and attitudes. From the literature review, they can be summarized in the following:

- Games can attract and hold the player's attention so they facilitate the initial stage of behaviour change process to take place (Thompson et al, 2010).

- Games can elicit self-reflection - they can raise the players' awareness of the issue which causes them to reflect upon the behaviour and lead to attitude and/or behaviour change (Grimes, Kantroo & Grinter, 2010; Orji et al, 2012).

- Similar to stories, games have the ability to engage the players and develop
empathy with the protagonist by the means of transportation and identification. Hence, the ways the protagonist overcome the barriers can be served as modeling for effective problem-solving and behaviour change (Baranowski et al, 2008).

- Games can reinforce behaviour by rewarding the players' of the intended behaviour so that the desirable behaviour can be enhanced (Baranowski et al, 2008; Orji et al, 2012).

- Playing games are intrinsic motivation since games, particularly video games, have the characteristics of fun, interactive, and entertaining, they can capture the players' attention and imagination, and immerse the players literally and emotionally in the story, hence, they enhance motivation for behaviour change (Baranowski et al, 2008).

Although gamification is usually used for children and teenagers, studies have shown that educational causal games can equally effective for adults for learning and reflection (Grimes, Kantroo & Grinter, 2010; Orji et al, 2012). It should be aware that the demographic such as genders and age groups affect the interests and appealing of the games, for example, games for children should not be the same as for adults since the cognitive development are different throughout different age range; and boys and girls have different interests in stories and game types (Baranowski et al, 2008). Research should be taken in developing games for different demographic groups, however, not many researches and guidance were found to led to development of a theory of game design in this area (Baranowski et al, 2008).

4.3.4. Graphs and Statistics

The use of graphical and statistical format is another type of risk communication strategies. According to Julian-Reynier et al, (2003), risk information can be presented with two types of messages: probability-based approach and contextualized approach. **Contextualized approach** is to communicate risk information through antecedents and consequences of a health problem, which is similar to the narrative messages discussed above. **Probability-based approach** is mainly numerical information
which can be communicated through a wide variety of formats including numbers, verbal labels or visual displays. The numerical information can be displayed as absolute numbers or relative risks in a form of frequency, proportions, percentages or probabilities (Julian-Reynier et al, 2003, p.731).

The visual displays of graphics or statistics can assist in presentation of risk. According to Lipkus and Hollands (1999), the use of visual display to communicating risk has at least three advantages, they include: 1) graphics reveal data patterns that may go otherwise undetected since different kinds of graphs are good in communicate certain types of information, for example, line graphs for displaying trends, charts and bar graphs for depicting proportions; 2) specific graph types can aid viewing and interpreting the numerical information and they are more effective for people to process certain information such as comparing risks than just presenting numbers; 3) graphs can also attract attention than numbers due to the vividness effects in visual forms (Lipkus & Hollands, 1999).

Moreover, graphical visualization helps to create structure, accountability, and motivation (Goodman & Foucault, 2006). The graphs or charts, especially computer-based visualization, can be seen as an objective proof of progress that can increase motivation due to a feeling of success (Goodman & Foucault, 2006). They can also served as diary that users can get "distance echo" of their activities over a period of time. However, it can be demotivation if the progress is not satisfactory or lives up to the goal, therefore, care should be taken when using the charts and graphs (Goodman & Foucault, 2006).

On the other hand, information visualization of personal data such as physiological data and behaviour could elicit self-reflection by assisting people to be more aware of their own behaviour and improve decision making (Li, Dey & Forlizzi, 2011). With the growing popularity of mobile devices and wearable technologies, the use of graphs and statistical presentation of personal data as personal informatics is becoming increasingly useful (Li et al, 2011). Ubicomp or ubiquitous technologies can be used to collect personal relevant data from users' activities to provide self-knowledge. It is
particularly valuable for collecting health-related data such as vital signs, calories burned, exercise levels, and sleep quality, it helps users to explore the health trends and patterns from their own activities. For example, Nike+ can track workout information and Fitbit can record daily activities such as steps taken, calories burned, and even sleep quality (Figure 4.1 and 4.2). In terms of diabetes care, studies have used information visualization to assist diabetic patients to examine the relationships between their blood sugar level and their diet intakes (Frost & Smith, 2003). The Ubicomp technologies are used to provide personal informatics in encouraging more exercise (Lin et al, 2006) and assisting diabetes self-care (Preuveneers & Berbers, 2008).

![Monthly steps count](image)

**Figure 4.1: Monthly steps count**
4.3.5. Comparison of narrative and statistics formats in behaviour change

The comparison of effectiveness between narratives and statistical format in persuasion and health behaviour change have been studied extensively (Kopfman et al. 1998; Julian-Reynier, 2003; Hinyard & Kreuter, 2007; De Wit, Das, & Vet, 2008; Siaw, 2009). Although many studies found that narratives seem to have greater effects than statistical presentation, which format is more effective is still not conclusive (Kopfman et al 1998; Hinyard & Kreuter, 2007; Siaw, 2009). For example, De Wit et al (2008) found that their participants who were presented with narrative evidence (a personal account) had higher perception of personal risk and intention to obtain vaccination against hepatitis B virus (HBV) than participants who received statistical evidence (abstract prevalence data). On the other hand, Slater and Rouner (1996) discovered that persuasive message using statistical evidence in alcohol-education for college students was more effective when the message was corresponding with their values while narrative evidence was effective when the message was incorresponding with their values.
Siaw (2009) has conducted a comprehensive literature reviews of the presentation related factor in modalities and the content related factors in narratives and graphical effects on persuasion in risk communication. In the studies of influence of different modality formats in graphs versus numbers, and texts versus images, he found that graphs have a stronger persuasive effects than numbers since they were perceived to have greater adverse results and causes stronger negative association. He concluded that people use similar decision-making processes to evaluate numbers and graphs, and both cognitive and emotional components are involved to contribute the persuasive effects of graphs. In comparison of texts versus images, the use of pictures and imageries has a greater persuasive effect to change people's attitudes. The pictures used are accompanied with texts to explain the consequences of the concerns and imageries have a greater ability to present fear visually and cause affective responses. In fact, combining pictures with spoken or written text has been found to improve health communication and enhance patients' attention, comprehension, and recall of the messages, as well as increase the likelihood of adherence according to the message (Houts et al, 2006). It is especially beneficial for patients with low literacy skills. Siaw (2009) provides some recommendations for using graphs and images in risk communication.

On the other hand, he found inconsistency within content usage of narrative versus statistical content in risk communication (Siaw, 2009). He found from the literature that the use of narrative content and statistical content have similar persuasive effects in risk perception and the narrative content is not significantly more effective than statistical content. The temporal effects of the narrative and statistical content was also inconclusive. Nevertheless, he found some characteristics of narrative and statistical content in the studies and concluded that "narrative content gives a more involved and realistic impression to people, while statistical content is considered as more truthfully and closer to fact based reality." (Siaw, 2009)

One of the arguments between the effectiveness of narratives and statistical persuasion is based on the notion of affective and cognitive reactions of health messages. Although
most of the health theories consider that cognitive component is important for self-reflection and persuasion, other researchers such as Kaplan (1991), Dillard and Kinney (1994), argue that affect also have a role to play in this process since even cognition contains certain emotional elements (Kopfman et al, 1998).

Persuasive communications are usually targeted for cognitive reactions since rational communication and logical reasoning have considered to be essential for persuasion (Petty & Cacioppo, 1981). Moreover, self-reflection is a cognitive process involved critical examination and evaluation of internal self and past experience (Boyd & Fales, 1983; Daudelin, 1997). For example, studies found that the use of statistical evidence for organ donation message had a greater persuasive effect on the participants' cognitive reactions than when they read narrative evidence message.

On the other hand, emotional reactions such as fears, empathy or positive mood can influence attitude change in certain conditions (Edwards, 1990). Narratives are powerful and compelling since when reading narrative messages, different affective reactions may be generated. Another notion is vividness effect (Nisbett & Ross, 1980). Vivid information is arguably as more memorable and persuasive than nonvivid information (Nisbett & Ross, 1980; Taylor and Thompson, 1982). Since vivid messages such as narratives, stories, and case histories are best tools to aid causal relevant argument where it leads the recipients to recognize the causal relevance of information to their judgments (Taylor & Thompson, 1982). They are also more imaginative and emotionally interesting, able to induce certain affective reactions than nonvivid information that are often abstract and dry (Taylor & Thompson, 1982). Research has found that when individuals reading narratives, they generate more emotional responses than those reading statistical evidence messages (Kopfman et al, 1998).

Moreover, Kopfman et al (1998) propose that individuals reading narrative could produce a higher self-efficacy, that is, they perceive to have the capability to solve a problem by acting on the recommended behaviour, than reading statistical evidence messages. The notion is that a cognitive gap may exist between the problem and solution when reading the statistical evidence message. Since when individuals reading
the statistical evidence messages, they were provided with information about the problem and logical solution, but there is a lack of causal relevance connecting the two. As such, individuals may not have enough self-efficacy to perform the action. In narratives, on the other hand, modeling of the characters can help the readers to see how the problem can be solved. There is no cognitive gap between problem and solution, and self-efficacy can be increased. They regarded that perceived higher similarity to the character in the story will create higher causal relevance between problem and solution, resulting in higher self-efficacy.

Furthermore, the individual differences of the receivers such as cognitive and affective needs, intend, attitudes and ability may also affect the persuasion outcomes. For example, Haddock et al (2008) regarded that individual differences in cognitive and affective needs associate with different experiences and information people seek and receive. They found that individuals with cognitive needs were mostly affected by cognitive-based messages such as beliefs and factual information, and they like to consider more details information to educe attitude change. By contrast, individuals with affective needs were more influenced by affect-based messages, and they prefer simple and less detail information. They suggest that individuals with high in need for cognition should be more receptive of messages that emphasis on cognitive information, whereas for individuals with lower cognitive needs, affective message is more effective in eliciting attitude change. They regarded that the individual differences in cognitive or affective need may also relate to the pursuit and experience of emotions, where individuals with higher affective need should be more responsive to the emotional stimuli in their environment such as emotional words.

Similarly, Kari (1990) found that cognition-based and affect-based attitudes of the individuals have an influence on the persuasive effects of cognitive or affective messages. He argued that there is an interplay of affect and cognition in attitude formation and change. He regarded that attitude change involves both affect and cognition, but there is a function of the primacy or dominance of affect or cognition during attitude acquisition. Affect-based attitudes are dominated with affective reactions and are more influenced by affective messages. The attitude required less
cognitive appraisal and relevant information is served for confirmation of the initial attitude. Cognition-based attitudes, in contrast, require primary domain-relevant information and affective factors are only assisting as part of cognitive appraisal. Affective processes are involved in cognition-based attitudes development, but their role are only minimal in shaping attitude development.

Additionally, Kopfman et al (1998) regarded that individuals' prior thought and intent also affect the cognitive processing of persuasive messages. Individuals with higher prior thought and intent were found to have higher positive belief change and behaviour change than those with lower prior thought and intent.

Researchers have suggested that both cognitive and affective reactions of receivers should be considered when developing health communication strategies. According to the study by Kopfman et al, (1998), statistical evidence messages produced higher cognitive heuristic cues such as credibility and effectiveness than did narratives. In contrast, narrative produced higher amount of affective reactions and diverse anxiety levels than did statistical evidence messages (Kopfman et al, 1998). So understanding the receivers cognitive need and affect need can help to develop more effective persuasive strategies.

**4.4. Summary of the Chapter and the Concepts of Persuasive Communication Strategies for Health Behaviour Change**

In summary, this chapter reviews some of the major concepts of persuasion, starting with rhetoric as a language art to persuade, Elaboration Likelihood Model's (ELM) two routes of persuasion, and Six Principles of Influence of using peripheral cues for persuasion. It identifies the importance of self-reflection in behaviour change as well as in the healing process. Moreover, the communication of risk is also significant in promoting behaviour change. It has discussed some persuasive strategies including narrative, gamification, as well as graphics and statistics, of their psychological effects in persuasive communication. Examples of using these strategies in persuasive systems for health behaviour change is also considered. However, these examples are
overwhelmingly the studies from the western countries and how these effects on other cultures and context are unknown.

In particular, the Elaboration Likelihood Model (ELM) provides useful insights for designing persuasive communication, it indicates the relationships between the sender, the content, and user context in persuasion (Petty & Cacioppo, 1986). It shows that there are relationships between a person’s attitudes, beliefs, knowledge, competence, with the use of persuasive communication. The higher the person is involved (that is, a higher intention and motivation), and the higher the knowledge about the disease, the stronger cognitive information is important to influence the behaviour change. On the other hand, person with low involvement (that is, lower intention), and lower knowledge in the disease and competence, the affective information is more effective. Hence, designers should design systems or products tailoring to different types of users in order to make the persuasion and motivation more effective. The following table is to illustrate the relationships between involvement, health literacy, and the affective and cognitive needs of persuasive communication. (Table 4.1.)

**Table 4.1. The relationships between user's involvement, health literature, and the persuasive message preference**

<table>
<thead>
<tr>
<th></th>
<th>Affective</th>
<th>Cognitive</th>
</tr>
</thead>
</table>
| **High Involvement** | Strongly influenced by affective information  
More influenced by peripheral cues such as visual images, promotion, games, etc. | Strongly influenced by cognitive information  
More influenced by central processing route such as fact and figures, reports, etc. |
| **Low Involvement** | Strongly influenced by affective information  
More influenced by peripheral cues such as visual images, promotion, games, etc. |                                               |
| **High Health literacy** |                                                                           |                                     |
| **Low Health literacy** |                                                                           |                                     |

From the literature review, some key issues about persuasion for behaviour change are identified:

Firstly, there is a relationship between the sender, the content, and the user context so the same message or information effective for one person may not be the same with another person.

Secondly, persuasion is a process involves both affection and cognition, but the level of involvement may influence the reception of the cognitive or affective message, which affect the effectiveness of the persuasion.

Thirdly, narrative seems to be more effective than graphical and statistical information in persuasion, but it is still inconclusive.

Since there are limited studies of this kind in the Asia context, and how these concepts can affect health behaviour change in persuasive diabetes systems is not known. The research therefore is designed to answer the above issues related to the persuasive effects.

As the previous chapter recognizes that self-reflection is the key determinant in the initial stage of behaviour change, however, for a new behaviour to be formed and sustained, a positive experience during the new action could be more important. Next chapter I will focus on the experiential aspects of interactive products and systems by reviewing some concepts in user experience. I will also discuss why understanding the user values and meanings in persuasive systems are essential to sustain behaviour change.
5. **User Experience, Motivation and Engagement**

5.1. **Introduction**

The previous section discusses the use of different persuasive strategies to induce self-reflection for internalization of values and skills, especially through the content communication strategies. For the behaviour to be maintained, however, the user is required to gain positive experience in the interaction.

This chapter is to review and discuss the literature about experience design and user engagement. Diabetes management systems are usually targeted for use in long term, therefore, to provide a desirable user experience of the systems is essential to encourage and sustain user engagement. A system without considering the user experience will be resulting in user disengagement and attrition. Hence, to identify the attributes and factors in products or interactive systems that encourage user engagement and involvement, and what contributes user's self-efficacy and the values of the user experience in system use are important for long term behaviour change.

5.2. **Concepts of User Experience**

With the advanced of technology and complication of the modern life, focusing on functions and usability aspects of products and interactive systems are no longer sufficient (Blythe, Overbeeke, Monk, & Wright, 2003; Cockton, 2004ab). The focus of design is moving beyond the product and service towards the experience (Press & Cooper, 2003). Designers' role is not just a creator of objects, but an enabler of experiences (Press & Cooper, p.69). Suri (2003) also regards that "designers are being invited to influence not just the look and feel of individual things, but the quality of experience that people have as they live their lives through time and space."

Experience is important in attitudes and behaviour change. As Bate and Robert (2007) put it,
...All of our judgements, attitudes, sentiments, feelings, sensations, opinions, memories, actions and reactions are coloured and shaped by our experience, and it is therefore only by understanding, and ultimately designing, experiences that we can influence and begin to understand and create the very 'essence' of life itself. (p.39)

Experience can influence our attitudes and behaviours, therefore, understanding user experience of products and systems can help to design inspirational and desirable experience for behaviour change.

5.2.1. Components of User Experience

There are many approaches of user experience. Many scholars and researchers have been attempting to identify and providing frameworks of user experience (Forlizzi & Ford, 2000; Forlizzi & Battarbee, 2004; McCarthy & Wright, 2004; Roto, 2006). The basic knowledge is to understand what is experience, the components of experience, and how experience occurs so that designers can design for desirable experience that can engage users, as well as sustain behaviours and product/brand/service relationships.

According to ISO FDIS 9241-210: “User experience includes all the users’ emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use.” (Bevan, 2009) This definition identifies that user experience is a design concept that exceeds usability, which includes consideration of many aspects of the users when interacting with a product, system or service in different point in time.

Hassenzahl & Tractinsky (2006, p.95) define experience is “a consequence of a user’s internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organizational/social setting, meaningfulness of the activity, voluntariness
Therefore, experience is a result of an interaction between the user's personal internal state of being, the product attributes and characteristics, the environment or context where the user is using the artifact, and the activity in this context. These components are intertwined and may affect one another. Hence, user experience is a holistic design concept where designers require to understand and consider different aspects of user interaction and how these components are intertwined so as to provide successful user experience.

Forlizzi and Battarbee (2004) identify three types of models and theories of user experience design: product-centered models, user-centered models, and Interaction-centered models. Product-centered models mainly provide information and application for design practice. They discuss the design issues and suggest some criteria for evaluation of artifacts, services or systems. Examples include Alben's (1996) criterion of interactive design and Garrett's (2011) the elements of user experience. User-centered models focus on the user aspects and they help designers and developers to understand the users such as the goals and motivation, the aspects that related to the interaction of the products or systems. For example, Hassenzahl (2003) provides useful insights for understanding the needs and goals of the users in system use. Interaction-centered models investigate "the role that products serve in bridging the gap between designer and user." The Four Thread of Experience by McCarthy and Wright (2004) is an example of this aspect. These models and frameworks provide comprehensive understanding of the interaction between users and the products or systems, they also help to supply guidelines for experience-based design. The following sections present some of the reviews of these models and frameworks.

5.2.2. Goals and Needs in User Experience

Hassenzahl (2003) considers that products serve some major functions to fulfill two basic universal needs of human beings - pragmatic needs and hedonic needs.
Pragmatic needs are the needs of individuals to control and manipulate their environment, which are mainly related to usability and utility aspects such as security and control. Hedonic needs include stimulation needs for sensory stimulation, novelty and challenge, which are related to people's need for personal growth and development. Identification needs refer to social aspects including self-expression, group identification through using a certain kind of products. Evocation needs refer to the symbolic meaning of the product and the potential to produce personal memories.

People choose pragmatic quality focusing on the utility and usability of the product to support the achievement of a 'do-goal', which are the 'what' and 'how' levels of interacting with a product. People choose hedonic quality focusing on the psychological needs and symbolic values to fulfill a need of Self - the reason 'why' people own and use a particular product, which is the 'be-goal'. The be-goals are the source of experience and the drives of product use.

Hassenzahl (2003) considers that the satisfying user experience in products and services include the fulfillment of the pragmatic and hedonic psychological needs. The meaning is created if the need is fulfilled in the interaction of a product or service. In most of the time, the products or services need to fulfill the utility and usability purposes before the hedonic psychological needs are satisfied. Aligning with Jordon (1999), he regards that although pragmatic quality is essential, by itself it has no meaning: "Pragmatic quality was not related to need fulfillment. Again, this does not imply that pragmatic quality is superfluous. It still enables or blocks experiences. But in itself, without an active need, it is without any value" (Hassenzahl, 2011, p.52).

Hassenzahl (2003) argues that to emphasis on the hedonic quality in user experience reminds us of what is important in life. Productivity is a means, a do-goal, although sometimes it is important, it is always related to the accomplishment of a be-goal which is more robust than the do-goal. The instrumental levels of "what" and "how" are to support the achievement of the motives "why" behind the interaction. Hence designers should put experience as the primary goal and then design product or service.
with appropriate attributes to fulfill that goal. As he puts it, "Experience is prime, and the product only a means. Accordingly, one of the basic claims of Experience Design is to consider the experience before products." (Hassenzahl, 2010, p.63) To study user experience helps designers to broaden the notion of usability from solely examining how people do things, to studying and understanding why they do them (Hassenzahl, 2010, p.12). However, these levels have to be aligned to establish a meaningful and desirable experience.

Furthermore, Hassenzahl (2010) emphasizes the importance of situational influence in usage to understand the appealingness and emotional reactions. A usage situation can affect the perceived value of product character since it involves a particular goal to accomplish. As usage situation is diverse, product character in one situation may be perceived as valuable, whereas in other situation may not. For instance, in a situation requires effective and efficient such as working for a presentation or writing an article, the pragmatic quality of word processor is valued, but it is not in a situation requires fun and exploration. Hence, he suggests that the usage modes, that is, whether it is goal oriented or action oriented, as well as the mental state of the user determine how the product quality or character is perceived valuable.

5.3. User-Product Relationships

Research has proposed that user can develop an attachment to products beyond the function of usability (Jordon, 1999; Djajadiningrat, Overbeeke & Wensveen, 2000). User attachment is important in healthcare products or services to assist the users in their healing process or support their daily functions, therefore, providing a satisfactory user experience is crucial. The following part reviews some of the concepts of essential components in user-product relationships.

5.3.1. Four Pleasures of Product

Jordon (1999) contends that products can bring four different benefits or 'pleasures' to their users, including physio-pleasure, socio-pleasure, psycho-pleasure, and
ideo-pleasure. Physio-pleasure is related to the senses, such as see, touch, taste, smell, as well as feelings of sensual pleasure when holding and touching a product during interaction. Socio-pleasure is the enjoyment derived from relationships with others, which relates to status and self-esteem. Psycho-pleasure refers to pleasures of the mind. It is derived from the cognitive and emotional satisfaction by using the products. Usability is an important issue here. Ideo-pleasure relates to the match of a person's values to the values embodied in a product, it includes aesthetic values and moral values. For example, products made with eco-friendly materials might be reifying the value of environmental responsibility. He emphasizes the importance of applying a holistic approach in inclusive design that designing a product should not just fits with users' physical and cognitive characteristics, but also reflect the users' values and lifestyles in a wider sense, even for products for disabilities.

5.3.2. Three Levels of Interaction

Don Norman (2004) in his book Emotional design proposes three levels of emotional and cognitive processing of a product: visceral, behavioural and reflective. Based on his cognitive research, he considers that these three levels of design are important in design. Visceral level is the immediate response to a product, which involves the sensory aspects of a product such as its look and hand feel. This level provides an initial perception and affects deeper involvement to take place.Behavioural level is about the cognitive processing and our daily behaviour in using and handling the product. The behavioural level can enhance the visceral and reflective level of the product, and vice versa. Reflection level refers to the conscious consideration and reflection on past experiences. This level of cognitive processing involves association and meanings of the product and the user through reflection and experience with the product, it affects the relationships between the user and the product.

Norman suggests to analyse products in a holistic way to include these three levels of design and their relationships with the user and the owner. He regards it is important for designers to consider these factors in design.
5.3.3. Framework of Product Experience

Desmet and Hekkert (2007) considered that a product consists of three levels of product experience: aesthetic experience, experience of meaning, and emotional experience. Aesthetic experience refers to the sensory gratification of all human senses when interacting with the product. Experience of meaning refers to the cognitive factors such as interpretation, memories retrieval, and associations. People can recognize metaphors, and assign personality, symbolic or personal meaning to a product. Emotional experience is the feelings and emotions that are elicited. According to appraisal theory, an emotion is elicited by an evaluation of an event or situation, that is, the stimulus, as beneficial or harmful, and how this stimulus relates to the individuals. According to Desmet and Hekkert (2007, p. 61), "It is this personal significance of a product, rather than the product itself, which causes the emotion." As such, the emotional experience of a product may be quite different individually due to the appraisal of a product is not the same for different individuals.

Although product experience composes of these three components and they seem to be hierarchical, they are intertwined and cannot be differentiated since only when these components are unified that it is an experience - we have the sensory pleasure when encountering a product, which derives meaning and it involves some kinds of emotions in the interaction. It highlights the interrelationships between these three levels of components in a product experience.

Furthermore, Desmet and Hekkert (2007) regard that usability is not a product experience but a source of product experience that seems to generate and affect all three levels of product experience. According to them, usability is an instrumental interaction which involves goal attainment - whether the goal of the user is achieved through uses and interacts with the product. Emotions arise from the appraisal of this goal attainment; for example, positive emotions such as satisfaction and happiness will happen if the goal is appraised as successful, whereas negative emotions such as frustration and anger will likely to occur if the goal is appraised as unsuccessful. It can also be applied to experience of meaning where usability of a product can relate to
certain kinds of meaning such as innovative, boring, or frustration, that are assigned by the users during the interaction.

5.3.4. Four Threads of Experience

McCarthy and Wright (2004) propose a comprehensive framework of user experience in technology. They consider that in every interaction it involves four threads of experience: **Sensual, emotional, spatio-temporal, and compositional**. **Sensual thread** refers to the visceral character of experience. We experience the world through our senses. It is similar to Norman’s (2004) visceral level of design. **Emotional Thread** is about value judgments attributing importance to other people and things with respect to our needs and desires. Our emotional response will help us to remember an experience. **Spatio-Temporal Thread** refers to the space and time, the context of an interaction. Due to each interaction involves a particular context with a particular person, no single experience is the same. **Compositional Thread** regards the narrative structure of an experience. It concerns how the different parts of an experience fit together to form a coherent whole to explain who, how, what, and why of the actions, the causes and consequences of the actions.

McCarthy and Wright (2004) regard that these four threads of experience are interrelated and hence experience is a holistic phenomenon evoked from our senses, emotions and intellect when we interact in a particular situation at a particular time.

| Table 5.1: The comparison of the four user-product relationship models |
|-------------------------------------------------|----------------|----------------|-----------------|----------------|
| Sensory                                        | Physio-pleasure | Visceral       | Sensual thread  | Aesthetic       |
| Emotional & Cognitive                          | Psycho-pleasure | Behavioural    | Emotional Thread| Emotional       |
| Semantic                                       | Ideo-pleasure   | Reflection     | Compositional Thread | Meaning |
| Social Context                                 | Socio-pleasure  |                | Spatio-Temporal Thread |               |

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The concepts of product experience and interaction provide a comprehensive understanding of the human-product interaction and how user and product develops relationships in the interaction. It shows that all the models perceive that an experience has a hierarchical structure which involves sensory stimulation, cognition and emotions, meaning, as well as factors including the context of the interaction. The meaning of experience and the user-product relationships is developed from each layer of interaction. All of them consider that these levels of structure are interrelated and experience should be seen in a holistic way. A comparison of these concepts is shown in Table 5.1.

Nevertheless, these models are not sufficiently explain the interaction of software design especially for websites and mobile applications where the content plays an important part of user experience. In persuasive technologies or health informatics, however, content information is important since the users not only use the products but also need to be able to understand the content information of their own health situations and response to it. Furthermore, these models do not explain how the user experience develop over time and the user interaction process (Karapanos, Zimmerman, Forlizzi, & Martens, 2009).

5.4. User Engagement and Long-Lasting User-Product Relationship

5.4.1. User engagement

Engagement is user experience that involves both cognitive, affective, behavioural, experimental that the user is emotionally involved and the state of being in gear when interacting with a system (O’Brien, 2010).

O’Brien and Toms (2008) define engagement as "a quality of experience with technology that is characterized by challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and
affect.” (p.949) The definition was drawn from their studying about theories of flow, play, aesthetics and information interaction incorporate with their research from users of several interaction systems including video games, educational applications, online shopping sites, as well as web searching sites.

From the research, they identify four distinct "stages of engagement" and the "attributes of engagement" in technologies including: focused attention, affect, aesthetic and sensory appeal, ease of use, challenge, control, feedback, motivation, novelty, and social involvement (O’Brien & Toms, 2008).

Using the threads of experience from McCarthy and Wright (2004) as a framework, they identify four stages of engagement include: point of engagement, engagement, disengagement and re-engagement; and the attributes that characterize in each stage. In the point of engagement, aesthetic and sensory appeal or novelty plays important part to attract the users' motivation and interests, the users also need to have the desire and ability, and to perceive they have sufficient time in the interaction.

In the engagement stage, users have already attracted to the system and maintained their attention and interest in the interaction, usually with positive emotion. In this stage, users are in focus attention; the attributes of perceived control, ease of use, timely feedback and social interaction are important to maintain their interest and engagement. The users also want to have some customized features to suit their needs and receive appropriate feedback from the system or application. According to O’Brien and Toms (2008), there are several internal or external reasons for users to disengage in the interaction such as the physiological needs, the challenge levels, the interactivity of the system or application, or the distractions in their environment. During this stage, the expression of positive and negative emotions are mixed and the results of the emotions are depending on circumstances or influenced by the interaction. Users may reengage in the system or application for a short-term or long-term. There are many reasons for reengagement including: past successful experience of the users have, new product or experience that could not be found elsewhere, or new challenge or feedback that keeps the users interests. The attributes such as convenient and ease of use, new information, and novelty were more
prominent in this stage. Positive experience in the interaction also increases the likelihood of users' reengage the application (O'Brien & Toms, 2008).

On the other hand, the attitudes, motivations, intentions or goals of the user before engaging in the interaction will affect the user experience (O'Brien & Toms, 2008; O'Brien, 2010). Since people usually have a goal, whether it is a well-defined goal or a past experience, that pre-existing in mind prior the interaction of an application or system (O'Brien, 2010). The goal may affect the expectation of the system. O'Brien and Toms (2008) studied the intrinsic and extrinsic motivations of engagement and found that motivation is most critical at the point of engagement where the users want to accomplish a task or to expect certain experience such as fun or socializing in the interaction.

On the other hand, O'Brien (2010) attempted to examine the hedonic and utilitarian motivations of online shopping experience. According to her, the terms hedonic and utilitarian are not only about motivations, but also to the system and the aspects of experience, for example, hedonic can be referred to experience such as flow, aesthetics and playfulness. She intended to investigate how hedonic (seeking pleasure) and utilitarian (functionality-driven) motivations affect the aspects of engagement in online shopping site. She tested the hypotheses with hedonic and utilitarian motivations (Idea, Social, Adventure/Gratification, Value and Achievement Shopping) and attributes of user engagement (Aesthetics, Focused Attention, Perceived Usability, and Endurability). The results showed that some hedonic motivations affected certain expectations and specific variables of user engagement in the online shopping environment, for example, Adventure/Gratification predicted Focused Attention and Aesthetics predicted both Focused Attention and Perceived Usability.

However, her study did not answer clearly if hedonic and utilitarian motivations have influences on the expectation of hedonic or utilitarian experience. One of the reasons may be because the hedonic and utilitarian motivations were not clearly defined, for example, if the "idea" and "value" belongs to hedonic or utilitarian motivation? Since "idea" and "value" can be both hedonic and utilitarian motivations depending on
different persons, situations, and systems. On the other hand, the hedonic and utilitarian aspects of these attributes in user experience are difficult to distinguish clearly, for example, endurability can be a hedonic and utilitarian experience.

Their studies on user engagement identified several attributes of engagement including: interest, motivation, affect, attention, challenge, feedback, aesthetics and sensory appeal, awareness, novelty, perceived control, perceived time, and interactivity, mainly for product-system interaction. Hassenzahl and his colleagues (2010) conducted a similar study - they wanted to identify what constitutes “pleasurable experiences” with technology. They studied 500 positive experience interactive products including mobile phones, computers, and so on, and found a significant relationship between need fulfillment and positive affect, the most prominent needs include stimulation, relatedness, competence and popularity. In fact, these attributes are intrinsic motivation that should be the universal needs for interactive systems.

Hassenzahl et al (2010) also discovered that pragmatic quality as "hygiene factor" and hedonic quality as "motivator" as it strongly related to need fulfillment than pragmatic quality. However, the need fulfillment derived from the hedonic quality rating was also linked to the belief that if the product attributes responsible for the experience.

O’Brien’s (2010) study was also solely on the e-commerce environment and it is not knowing if the attributes of engagement are equally applicable to the other applications or systems such as banking and healthcare where the goals and motivations are quite different, and how the goals affect user engagement over time.

The attributes of engagement combine hedonic and utilitarian aspects of experience indicate that user engagement involves both cognitive, affect and behaviour aspects in the interaction. Some of these attributes such as ease of use and control are related to usability variables naming effectiveness, efficiency and satisfaction. They found that usability is the basic requirement for a user to engage in a system, however, usability alone is not sufficient to engage the user - "usability is intricately woven into the experience of engagement; while an application may be usable, it may not be engaging,
but engaging applications do appear to have an inherent baseline of usability." (O’Brien & Toms, 2008, p.951) It is consistent with Jordon (2000) and (Hassenzahl (2011) that functionality and usability are the fundamental of a pleasurable experience, but "functionality and usability without pleasure are meaningless." (Hassenzahl, 2011, p.54).

5.4.2. User experience over time and long-lasting user-product relationship

To maintain behaviour change, the understanding of the user's experience over time and the long-lasting relationships with products are useful since it relates to prolonged use. Karapanos (2013) discovers that the initial and prolonged experience are different in terms of the overall user judgments about a product. He identifies three phases in the adoption of the products: Orientation, Incorporation, and Identification, each phase of the experience reflects distinct qualities of the product. **Orientation** refers to the initial experience of the product interaction, aesthetics, novelty and learnability are essential for further interaction. **Incorporation** refers to how the product becomes meaningful in our daily lives. In this phase, long-term usability is even more important and the product's usefulness determines our overall evaluative judgments. **Identification** refers to the self-identity that derives from the social interactions and the connections with the others through the use of the products. It is crucial that the interaction can provide positive identification and a sense of community. He suggests that design should provide meaningful mediation that the product should fit into the context of use and the user's life, adopt for daily rituals and support a self-identity of user desire to communicate with others. Nevertheless, he also mentions that **anticipation**, that is, expectation before any actual experience of use, can affect the judgment of the experience. He concludes that hedonic aspects are important for early experience, whereas prolonged experiences rely on how the product becomes meaningful in a person's life.

On the other hand, research about product attachment found that people keep the product for a long time based on both **instrumental** and **symbolic** aspects (Sava,
2004; Wehmeyer, 2007). For instance, Sava (2004) discovered that people tend to form relationship with the products relates to their past and present lives, interests, goals and social roles, and so on. Wehmeyer (2007) found that perceived aesthetics (beauty and aesthetics), perceived symbolism (meanings attached to the device) and perceived necessity (necessary for communicating and socialising) are the dimensions of users' attachment to their mobile devices. Nurkka, Kujala and Kemppainen (2009) propose that the most influential factors for lasting user-product relationship are: "the congruency between the user values and the user's perception of product values; the user's ability to express self-identity by meaning and associations evoked by the product, and the ability of the product to evoke affective responses by, for instance, an aesthetically pleasant appearance."

In summary of the above concepts, it can be concluded that user's interaction with a product involves different phases of experience and each of these experiences reflect distinct product qualities. The initial encounter requires hedonic aspects such as aesthetics and novelty, as the product is becoming more acceptable in one's life, perceived usefulness and usability are more dominant. The lasting user-product relationship is dependent on the concordant with the user's values and perceived product values which include instrumental values such as usefulness, and symbolic values such as self-identity, as well as how the meanings of the product supply in one's life.

**5.4.3. Motivation and user experience**

Self-Determination Theory suggests that the maintenance of behaviour requires the individuals experience self-determination (Deci & Ryan, 1985; Williams, Deci, & Ryan, 1998). Based on the theory of Self-Determination, Sundar, Bellur and Jia (2012) propose a theoretical framework for designing **Motivational Technologies** in preventive health website and mobile applications. They consider that technologies designed for intrinsic motivation can help to engage users, translate them into healthy lifestyle, as well as maintain the behaviour as a habit for long term.
Their theoretical model explores the ways technology-based variables can play to enhance users' sense of autonomy, competence and relatedness. They suggest that *navigability* can support *competence*, *interactivity* can build *relatedness*, and *customization* can promote *autonomy*.

**Figure. 5.1. Theoretical model of motivational technology to promote preventive health behaviors (Sunder et al, 2012)**

*Navigability* refers to "the extent to which users can explore a mediated environment, e.g., a health website, in a highly idiosyncratic manner." (Sundar, Bellur & Jia, 2012, p.115) Since information on the websites is in large amount, hence, if the structure is complex and confusing, the users will get lost and feel frustrated when browsing. Good navigation design such as providing sitmaps or alphabetical indexes in logical manner, or offering visual cues that assist information processing can help the users to find information or accomplish a task with ease. Navigability allows the users to navigate the content in their own pace, needs and abilities, it can produce a sense of control over the websites that leads to positive cognitive, emotional, and behavioural outcomes (Sundar, 2008). It is suggested that highly navigable interface can increase self-efficacy and competence to enhance the persuasive effects of the content of the websites. In brief, designing effective interface is to provide navigational structures for guiding the users to accomplish their tasks and goals with ease (Sundar et al, 2012).
**Interactivity** is to facilitate the social connection and communication with other people in the application. People want to connect and be connected with other people. Sundar and his colleagues (2003) have found that higher degrees of interactivity can induce a sense of relatedness among users and also higher motivation in participating in the interaction. They regard that for health site, it is important to facilitate online social and emotional support so interactivity can help to build a sense of community. Therefore, health site should provide health content and interactive features that connect the users deeply as well as facilitate them to build relatedness among others. For example, the site can provide online forums for users to share information and experience to create a sense of community and promote positive health behaviours.

**Customization** means to offer information or features that tailor to the needs of a specific user according to his/her distinctive attributes. Tailoring was found to have positive effect on health behaviour and especially more effective when user does it and for people who are power-users (Sundar et al, 2012). Customization features that allow users to make their own choices and options can create the locus of causality and control, which is essential for the sense of personal autonomy and self-determination. Their study found that participants had higher intention to perform health behaviour over time when they were highly involved in their health and customized their diet and exercise activities than participants used the control site (Sundar et al, 2012).

They argue that only providing health information and data available, or using persuasive message for behaviour change are not enough for promoting sustainable and self-motivating health behaviour. Rather, designing technologies for empowerment and intrinsic motivation that create the feelings of competence, relatedness and autonomy are more effective for long term behaviour change. They regard that their model is not only influence intrinsic motivation by navigability, interactivity and customization in system and application design, it will also affect health attitudes and actions for health behaviour over time.

The theoretical framework has connected the motivation theory and the technology-based variables in interaction systems and they have persuasively
explained how the SDT can be used in designing technologies for maintaining behaviour change. However, this framework is mainly focused on the behavioural level and does not explain why the users want to interact with the system in the first place.

### 5.5. Meaning and Values in User Experience

O'Brien et al (2008) identify the attributes of the system that affect users' engagement and Sundar et al (2012) propose some technological variables in health applications that motivate users for sustaining health behaviour. However, they are the qualities of the system's features, the 'what' and 'how', and still not answering *why*, the be-goal, the user wants to engage and use it over time, especially for health systems or applications. Hence, it draws to the understanding the meaning and values in user experience.

The role of meaning and values have been considered as prominent factors in user experience (McCarthy & Wright, 2004; Diller & Shdroff, 2006; Bate & Robert, 2007; Desmet & Hekkert, 2007; Anttonen & JumiskoPyykkö, 2008; Nurkka, Kujala & Kemppainen, 2009; Hassenzahl, 2010). As Kujala and Väänänen-Vainio-Mattila (2009) remark, "user experience is inherently affected by the set of user values and motivations as one of the factors affecting the eventual user acceptance or rejection of the system or product use." (p.13) Hence, understanding the values and meaning can provide valuable information for designing systems and products that develop long term user engagement and relationships, especially for health-related products and services.

#### 5.5.1. The concept of values

The concept of values can be understood from the literature of psychology, marketing and design disciplines (Nurkka, Kujala & Kemppainen, 2008). In principle, values are related to needs, goals and motivations, and they are always interchangeable. According to Bilsky and Schwartz (1987), values are cognitive representation of needs
and are "desirable transituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" (Schwartz, 1994, p.21). Values as goals since they can motivate people to take action for certain directions and serve as standards for evaluating and justifying actions or things (Schwartz, 1994). Kujala and Väänänen-Vainio-Mattila (2009) regard that "values are personal presentation of goals that are important and appropriate to maintain in the long run". (p.7) In this sense, values can be seen as desirable goals that are important to the individuals and serve as criterion for guiding actions and influencing behaviours.

Values are acquired through socialization to dominant group values and unique learning experience of individuals (Schwartz, 1994). Hence, values are considered as relatively stable individual preferences related to culture and socio-economic status of the person (Flanagan, Howe, & Nissenbaum, 2005), self-concept (Verplanken & Holland, 2002), and personality (Bilsky & Schwartz, 1994). Verplanken and Holland (2002) designate that although values are culturally shared, individuals rank the importance of specific values differently and depending on a practical context.

### 5.5.1.1. Values in marketing science

In marketing science, values have been conceived mainly from the perspective of the expectation and benefits in products or services that deliver to the customers, and focused on the customer perceived values and consumer segmentation of value perceptions (Kujala & Väänänen-Vainio-Mattila, 2009). Customer perceived value is a concept refers to the value that the consumer perceive they receive or experience by using the offering; the perceived values of the customers can predict and affect purchase behaviour (Bettman, Luce, and Payne, 1998). Nevertheless, not every customer perceive value is the same, since customer perceive value may be based on their personal values, needs, preferences and financial resources (Ravald & Grönroos, 1996), as well as in usage situation (Anckar & D’Incau, 2002). Therefore, it is suggested to have a good understanding of the underlying needs and values perceptions of the specific user segments to develop effective marketing strategies (Pura, 2005).
Several consumer segmentation models have been developed to study the demographics, behaviour, psychographics, and values (Kujala & Väänänen-Vainio-Mattila, 2009). For example, the VALS (VALS 2006) is a questionnaire tool to segment individual consumers into eight value-related segments, these segments combine psychological attributes and demographics to describe consumer decision-making (VALS, 1982). Although these value segmentation models and customer perceived value are useful to provide some understanding of different lifestyles and needs of customer segments, they can only help in the general positioning of a product, but limited in helping designers to identify design details and particular context of use of a product or system (Boztepe, 2007).

5.5.1.2. Values in user and product relationships

In terms of user and product relationship, Allen, Ng and Wilson (1999) propose that users' evaluation of products is shaped by values in two ways. Firstly, users evaluate a product's utilitarian meaning and make a piecemeal, attribute-by-attribute judgment. Secondly, users evaluate a product's symbolic meaning with an affective, intuitive and holistic judgment. The symbolic meaning of the product plays a large part in many product choice since it is directly influenced by the values the individual holds. In this regards, the individual's selection of certain products and services is to achieve the desired goals of the individual (Nurkka, Kujala & Kemppainen, 2009). For instance, individuals who value achievement may favour products and services that bring about a sense of power and achievement such as luxury cars and hotel stays. In their studies, Allen et al (1999, 2002) found that the psychological values are related to product preference, however, which of the judgmental ways is more influential is depending on the preferences of the individual and type of products.

5.5.1.3. Value-centered design

In HCI, value has been received research interest in the past decade (Kujala & Väänänen-Vainio-Mattila, 2009; Nurkka, Kujala & Kemppainen, 2009). One of the
proponents is Gilbert Cockton who proposes the concept "Value-Centred Design" (VCD) (Cockton, 2004ab). As Cockton (2004a) states that the field is moving from focusing on usability in the product to looking for needs, behaviours, and capabilities in human contexts. He argues that to achieve quality in use and fit to context in HCI is not sufficient, it should also include the concept of value as the dominant concern of design as design is the intent to create value (Cockton, 2006). He regards that all these goals are dependent on each other with quality in use at the bottom and fit to context in the middle, but the most important goal is to achieve value since lower level achievement have limited worth without the support of the higher level ones. On the other hand, the problems in quality in use and fit to context can both degrade or even destroy intended value. The HCI in the contemporary time should place value as the center of design guidance, and to coordinate and reshape the quality in use and fit to context to the delivery of intended product value. The role of designers should comprehend what values the stakeholders hold in a system and support them in delivering this value (Cockton, 2004b).

Nevertheless, Cockton (2006) later changed "Value-Centred Design" (VCD) to "Worth-Centred Design (WCD)", and the term 'worth' he later describes as being the balance of benefits over costs. Since he thought that the term 'value' and 'values' are confusing in English and some people may only refer the words to commercial or moral sense. WCD, according to him, is focusing on "development on the worthwhile, somethings that will be valued, as manifested in people's motivation, to invest own time, money, energy and commitment." (Cockton, 2006, p.168) WCD is shifted from the focus on cognition, emotion to volition. The starting point is not 'user goals' or 'objects, but human motivation, to understand what motivates usage, purchase and recommendation. He contends that this approach can help to identify the needs, wants, and unmet needs as innovative design opportunities to achieve intended worth or value. Furthermore, he argues that the value of the enduring outcomes of interaction is more important than the usability, fit to context, and inherent qualities of interactive systems, that it must have a 'happy ending’ in terms of system impact. VCD or WCD provides additional concepts in developing methodologies to study and evaluate value and worth of interactive systems, products and services.
5.5.1.4. Values as experience

On the other hand, user values are considered as derived from the interaction between the product and the user's goals, needs, perceptions and context of use instead of the properties or symbolic meaning of a product or system alone (Cockton, 2004ab; Boztepe, 2007; Kujala & Väänänen-Vainio-Mattila, 2009). For instance, Kujala and Väänänen-Vainio-Mattila (2009) propose that user values can be defined as "users’ psychological values that affect their views as to what kind of purpose, functions and characteristics are important to them in a certain usage situation and context." (p.14) They hold that a product or system does not have absolute value, but the value of it depends on the user's internal conceptions of what is important in a certain usage context instead of the perceptions of products.

As Heskett (2002) states that the utility/use or significance/meaning of an object or communication are closely interwoven and it is also difficult to say that values are inherent in the object's materiality or in the symbol system alone. Pine and Gilmore (1999) contend that what people desire is not products, but the experiences the products provide. Cagan and Vogel (2002) regard that products enable experience, the better experience the product brings to the consumer, the greater value the product is perceived. Hence, the values of a product or system are a result of the interactive experience that it matches with the user's needs, goals, desires, and perceptions in a particular situation or context. In this case, value is contextual and different types of values emerge from the user's experience with the product (Boztepe, 2007).

5.5.1.5. Value is contextual

As values are closely linked to experiences which are context- and situation-specific, they change from situation to situation, therefore, values also change as external contextual factors change (Boztepe, 2007). When a product is valued in one situation may not be valued in other situation. For example, an expensive luxury watch may be valued in a situation of prestige dinner, however, it seems not valued when it is worn to
play sports. Boztepe (2007) regards that a set of common behaviours or ways of doing things, the infrastructure, institutional factors, and social cultural shared meanings such as symbols and traditions, can significantly affect user value. As she puts it,

"Therefore, the notion of value as experience encompasses aspects of both utility and social significance consequences created through interaction with products. User experience involves the juxtaposition of (1) user context and characteristics, and (2) whatever features the product brings to the interaction, including both formal and functional characteristics. Users interact with products within the context of their goals, needs, cultural expectations, physical context, and emotions. And products, with their tangible and intangible qualities, can influence the way users interact with them. What we call user value is thus created as a result of the interaction between what the product provides and what the users bring in terms of their goals, needs, limitations, etc. (Boztepe, 2007)"

Hence, user values can be affected by two factors: the user context and characteristics, and the tangible and intangible qualities of the product. On the one hand, the context influences user-product interaction and can hinder or enhance the user’s experience with the products and their assigned value. On the other hand, the product features and properties can affect product interaction and then user values, depending on if they can meet the user’s needs, goals, and expectations.

In addition, Boztepe (2007) mentions that user values dependent on the stages of experience such as pre- and post-purchase, the disuse or dispossession of the product; and it can also vary over time as the users have gaining more experience with the product. Furthermore, the user values on one product may not be applicable to another product in certain user groups or contexts (Kujala & Väänänen-Vainio-Mattila, 2009). For instance, the values of washing machine for Turkey’s homes from Boztepe’s (2007) research may be different from the user values of publicly mobile phone use for Chinese people. So researching user values need to consider both the user context and characteristics, and how they relate to the needs of certain products or services.
5.5.2. Meaning in experience

Why meaning is important to us? Diller and Shedroff (2006) use the famous anthropologist Clifford Greetz's explanation that "human being require an explanation of the world that helps us decide how to act. Meaning helps us understand the world and ourselves, learn, and make sense of what's around us. It provides a framework for assessing what we value, believe, condone, and desire. Anything that supports a sense of meaning supports the basis for understanding and action, making it extremely valuable to us." (p.23) They contend that creating meaning to experience is to help defining one's life story and his/her value and purpose in life. They regard that the most successful experiences are meaningful that can maintain lasting effects of consumers.

Then where the meaning comes from and how designers can achieve it? Many scholars and researchers believe that meaning is derived from the user's interaction and the experience with the products or system (Margolin, 2002; McCarthy & Wright, 2004; Vyas & Van Der Veer, 2006; Boztepe, 2007; Hassenzahl, 2010). For example, Margolin (2002) regards that experience has both operative and reflective dimensions that user can create symbolic meaning from the experience of the products in their lives and activities.

McCarthy and Wright (2004, 2008) consider that experience is a process of sense making. They adopt the philosophical concept from John Dewey's pragmatist perspective that experience is constituted by the relationship between self, the object and the world. They emphasize that experience is derived from the interrelationships between sensation, emotion, intellectual as well as semantic qualities where all of them are integrated as a unity in a setting. It is a holistic in interaction including sensual, emotional, spatio-temporal and compositional thread. Experience is developed by continuously engaging of the self with the world through sense-making. Meaning is constructed by the dialogical and ever-changing interaction between the user's self, objects, and setting, including the construction from the past to the future experience,
through six processes of sense-makings. The experience may have an effect on our sense of self, it may relate to our past, our desires and future hopes. It may result in changing our sense of self after this experience, or it is just another experience.

Meaning in the experience may change when we communicate and share our experience to others or others to us. There is a connection between the individuals, the social, and the culture in this process and it influences how we reflect on and interpret the experiences. Hence, aesthetic experience also has a dialogical characteristic in which self and others, the artifacts and the setting are all constituted creatively in the interaction to generate manifold values, feelings, and emotions synchronously in the experience by the self and others. Hence, there are at least two centers of meaning or consciousness in the dialogical relation and the meaning is open and keep evolving in the continuous interaction with the others (McCarthy & Wright, 2004, 2008).

On the other hand, Hassenzahl (2010) holds that need fulfillment creates meaning in interacting with a product, which is essential for product success and sustain interaction. According to him, the user's goal, need, and motivation have great influence on user experience of a product since they are the underlying reason for interaction, so fulfilling a need is essential for a positive experience. He regards that experience design is about the experience that the product delivers through an integration of different aspects of products such as functionality, content, presentation and integration. The ultimate goal is to create positive experience that fulfill needs and values, which in turn creates meaning and emotion of the users. As he puts it, "Need fulfillment and according experiences, energize our behaviour. They are the reason, why we do things. ..... that we do things primarily because we find them 'interesting' or 'important', and they are likely to create a positive feeling." (Hassenzahl, 2010, p.36)

He regards that needs and meanings can be transferred into product attributes in a process. However, the urge of fulfilling the needs may be different depending on the situation at hand and different products types or genres. Hence, the purpose of human-computer-interaction should understand user needs and values, and integrate the three levels of goal model into a meaningful, inseparable whole that can influence
the user experience: "Human-Computer Interaction and interaction designers should focus on exploring their ideas' power to impact and change thoughts, feelings, and action - in short: experience." (Hassenzahl, 2010, p.75)

Based on the concept that experience as meaning, Vyas and Van Der Veer (2006) proposed four concepts underlying designing technologies to support users’ experience. **Experience in Interaction** suggests that experience occurs during the interaction between the experiencer and the experienced object or artifacts in the lived reality, and the action and reflection of their interaction affect the quality of experience. Experience is a dynamic process that is constructed contextually and socially in the interaction. **Experience in Interpretation** refers to the notion that users are not passive receivers of information but they will actively construct meanings employing their knowledge, sense-making and interpretation skills. The meanings are a social and cultural products during the interaction with the system, and the users may not construct or interpret the meaning as per the designers intended to convey. **Experience as what the designers offer and what users bring to it** indicates that the expert artists or designers can trigger certain experiences but they are not guaranteed due to the diverse social, cultural, and intellectual knowledge of the users, which affect the interpretation of meanings. In this sense, experience depends on both the users and the experienced objects that built by the designers with some meanings attached to it. **Four forms of Experience** means that people construct meaning of arts and interactive technology involve different forms of users' experience including Sensual, Cognitive, Emotional and Practical. These forms of human experience are inseparable and interrelated that are experienced as a coherent whole, but their intensities may differ based on the users and the experienced artifact, and in particular context.

Based on these concepts, they develop a design framework consisting three steps: 1) experience occurs during the interaction between the user and the interactive system in the lived environment; 2) designers convey meanings through the appearance, interaction and function of the system; 3) users construct a coherent whole that are a combination of sensual, cognitive, emotional and practical forms of experience (Vyas &
Van Der Veer, 2006)

They suggest that the four forms of experience can be incorporate with function, interaction, and appearance properties when designing of interactive systems that helps designers think beyond the instrumental aspects and focus on the desirable possibilities. Considering the experiential aspects of how users’ interpretation of meanings is challenging for designers; however, it also helps them to come up with new ways of envisioning their designs (Vyas & Van Der Veer, 2006).

In summary, values can be defined as goals and needs that are important to individuals, that serve as guiding principles in their lives, and therefore can be maintained in longer run (Schwartz, 1994; Kujala & Väänänen-Vainio-Mattila, 2009). User values are perceived values that the users or consumers want to achieve by using or owning the products or services. However, as values may be different in important level depending on the circumstances, situations, and contexts; therefore, different products and services may have different perceived values. On the other hand, meaning is a process developed from the users’ interactive experience of the products or services (McCarthy & Wright, 2004; Vyas & Van Der Veer, 2006). It relates to the sense of self and need fulfillment (McCarthy & Wright, 2004, 2008; Hassenzahl, 2010). It is important for individuals since meaning in the experience could change our perception, how we reflect on ourselves and the world, and influence our behaviour (McCarthy & Wright, 2004).

<table>
<thead>
<tr>
<th>Values</th>
<th>Content</th>
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<tbody>
<tr>
<td>Emotions/cognition</td>
<td>Features/functions</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Navigation</td>
</tr>
<tr>
<td>Sensory</td>
<td>Interface</td>
</tr>
</tbody>
</table>

Experiences increase over time produces meaning

**Figure 5.2. The concept of values and meaning in products and services**
User values and meanings are dynamic and multi-faceted including those factors such as the user context, the product attributes and features, as well as context of use. In order to create desirable user values to meet user needs and goals, an in-depth understanding of the product qualities and user context of different types of products and services and the interaction between the user and the product in particular context is essential.

Due to the complexity of the construction of user values and meanings, various research methods and tools may be needed to investigate the users' needs and unfelt needs, values, goals, desires and motivations (Cockton, 2006; Boztepe, 2007; Kujala & Väänänen-Vainio-Mattila, 2009). Furthermore, involving users in the process is also vital to understand their point of view (Kujala & Väänänen-Vainio-Mattila, 2009). Several research methods are suggested including ethnographic, semi-structured in-depth interviews, probes, and prototyping.

The means-end approach by prototyping and using probes and 'laddering' is regarded as an effective way for studying user values and meanings (Cockton, 2006; Boztepe, 2007; Kujala & Väänänen-Vainio-Mattila, 2009; Nurkka, Kujala & Kemppainen, 2009). The mean-end approach allows the researchers to dig below the consumers' surface knowledge through the product attributes and functions in a prototype. Since the product attributes or properties are symbolic cues that always reflect the deeper beliefs and meanings of the users who perceived certain values and meanings from using the product to satisfy their needs and wants (Gutman, 1997; Kujala & Kemppainen, 2009). As Boztepe (2007) states, "Product properties are treated as cues, or indicators, of value. Through their visible and intrinsic characteristics, they convey certain uses and meanings, which are constantly matched and compared against the requirements of the user's context." Therefore, the use of mean-end approach can be an ideal way to examine user values and meaning, particularly in the initial stage of product or system development.

5.6. Design for User Experience
As the above concepts show that experience involves different levels and processes which reflect distinct product qualities, so it should be considered in the design for user experience. Garrett (2011) develops a model for designing for user experience called **The Elements of User Experience** to provide a structure of user experience design. Originally developed for website design, the model can also be applied for mobile applications, product and service design with both functional and informational aspects to communicate with the users and help them to accomplish tasks (Garrett, 2010).

He proposes that design for user experience is constituted of five planes: *the surface plane, the skeleton plane, the scope plane, and the strategy plane*. The lowest plane is the most abstract since it is about how the website or product fits into the company's strategy and the users' needs. The higher the planes the more concrete they are in relation to how the website or product actually looks and works. Each plane depends on the plane below it to build and take shape, for example, the surface plane depends on the skeleton plane to decide on what and how the visual elements are used and arranged, etc. The choices of the elements should be aligned in each plane to deliver a coherent user experience. (Figure 5.3)

![Figure 5.3. The elements of user experience (Garrett, 2011)](image-url)
The **Strategy Plane** is the foundation of the user experience where it determines what the company wants to deliver to the users through products, services or systems to meet their needs and expectations. It requires to identify users' needs through user research. The strategy must seek a balance between the business's objectives and the needs and expectations of the users.

The **Scope Plane** refers to the various features and functions that are offered. Both functional and informational aspects of the products or services should be considered in the scope. The functional specifications refer to the set of operations that help the users to perform the tasks, whereas the content requirements are the information the product needs to communicate to the user. For example, in a mobile phone, the functional specifications include the functions that help the users to place and answer calls, and the content can be textual, images, or games in the mobile phone.

The **Structure Plane** is where the user experience starts to take shape. It maps out the flow of the users' movement from one task to the other, and the arrangement and organization of information for the users to easy to use and understand it. It requires an intertwinement of interaction design and information architecture to provide quality user experience that fulfils their needs. Understanding the psychology of users can help to design the flow of a task that facilitates the users to achieve a goal, meet or even exceed their expectations. Good information architecture including the relevance of content and use of language is able to create emotional resonance with the users that results in positive user experience and consumer loyalty.

The **Skeleton Plane** is to define the forms of experience to be delivered. It composes of three parts: information design, interface design and navigation design. On both sides is the information design to present information in such a way for facilitating understanding. The interface design in software products is to arrange interface elements for users to interact with the system. The navigation design is the selection of screen elements to facilitate the users to move through the information architecture. The goals of navigation design are to communicate with the users the choices available
to them, and help them to access the content of their choice. For instance, information design in a shopping environment can refer to the signages or other visual cues for wayfinding; in a website, it can be the sitemap or scroll down menu to show the content parts of the site.

The **Surface Plane** is about the sensory design that users first come to contact with the products or websites. Sensory design includes visual elements such as colours and typography, audio elements including musics and sounds, as well as tactile qualities such as the textures and the click of the buttons, and so on. The sensory should go beyond aesthetics but also need to help the users to make easy choices and controls to accomplish the tasks. Great sensory design has powerful effects on customer loyalty since it can evoke emotions and affect that persuade users to repeat patronages.

The model suggests that it is important to understand the users in all of these planes - the users' needs and expectations, as well as the behaviours of the users - in order to design a positive experience that can build customer loyalty (Garrett, 2010). The choices and elements in each plane should work together to achieve the plane's goals and to fulfill the needs of the users. Moreover, he suggests that content and technology also play important roles in shaping the website and user experience. Since the quality and arrangement of the information, as well as the availability of technology can enhance or prejudice positive experience. The value of this model is to suggest a strategic view of designing user experience where understanding the user needs is essential in the whole planning process.

### 5.7. Conceptual Frameworks of Design for Sustainable Behaviour Change

This section is to sum up the literature reviews and propose some conceptual frameworks for designing persuasive and motivational systems.

#### 5.7.1. The structure of designing persuasive and motivational systems
By studying the literature review, a proposed model adopted from "The elements of user experience" by Garrett (2011) is drawn to describe the process and the elements of designing of persuasive systems (Figure 5.4). The model is developed by combining the knowledge of health psychology, health behaviour change theories, persuasive communication strategies, as well as design concepts of interaction design. It can be divided into 4 stages:

1. Understand the motivation and health behaviour change theories;
2. Study context inquiry;
3. Identify design objectives;
4. Develop design strategies.

When developing an interaction system that aims for promoting health behaviour and sustaining health behaviour change, first of all, the designers should have some knowledge about the health behaviour change theories. Then the designers should understand the users by contextual inquiry which includes the domain (the disease and its related information), user context (age, gender, health literacy, social and culture, etc.), the physical context (environment), the spatio-tempo context (when and where the system is used), the task context (the goals and tasks), as well as the technological context (infrastructure, costs, and technology availability). With these kinds of knowledge and understanding, the designers can identify the design objectives, and decide on the using of different strategies to persuade and motivate health behaviour change, as well as develop more appropriate systems that meet the needs of the users to achieve long-term behaviour change.
In the design strategies, it can be mainly divided into 3 parts: **content**, **interaction** and **interface**. Each part is also sub-divided into components that form the persuasive strategies in the interactive systems. The following explains the components in more details.

1. **Content - the message**
   The content is the most important part to persuade people to change behaviour since understanding the rationale of change can help to generate reflection which is a process of internalization. To achieve internalization is regarded as a more effective way to initiate and sustain behaviour change. Content includes providing information about the problem (in this case, diabetes), the risk factors, the consequences, and the
solutions. The content in an interaction system also includes the functions and features, and the format of the information use, for example, games or statistics. The content is not necessarily mean it should all be texts, content can be images and sounds, but the main point is that it needs to explain and set forth the information of why there is a need to change and how the system can support it. Since without the understanding of the rationale of change and the availability of solutions, there is no long-term action and the change is only temporary. Moreover, if there is only conceived threats without supportive actions and solutions, it will only produce stress and depression.

Subset parts and the questions to consider:

**Information** - It includes the quality and content of the information. Information such as "Why it needs to change? What can we do about it? How can we do to overcome the problem?" should be provided.

**Functions or features** - What kinds of functions and features need to be included to support the behaviour?

**Format** - What kind of format is most effective to aware, inform, educate, and persuade for this groups of users?

2. Interaction - the behaviour - how the system behaves in response to the user

Interaction is mainly referred to the behaviour issues. It involves how to organize the information and content elements in a way to convey the message more effectively. This part is also related to the usability issues.

Subset parts and questions to consider:

**Information architecture** - It relates to "the arrangement of content elements to facilitate human understanding" (Garrett, 2011, p.88). Questions should be ask such as "how can we structure the information in a way so other people can understand and use it?"

**Navigation** - It communicates the relationship between the contents and the page the user is currently viewing, and provides with a means for getting from one point to another on the site.
3. Interface - the sensory - how effective does the design support the objectives defined by each of the lower planes? (Garrett, 2011, p.88)

The interface is the medium that helps to convey the message and it is what the user is come to contact with. The elements of the interface such as visual images, icons, graphics, sounds and musics, can be arranged in such way to attract, communicate, motivate and persuade the users. It also relates to the usability and satisfaction. On the other hand, the use of language is also a factor to affect the persuasion and motivation, as well as the user experience.

Subset parts and questions to consider:

**Sensory** - What kinds of senses we should use to communicate and persuade?

**Semantic** - What language is used to be most effective?

This model provides a structure for designing persuasive systems and the following is to propose the design principles that are needed to generate reflection, motivation and behaviour change in the persuasive systems.

5.7.2. A proposed integrated model for the design principles of persuasive interaction systems

To provide more comprehensive framework for designing and evaluating persuasive interactive systems, an integrated model is proposed. A CBS (content, behaviour, social) model for persuasive systems (Table 5.3) is developed by adopting the theories from health psychologies, persuasive communication and user experience, as well as interaction design from the literature review. (Table 5.2) Some concepts are adapted by the Persuasive Design Model (PDM) by Oinas-Kukkonen and Harjumaa (2009). The framework can be used as evaluation criteria for these kinds of systems. It includes three main parts: **content supports, behaviour supports, and social supports.**

1. **Content support part**

Content support refers to the content and information of the system. It helps to inform,
explain, persuade, and educate the users towards the actions. It includes the quality, the forms and the sources of information that provide appropriate information and solutions for the users. Three subsets regarding the content support include exposition, credibility and relevance of the information. The content information needs to be adequate, comprehensible, as well as trustworthy to be useful and effective. Moreover, the content, skill sets, layouts and visual design, and so on, should be relevant to the users, and it should meet with the goals and needs of the users.

2. Behaviour support part
Behaviour support refers to the execution and implementation of the strategies in the interaction system. It composes of two subsets - persuasive techniques and interactive factors.

A) Persuasive techniques refer to the techniques that could direct the users to accomplish their goals, such as goal setting, prizes and rewards, or coaching. The persuasion and the motivation are effective when it is also perceived meaningful and valuable to the users. It is also important to provide hopes and realistic expectation of the outcomes. This part includes induce - the persuasive techniques; provide meaning - the reasons of why it needs to change, and the values and benefits of the change; prospect - what is the expectation of conducting or not conducting the action.

B) Interactive factors are mainly regarding the implementation of the system, which refer to the system design and features that can help the users to achieve their goals as well as the performance of the system design. The experience of using the systems can affect the motivation and expectation of the continuous action in the future. It includes:

Support autonomy - the system should provide autonomy and personalized features for the users.
Perceived control - it refers to the usability issues and helps the users to accomplish
the tasks in the system effectively and efficiently.  

**Aesthetic experience** - it should provide sensory, emotional, and intellectual satisfaction when interact with the system. Since the sense of self and positive emotion experience is important to engage in the system.  

**Stimulation** - the system should attract interest, and it can maintain longer-term interest by updating information or providing adequate challenges. It is also important to support a sense of personal development for people to check their progress. The interactivity of the system is also an essential element to motivate using the system.

3. **Social support part**  
Social support refers to the design features that facilitate social connection with the others and find social supports. Positive social supports have been found useful in maintaining healthy behaviour. **Social connection** means the system should support social interactions and human-to-human communication. To provide Instant feedback is also essential to encourage and motivate interaction, as well as induce positive experience. **Social relation** refers to the assisting in formation of modelling and resemblance of others that motivate positive behaviour. It should also provide recognition of their efforts to encourage desirable behaviour.

### Table 5.2: Theories inform design principles for persuasive systems

<table>
<thead>
<tr>
<th>Theories</th>
<th>Implication to design</th>
<th>Design Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health behaviour change theories</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Theory of Reason Action, Theory of Planned Behavior, Health Belief Theory | ➢ Encourage lifestyle change and redesign by providing adequate and appropriate information  
  ➢ Provide benefits of change and use of the system  
  ➢ Provide education and training to increase self-efficacy to cope with the change | ● **Exposition**  
  - inform  
  - explain  
  - persuade  
  - provide solutions |
| Elaboration Likelihood Model, Transtheoretical theory | ➢ Tackle cognition and emotion in the message.  
  ➢ Tailor the messages to different needs | ➢ **Credibility**  
  - trustworthiness  
  - expertise  
  - endorsement |
<table>
<thead>
<tr>
<th><strong>Goal Setting Theory</strong></th>
<th>➢ Provide tools for achievable goals</th>
<th>➢ <strong>Induce</strong> - help users direct towards their goals and desired behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive motivation theories</strong></td>
<td>➢ Promote positive self-identity ➢ Promote creativity ➢ Support safety and security needs</td>
<td>➢ <strong>Relevant</strong> - the information, skill sets, layout design, story, etc. are relevant to the person - the message and the product is able to meet one's need</td>
</tr>
</tbody>
</table>
| **Self-acceptance**  
**Self-actualization** | ➢ Promote a sense of personal growth and achievement | ➢ **Stimulate** - interesting interaction - updated information - appropriate challenge - show progress |
| **Personal growth**  
**Self-actualization** | ➢ Support autonomy and a sense of locus of control ➢ Provide freedom of choice | ➢ **Support autonomy** - Provide personalization - provide flexibility to help the user to accomplish their goals - |
| **Self-determination Theory** (autonomy)  
**Self-efficacy Theory** | ➢ Support and facilitate task accomplishment in manageable manner | ➢ **Perceived control** - timely and convenient to use - easy to use and operate - simplify procedures - clear guidance of procedures - facilitate task accomplishment |
| **Sense of Coherence Theory** (meaningful)  
**Eudemonic views of well-being**  
**Purpose in life** | ➢ Provide values, benefits and meaning in interaction | ➢ **Provide meaning** - Provide values, purposes, and benefits of using and acting |
| **Hedonic and Eudemonic views of well-being** | ➢ Induce positive emotions ➢ Pleasant to look and use ➢ provide pleasurable and meaningful experience | ➢ **Aesthetic experience** - aesthetic and sensory appeal - focus attention - pleasurable to use - emotional and intellectual fulfilment |
| **Social Cognitive Theory**  
**Self-Determination (relatedness)** | ➢ Support positive social relations | ➢ **Social connect** - provide social supports - facilitate human bonding - provide timely feedback |
| Sense of hope | ● Promote hope and motivation for people to take control their health  
● Provide information of how to solve the problems  
● Provide positive encouragement | ● Prospect  
- promote realistic hopes and possible outcomes  
- provide positive encouragement |

Table 5.3: The CBS Model for persuasive systems

<table>
<thead>
<tr>
<th>Design Principles</th>
</tr>
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</table>
| **1. Content support** | **Content and information** - the quality, the forms, and the source of information | ● **Exposition**  
- appropriate information  
- provide solutions  
- facilitate reflection  
- appropriate format |
| | **Credibility**  
- trustworthiness  
- expertise  
- endorsement  
- authority  
- verification | |
| | **Relevance**  
- the information, skill sets, layout design, etc. are relevant to the person  
- the message and the product is able to meet one's need  
- tailoring the content and features | |
| **2. Behavioural support** | **A. Persuasive techniques**  
- techniques that help to direct the users to achieve their goals  
- such as praise, rewards, suggestions, coach, goal setting, reminder, etc. | ● **Induction**  
- goals direction  
- proper encouragement  
- praise or rewards  
- reminder |
| | **Provide benefits**  
- Provide values, purposes, and benefits of using and acting  
- compare the results | ● **Prospect**  
- promote realistic hopes and possible outcomes |
| | **B. Interaction factors**  
- system design and features that help the users to achieve their goals  
- performance of the system | ● **Simplification**  
- timely and convenient to use  
- easy to use and operate  
- simplify procedures  
- clear guidance of steps |
- facilitate task accomplishment

- **Support autonomy**
  - Provide personalization
  - provide flexibility

- **Aesthetics**
  - aesthetic and sensory appeal
  - pleasurable to use
  - emotion and cognition fulfilment

- **Stimulation**
  - interesting interaction
  - updated information
  - appropriate challenge
  - show progress

- **Self-monitoring**
  - facilitate to track information about own activities

### 3. Social support

<table>
<thead>
<tr>
<th>Social factors and supports</th>
<th>Social connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>- facilitate social interaction and supports</td>
<td>- facilitate human bonding</td>
</tr>
<tr>
<td></td>
<td>- provide instant feedback</td>
</tr>
<tr>
<td></td>
<td>- promote cooperation</td>
</tr>
<tr>
<td></td>
<td><strong>Social relation</strong></td>
</tr>
<tr>
<td></td>
<td>- modelling</td>
</tr>
<tr>
<td></td>
<td>- resemblance</td>
</tr>
<tr>
<td></td>
<td>- normative influence</td>
</tr>
<tr>
<td></td>
<td>- recognition</td>
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### 5.8. Summary of the Chapter

This chapter gives a comprehensive overview of the concepts of user experience and user engagement in interactive systems. It discusses the user interaction and how the user develops relationship with the system or artifact through the experience over time. Several motivation attributes are also recognized in the user engagement. It also clarifies the values and meaning in interactive systems and the importance of understanding them in designing persuasive systems to initiate and sustain behaviour change.

This chapter also summarizes the literature reviews in the present and previous
chapters and develop models and frameworks to provide conceptual understanding of designing of motivational and persuasive experience for behaviour change. It includes a model of designing persuasive systems and a theoretical CBS model to suggest design principles for persuasive design, and the principles can be served as criterion for evaluation of persuasive interaction systems.

Based on the concepts from the literature, the study identifies several research gaps including:

- The persuasive effects of different persuasive strategies in persuasive systems are not well-understood, particular narrative or statistics formats, which are the most commonly used of these kinds of systems.
- There is a lack of study about the persuasive strategies in the behaviour change process, and if these strategies play distinct roles in different stages of behaviour change?
- Positive experience can affect attitudes and behaviour, however, not many studies examine the experiential factors of persuasive interactive systems and how they affect the motivation and persuasive effects especially the role of content in these systems.
- The study proposes a CBS model of persuasive system design according to the theories from the literature, is the model reliable for evaluating the motivation attributes of the persuasive systems?
- The user needs and user values are important for sustaining user interaction with the systems, however, they are less studied in the persuasive systems especially diabetes management systems.
- What contextual factors affect the user experience and persuasive effects are also not understood in Hong Kong Chinese context.

Those research gaps serve as the research objectives in designing the research methodology in this study. Next chapter is to describe the research methodology and the research findings will be discussed in the coming chapters.
III - RESEARCH PROPOSITION

6. Research Methodologies

6.1. Introduction

This chapter is to discuss the research methodologies employed for this study to answer the research questions. As discussed in the previous chapters, design for people with diabetes should not only focus on managing their health but also promoting health by persuading and motivating healthy lifestyle, as well as facilitating self-management. This study is focusing on design for sustained behaviour change with the use of digital technologies and understanding if they can empower, persuade and motivate patients to engage in healthy behaviour over long term. As an exploratory study, the research methodologies are designed for gaining insights and understanding how the psychological theories and persuasive design concept could be applied for diabetes management and promoting health behaviour change in the Hong Kong context. The findings would provide knowledge for future development of these concepts and persuasive design.

6.2. Research Design

According to the research questions, the research objectives consist of answering three main areas:

The first area is to understand the current diabetes management and its contexts. Questions to examine include: What are the most important issues related to diabetes management? What is/are the most problematic areas and the patients’ perceived challenges in their diabetes management in the Hong Kong context? What are the barriers and why they are so? What are the contextual and motivational factors affecting these problems of self-management?

The second area relates to the persuasive technologies for self-management. Questions
include: What are the persuasive technologies available, particularly in the Chinese context, to support diabetes self-management? What are the persuasive communication strategies using of these systems?

The third area is to examine about the relationships and the interaction of the persuasive technologies in the patients' psychosocial context including the values, lifestyle and the experience of using the technologies in their own environment. It aims to examine which kinds of persuasion and motivation strategies, the narrative or graphic presentation format, are most effective to promote health behaviour change and support diabetes management? Are different persuasive strategies play distinct role in the behaviour change process? Does the user experience of these systems affect the motivation and persuasive effects? What are the user values of this kinds of systems? Which use context and user context affect the motivation and persuasive effects?

The research design is drawn from these three main areas and developed in such a way to address the research questions, and the findings will help to propose and constitute design guidelines. It takes a flow of inquiry from discovery, explanation, analysis, comparison, evaluation, to implementation. To do so, the research design is divided into several stages to gain deeper insights and recognition from a general understanding to a more specific sort of knowledge of the subject matter. The goals are to generate new knowledge to enrich the existing design approach in theoretical concepts and design practices.

6.3. Research Participants

The target informants include two types: the diabetic patients and the healthcare professionals. In order to acquire clinical and healthcare knowledge about diabetes mellitus and their treatments, as well as the critical issues in self-management and rehabilitation, some healthcare professionals, including rehabilitation professors, occupational therapists, or other healthcare providers were initially interviewed in the exploratory phase of research.
The study intends to obtain more insights from Chinese adults aged 40 to around 70 since they are the largest population with Type 2 diabetes. Since different age cohorts have different characteristics, including such as values, physical characteristics, educational background, financial situations, and particularly their experience of using technologies; hence, studying different age cohorts can provide broader and more comprehensive information of diabetic patients in their self-management through using digital technologies. They can also provide insights for designers or health care providers to develop long-term plans for Chinese older adults in the near and coming future.

**The Sampling**

The diabetes informants were recruited from patients' self-help organisations and NGOs, including *Regeneration Society, The Hong Kong Society of Rehabilitation*, as well as *The Angel of Diabetes*. The main samples were Chinese adults with Type 2 diabetes because it can be prevented and improved by adopting a healthy lifestyle. Since the research involved several stages of study, different sampling methods were used.

The sampling in the first stage of research included a wider range of participants since the study intends to gain a wider range of insights of people with diabetes by using quantitative research. Therefore, a casual sampling method was used to invite the diabetic patients to answer the questionnaires through the above organizations. The researcher collected the questionnaires and then selected targeted participants to conduct a more in-depth semi-structured interview, either face-to-face or through the telephones.

After the interviews, some of the participants were invited to participate in the user evaluation and design prototype stage. Purposive sampling was used in this stage specially targeting the participants with Type 2 diabetes, aged 40 - 70, with at least one year of diagnosis, as well as they have some years of using computers or smart phones.
The reason was that Type 2 diabetes is mostly found in these ages, and those with less than one year of diabetes may not have adapted to the disease, who may also have different attitudes and behaviour than the longer diagnosed ones. In order to understand if user context affects persuasion and motivation, participants with diverse demographics (e.g., age, genders, education, work or retired) and different years of diagnosis were recruited in this part of the research. Moreover, since the research required the participants used the persuasive diabetes systems in their daily lives, some years of computer and smart phone experience was also necessary.

The participants were explained the nature of the research and they could withdraw anytime during the research. Consent forms and Information Sheets were signed before the interview to ensure private and personal information were kept confidential.

6.4. Research Methodologies

This research uses an action research (AR) approach. Action research is defined as a kind of social research that “encompasses a professional action researcher and the members of an organization, community, or network ("stakeholders") who are seeking to improve the participants' situation. AR promotes broad participation in the research process and supports action leading to a more just, sustainable, or satisfying situation for the stakeholders.” (Greenwood & Morten, 2007, p.3-4) Rather than solely studying the problems of the situation, action research is more applied focus which employs systematic procedures in order to solve a practical problem or transform or empower individuals in a community setting (Plano Clark & Creswell, 2010). This study intends to investigate how design and technologies can help to motivate health behaviour change. It focuses on diabetic patients in their self-management as a case to understand the challenges in behaviour change and propose possible solutions in design. As AR, the research started from investigating the causes of the self-management problems and gradually leads to examining the means that can help to improve the situation. Then some solutions, in this case the diabetes systems, were selected, tested and evaluated the results. The findings were analysed and could provide implications for designing diabetes systems. Although this study is focus on
diabetes management, the findings of the research could also help to develop persuasive systems or technologies for other types of chronic disease patients and motivate healthy behaviour even for able-bodies in general (Figure 6.1).

Figure 6.1. Action research approach to design for change

This study is exploratory in nature with a longitudinal approach where the researcher examined the participants’ behaviour on persuasive systems over around 2 months and then followed up after 10 months for gaining a deeper understanding the experience and motivation issues.

As the purposes of the research questions differ, different research methodologies and analysis techniques are required in order to gain the best understandings of the questions (Knafl & Howard, 1984). This study used mixed methods comprising a set of research methods, including both qualitative and quantitative methods.

Mixed methods in research design are intended to use "both quantitative and qualitative data to answer a particular question or set of questions" (Hesse-Biber, 2010, p. 3). Qualitative and quantitative approaches employ different methodologies which can complement each other in a research for researchers to obtain a breadth and depth knowledge of the subject concerned. In studying a design artefact, "Quantitative evaluations are good at establishing what works, but qualitative evaluations help to
understand *how* a program succeeds or fails." (Padgett, 2012, p. 61). Quantitative data can provide a general understanding of the phenomenon in a broad context, and help the researchers to test the reliability and validity statistically, whereas qualitative data can assist researchers to gain in-depth understanding of the phenomenon and allow the researchers to explore anomalies or subgroups within the data (Hesse-Biber, 2010, p.6). Using both methods assists researchers to crosscheck the research results and enrich the knowledge and understanding of the particular phenomenon. Hence, it is essential in this study to adopt this approach to identify what the interactive experience was and motivation problems were with such kind of systems regarding the complex interactions between the patients, diabetes self-management, the artifacts and the contexts.

This study used a qualitative approach to mixed methods design. A qualitative approach refers to the qualitative methods as primary methods to the component of quantitative methods playing an auxiliary role in a mixed method framework (Howe, 2004, p. 54). According to Hesse-Biber (2010), a qualitative approach entails researcher to build a strong connection to the respondents "through the practice of empathy, that is, by closely identifying with the respondents' experiences." (p.63) Since "individuals are perceived to be 'meaning making' of the world they reside in", qualitative researcher seek to understand the complexity of their lived experience and "the contexts in which they arise" (Hesse-Biber, 2010, p. 64).

Qualitative approach can promote "deeper listening between the researcher and the researched" (Hesse-Biber, 2010, p.64) and provide "deeper, more genuine expressions of beliefs and values to foster a more accurate description of views held" and gather a more complex understanding of social life (Howe, 2004, p.54) (Quoted by Hesse-Biber, 2010, p.64). In addition, it can also open to new information than using hypothesis testing. As the purpose of the study is to gain more in-depth understanding the lived experience of the people with diabetes in their self-management and the user experience of the researched systems, a qualitative approach to mixed methods design can allow the researcher look deeper of the participants’ lives and the context of the system use.
Since the study aimed to examine the lived experience of people with diabetes, it employed a sequential mixed method design. According to Hesse-Biber (2010), ‘in a sequential exploratory mixed methods design, the qualitative component is primary and is used to generate theory or specific theoretical constructs.’ (p. 71)

The mixed method design was mainly divided into two stages: discovery and exploratory stage (Figure 6.2). In the discovery stage, it started with a quantitative research in the form of survey to gain a general understanding of people with diabetes in their self-management, and then followed by qualitative research in form of in-depth interviews in which the participants were selected from the previous survey. This method helped the researcher to identify and select subsamples from the target population which might otherwise be difficult to find. The results from this stage allowed the researcher to identify the key issues and paved the way for user evaluation and design prototype for the exploratory stage. In the exploratory stage, quantitative and qualitative research were conducted in parallel in order to assess the validity and reliability of the findings. The overall findings then can provide a rich and profound understanding of the particular phenomenon and answer the research questions. It may also discover new information and open up new areas of study in the future.

**Figure 6.2. The mixed methods design in the study**
Ethnography inquiry is used in this study since it can help to understand the context of the development and implementation of particular systems or interfaces (Lazar, 2010). Ethnographic research originates from anthropology and it is the study of the practices and behaviours of a group." The anthropologist aims to recreate for the reader the shared beliefs, practices, artefacts, knowledge and behaviour of some groups of people." (Bresler, 1995/2006). Ethnographic research emphasizes on 'thick' description and interpretation; and it stresses the combination of ‘emic’ (insiders) and 'ethic' (outsiders) perceptions and perspectives to provide with a deeper insight of the phenomenon or the culture under studied.

Major research methods in this study included surveys, questionnaire, observation, in-depth interview, self-documentation, as well as user evaluation. Participate observations were performed throughout the whole process since it allows the researcher gain personal experience in the participants' lives to truly learn about a situation (Plano Clark, & Creswell, 2010, p. 261). The researcher can also change roles as nonparticipant to just look around of the setting and activities, this allows the researcher to gain a subjective as well as objective view. All these methods were used in the purpose of participating in the patients' daily life to understand better the context and daily experience regarding to diabetes mellitus and the patients' use of technologies in self-management. Using ethnographic research methods can generate useful and deeper insights in this study.

6.5. Four Phases of Research Design

This study involves four phases of research design which aims at systematically researching the lived experience of people with diabetes and the effects of the persuasive systems. The four phases include: preliminary, discovery, system analysis, user evaluation and design prototype (Figure 6.3). It started with the researcher entering the field to gain general knowledge of the problems and narrowed it down to more specific concepts of addressing the problem; the results can inform and inspire for future development and improvement of the design.
Figure 6.3. The Four Phases of research
Overview of the research design:

Phase 1 was a Preliminary study. It was a first stage of research to gain background understanding of the subject matter. It included literature review, preliminary interview, field studies and participation observation. It helped to identify research gaps and key issues in the study.

Phase 2 was Discovery stage, which drew from the findings of the preliminary stage. The purpose was to understand the contextual factors in diabetes self-management and how people with diabetes perceived of using digital technologies to improve their health and self-management. Survey, questionnaire and participation observation were conducted at this stage.

Phase 3 was System Analysis. It related to the studying of the existing persuasive diabetes management systems or applications related to promoting healthy behaviours such as weight loss and fitness. System analysis of these systems facilitates an understanding about the characteristics, the features, and the persuasive tactics of these systems.

Phase 4 was User Evaluation and Design Prototype. This phase was to understand how the users' interaction of this kind of systems and especially focused on how might or might not these systems enable and motivate health behaviour. A user evaluation was conducted by questionnaire, semi-structured interviews, and self-documentary after the patients using some selected persuasive systems for 6 weeks. It could help to examine how different persuasive tactics and features affected the motivation and persuasive effects in new behaviour change. Furthermore, a design prototype was shown to the participants to understand their needs and user values in using these systems.

It is noted that during the processes, the research was not entirely linear but iterative where the findings of the research were required a constant review of the literature again to gain deeper or new insights of the study if necessary.
6.5.1. Phase 1 - Preliminary study to gain background knowledge

Phase 1 was a Preliminary study which was an initial stage to understand the conditions of diabetes mellitus, the issues in self-management and the use of e-health in health care. Literature review related to health care, rehabilitation, information systems, interaction design, experience design, health psychology, philosophy, design studies and cultural studies were reviewed to provide a broader understanding of the subject matter from different perspectives. However, it lacks specific knowledge to the research questions, hence, a participation observation from the field and interviewing the informants including health care providers and patients were essential.

Two health care providers, including a Ward Manager who had about 30 years of experience in nursing and an experienced Case Manager were interviewed about chronic diseases and self-management, as well as their perspectives on using e-health in Hong Kong. Some short and causal interviews were also conducted with two experienced nurses. A nurse with diabetes was also interviewed to gain some insights from the patient’s perspective. A half-day mobile clinic visit was also conducted to gain some insights about the health issues of the elderly in Hong Kong.

After the extensive research in the preliminary phase, some key issues in diabetes and self-management were identified, including: the compliance or adherence problems of self-management, the motivation problems, the social and emotional issues, and technological concerns in healthcare. In order to understand the issues more deeply, a preliminary research with more patients was needed.

6.5.2. Phase 2 - Discover the key issues in self-management

The purpose of the discovery study was to explore and understand the problems and perceived challenges of people with diabetes in their self-management, as well as their perception of using technologies in self-management. It could help to identify key issues or interesting questions that needed to be further explored and assisted a more
focused direction of the research. Survey and in-depth interviews were used in this phase to gain both breadth and depth insights of self-management.

The purpose of the survey was to gain a "snapshot" of the issues and identify the trends of the phenomenon of a particular user population (Lazar, 2010, p. 101). The survey was also a relatively easy way to obtain information of a larger amount of people in a particular period of time. People are more willing to answer the questionnaire than spends time on the interview. The purpose of the survey in this research has two-folds: firstly, it helps to identify the most problematic areas in diabetes self-management of the people with diabetes in Hong Kong, and if there are significant differences between user groups such as age, gender and working status. Secondly, it helps to screen suitable participants for later research including interviews and user evaluation.

The questionnaire was designed and developed based on the literature review and interviews with the health care providers. It aimed to understand the self-management in different aspects including medication taken, blood sugar tests, medical follow up, diet control, physical exercise, as well as emotional and social aspects, and how the disease affects their daily lives.

The questionnaire was reviewed by two healthcare providers and a pilot study was conducted with some diabetic patients in order to ensure the questions were clear and easy to understand, and the critical issues of self-management were covered. It consisted five parts: general conditions of the disease, self-management issues, social and psychological aspects, the perception of using technologies in self-management, and personal information.

The paper questionnaires were distributed through the NGOs and self-help diabetes organizations, including Diabetes Self-Help Association, Regeneration Society, and The Angel of Diabetes from the period of July to end of September, 2012. Then an online questionnaire was placed in the Survey Money, an online survey platform, from October to end of November, 2012. An advertisement about the survey was placed on the newsletter of The Angel of Diabetes to invite patients to conduct the survey.
After collected the questionnaires, some patients were invited for an in-depth interview through face-to-face interview or telephone interview. In-depth interview allows participants to express their personal experience and concerns in more details and private ways. It can allow researcher to gain deeper insights about the causes and concerns of the problems which would have been lost to surveys (Lazar & Wiley, 2010, p. 178). To understand the causes of the problems and the contexts of the disease and psychosocial in self-management can provide valuable insights for designers to design and create innovative solutions to motivate healthy behaviour and improve health. The interview will focus on the individual's emotions, attitudes, behaviours, motivations, and perceptions regarding the issues of health, healthcare, diet control, physical exercise and their perceived challenges.

In order to provide a more thorough understanding, patients of a variety of demographics, for example, age, gender, working status, were invited to the semi-structured interview as it is believed that people with certain demographics may affect their problems and challenges in their self-management. For instance, age differences may affect their self-efficacy, and working status such as retirement and working full-time may have different impacts on their self-management activities such as doing physical exercise. After the interview, the main obstacles in adherence problems can be identified and they can serve as a reference for design principles and guidelines.

6.5.3. Phase 3 - System analysis of diabetes systems

The diabetes management systems for mobile application have been widely used in the western countries such as the United States and some European countries, however, it is just a new concept in the Asian countries such as Hong Kong and China. It is valuable to understand how these kinds of systems can equally provide effective self-management and promote healthy behaviour for Chinese people in the Hong Kong context.
This phase was to search for suitable existing digital technologies and systems in Chinese that could help the patients in their self-management, especially in facilitating and motivating diet control and engaging in doing more physical exercise. The advantages of using existing systems in the research are: 1) the systems have already available in the market, meaning they are fully accessible and functional for the users to use in their own environment; 2) it can truthfully reveal the user experience and problems related to the context of use; 3) the users can enter their data which is better than just using a prototype; 4) it is more time efficient compared to building prototypes in this case. However, there are also disadvantages that need to be aware of: 1) the systems may encounter technical problems that are beyond the control of the researchers; 2) it cannot be customized to adapt certain features or functions for the research. Since the study aims to reveal the true situation of the use situation and user experience, the existing systems were decided to use in this research.

Two types of Chinese diabetes management systems, an online computer system and some mobile applications, were employed in this research. For computer users, a comprehensive and informative web-based diabetes management course developed by The Rehabilitation Society of Hong Kong was used. It was launched in August, 2012 specially designed for diabetic patients and their caregivers to use free-of-charge. For the smart phone users, some Chinese mobile applications related to diabetes management and weight loss control were introduced. The web-based computer system was mainly for training and educational purposes and it used narrative strategies with entertainment education in persuasion. The mobile applications were largely log book applications focused on monitoring purposes and assisted with some related information such as diabetes, diet and exercise. They mostly used graphical and statistical strategy by displaying the data of the users’ health situations and their activities.

The reasons of using these systems included: 1) they were using different persuasive and motivational strategies so they could help to understand the effectiveness of these systems; 2) one system was only available for computer use and the other two systems were mainly for smart phone use, it allowed the participants chose the digital systems
that were available for them to use in their lived environment; 3) it could also help to identify the different context of use, and how it might affect the persuasive effects and user experience of these systems.

At the time of research, there were only a handful of Chinese diabetes management mobile applications available in the market. The mobile applications were searched from the Google Play store and Apple Store during the period of September to November 2012. They had to be in Chinese, free of charge and provided some storage of personal data functions. As the purpose of this study was to examine if these kinds of systems could help to persuade and motivate a healthier lifestyle for diabetes patients, it needed to include applications that provide diet control and encourage physical activities. Some keywords including "diabetes" (糖尿病), "diabetes management" (糖尿病管理), "weight loss" (減肥), "fitness" (瘦身), and "diet control" (飲食控制) were used to search for the applications. Since there is no such diabetes management application available in Chinese, a diabetes management application along with a weight loss application were decided to be used. A diabetes management system named "Kiwi Blood Glucose Management Assistant" (Kiwi 血糖管理助手) and a weight loss application called "Weight Loss Assistant" (減肥助手) were chosen for Android system users. For comparison purposes and also because of the real situation in the market, a diabetes management application "Diabetes Little Nurse" (糖尿病小護士) was introduced to iOS system users. This logbook system supplied comprehensive health data entry and records, but no health and food information were provided.

The mobile applications were mainly developed by the mainland Chinese enterprises so simplified Chinese characters were used. Since the simplified and traditional Chinese systems of characters are very similar, most of the people of Hong Kong can easily identify the simplified Chinese characters with the traditional Chinese characters, therefore, this should not affect the major results.

The system analysis was using the proposed CBS Model, which was adapted from the Persuasive Systems Design Model developed by Oinas-Kukkonen and Harjumaa.
(2008), to identify their persuasive contents and related techniques. These systems were compared, analysed and evaluated to provide with useful insights for understanding their strategies in encouraging healthy behaviour.

6.5.4. Phase 4 - User evaluation and design prototype

The fourth phase was to investigate the persuasive effects and user experience of the participants after using the digital diabetes systems. It aimed at studying the relationships between user context, user experience, persuasive strategies and behavioural change. The findings could provide a valuable understanding of the adoption of technologies in patients' daily lives in managing health and engaging in healthy behaviour. These understandings can assist designers and software developers in designing more desirable systems for diabetes management as well as promoting a healthy lifestyle and well-being.

Since the participants were using different kinds of devices, they were divided into two groups randomly depending on the device they used: the online computer group and the mobile application group. The participants were aged 40 - 70 including different demographics (age, genders, education level), working status (working or retired), and years of diagnosis of diabetes. The participants were first taught about how to use the online course or mobile applications, and they were required to use the systems at home or in their daily lives for about 6 - 8 weeks. Then they came back to reflect their experience and problems when they were using the systems to discover any special issues affecting persuasion and motivation. Finally, they were also shown with a design prototype to examine their needs and values of diabetes systems.

The participants were recruited from the in-depth interviews in the second phase where they were asked to participate in the user evaluation research. The participants invited to the research were based on their age, years of diabetes, the problems in self-management and their use of smart phones or computer since they needed to use it in their own environment. The patients with some health conditions such as heart disease and cancer were eliminated because of the safety concerns.
The participants were invited to come to the campus with their glucose meter and their smart phone or tablet if any. If they used the computer only, they were provided a computer and the online self-management course was introduced. Some task sheets (Appendix D) were supplied to help the participants familiar with the applications or the online course. Assistance was provided if necessary to ensure that they know how to use the systems.

The participants were provided with a logbook diary to encourage them to record anything they thought meaningful in their experience related to using the systems. Diary is used when it is not feasible for the researcher to visit the participant's in their natural setting, or it may change the actions of the participant if the researcher is present in the setting (Carter & Mankoff, 2005). It helps to expand the explanation in a later interview and provides some degrees of validation (Lazar & Wiley, 2010, p. 127). Diary use in this research can provide a more in-depth understanding of what is important to the participants and of how they conduct their lives and manage their health by using the systems in a less intrusive way. Elicitation diary is used in this research to encourage the patients recording events or feelings that are meaningful to them when using the systems without too much interference. The participants are also encouraged to take photographs if needed.

The participants were checked with their body weight and marked it down in their logbook for reference. They were also encouraged to set their own goal in the coming 6 - 8 weeks and checked if their goal was achieved when they came back to the post-evaluation interviews. The interview for each participant took about one to two hours. In order to provide incentive and compensation for the transportation fees, a HK$100 (around US$12.82) supermarket coupon was granted for each participant after the research. All the interviews were audiotape recording. The purpose and the process of the study were explained to the participants and they were free to withdraw anytime during the research period. Informed consents were obtained from all participants.
A follow up call to each participant were conducted after about one week to check if the participants had any problems in using these systems. As most of these systems have already provided a reminder so no further reminder from the researcher was supplied in order not to interfere too much. A second call to the participants were given during around the 5th or 7th week to check their progress and confirm the post-use interview appointments.

After 6 - 8 weeks, the participants came back for a follow up interview to describe their experience and feelings about using the systems. They were also invited to answer a questionnaire (Appendix E) that was designed to stimulate their reflection about their user experience of the systems. The use of the questionnaire was a complement of the interview since some participants might not express their experience clearly. Next, a design prototype, which was adopting the mean-end approach of research design, was shown to the participants. Through understanding what kinds of design features were more desired for them, more ideas about their needs and values of the diabetes systems could be obtained. Finally, in order to know if the systems had lasting impact, the participants were telephone interviewed after 10 months to check their health conditions and if they were still using the systems. The total findings would help to develop design guidelines for designing diabetes systems, improving self-management and encouraging healthy behaviour. More details of the research methods and processes are found in Chapter 9.

6.6. Summary of the Chapter

This chapter describes the research methodologies and the use of research methods in the study. It explains why the use of mixed methods in this study is necessary and their advantages. It also describes in detail the research processes, that are, the four phases of research design, and the objectives and research methods in each process. The details of the findings are discussed in the following chapters.
IV - RESEARCH FINDINGS

7. Phase 2 Discovery Stage Research Analysis

7.1. Introduction

Phase 2 is a Discovery stage where it focuses on discovering the barriers and perceived challenges in self-management for people with diabetes in Hong Kong, as well as their views on using technologies in self-management. The research included a survey and was followed by in-depth interviews to gain deeper insights of how the disease affected their lives, their motivation in self-management and the psychosocial issues.

Quantitative data analysis and qualitative data analysis methods were used to analyze the research results. The data from the survey were coded and the variables were measured for statistic analysis by using statistic software. Frequency and correlations of the variables were measured to discover the trends and the relationships between some variables, such as age, working status and self-management problems that were significant in the situations. It could provide a snapshot understanding for people with diabetes mellitus in their self-management problems and what kinds of motivation strategies are most effective for these people.

The qualitative data analysis employed inductive content analysis approach to identify categories and themes related to diabetes self-management. Content analysis is "a research method for making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action" (Krippendorff 1980; Quoted by Elo & Kyngas, 2008, p. 108 ). Inductive content analysis are more appropriate if the phenomenon of this knowledge is not enough or fragmented (Lauri & Kynga s 2005). Since the knowledge of diabetes management and the perception of the use of digital technologies in self-management of the Chinese adults in Hong Kong are still not sufficient, this research used inductive content analysis to discover the key issues.
The qualitative data from the field notes and interview transcripts were first translated into English for open coding, then they were organized and sorted into categories, and through interpretation to discover the attached meaning of what have been observed. From the analysis, some themes and patterns emerged from the analyzed data and they can provide insights for understanding the challenges in self-management, and the patients' perception of technology use in self-management. All the quantitative and qualitative findings are discussed in the following.

7.1.1. Quantitative data

Total 98 paper questionnaires were received from three organizations in the period between August to November 2012. Only three questionnaires were received from the online survey site, it was possibly because not many patients accessed the site due to they were not using computer frequently or they did not familiar with the online questionnaire format. Total number of questionnaire received were 101. Since four of them in both paper and online questionnaires were found to be unsuitable for this research so the total number of questionnaires for this part of research were 97.

The quantitative data were analyzed by using statistical tools including SPSS and Excel. In order to understand better about the situations, some of the results were using cross-tabulation analysis. The following is the summary of the quantitative data from the survey which is divided into three parts: demographic and clinical characteristics, diabetes and self-management, and the perception of e-health in self-management. The full quantitative results can be found in the Appendix C.

7.1.2. Qualitative data

After the survey, some patients were invited for in-depth interview to understand more about the challenges and the use of technologies in self-management. Thirty patients in total were interviewed, among them eleven of them were face-to-face interviews and nineteen were telephone interviews. One telephone interview was conducted by the patient's son. It used purposed sampling since it was intended to study the
self-management issues in patients with different demographics (age, gender, educational background, working status) and clinical situations (years of diagnosis of the disease). It could help to understand if different user context affects self-management and the perceived problems.

The samples in this interview were people with diabetes aged 40 and above, with 13 of males and 17 of females. They had diagnosed with diabetes for at least one year and above (1-3 years, n=7; 3-5 years, n=7; over 5 years, n=4), and 11 of them had diabetes for over 10 years. The numbers of participants who had retired or were housewives were 17 and those who were working full-time or part-time were 13.

The interviews were mainly focused on five areas:
1) The perceived challenges in self-management;
2) The use of glucose meter and checking blood sugar level;
3) Family and social supports;
4) Health literacy and attitudes of self-management
5) The perception of e-health in self-management;

The following is to discuss the survey results and interview findings and followed by the analysis of each part.

7.2. Survey Results

7.2.1. Demographic and clinical characteristics

This section is to report and discuss the demographic and clinical characteristics of the participants who took part in the survey. It provides a context of the survey and also some insights about the user contexts in diabetes and self-management. Table 1 shows the demographic and clinical characteristics data.
Table 7.1 Demographic and clinical characteristics (n = 97)

<table>
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<th>N.</th>
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<tbody>
<tr>
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<tr>
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<td>60 - 69</td>
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<td>70 or above</td>
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<tr>
<td>Secondary school</td>
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<tr>
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<td>67</td>
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<tr>
<td><strong>Income per month</strong></td>
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<td></td>
</tr>
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<td>Less than HK$3,000</td>
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<td>51</td>
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<tr>
<td>HK$3,000 - HK$6,000</td>
<td>12</td>
<td>14</td>
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<tr>
<td>HK$6,001 - HK$10,000</td>
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<td>14</td>
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<tr>
<td>Over HK$10,000</td>
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<td>21</td>
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<tr>
<td><strong>Total number of family member living with you (including yourself)</strong></td>
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<tr>
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<td>3 - 5</td>
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<tr>
<td>Over 5</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td><strong>Duration of diabetes (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>1 - 3 years</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>3 - 5 years</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Over 5 years</td>
<td>62</td>
<td>64</td>
</tr>
<tr>
<td><strong>Treatment therapy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Take medication (oral)</td>
<td>78</td>
<td>80</td>
</tr>
<tr>
<td>Insulin</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Seek Traditional Chinese Medicine</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td><strong>Admission to hospital due to diabetes complications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>72</td>
<td>83</td>
</tr>
<tr>
<td>Yes</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Digital device use</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Computer for documentation</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Computer for both documentation and Internet</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>Tablet</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>None of the above</td>
<td>32</td>
<td>38</td>
</tr>
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</table>

There were 29 males and 68 females from different age cohorts answered the questionnaires. The largest age groups were age 50 - 59 (31%, n=30), and 60 - 69 (31%, n=30) and the second largest age group was age 70 or above (24%, n=23). Only 2 patients were aged 39 or below. The majority of them were married (67%, n=64) and living with 3 -5 family members (51%, n=48). Most of them have secondary educational level (53%, n=50) and primary level (37%, n=35), with only 7% (n=7) have university level of education. Many of the patients were retired or not working (67%, n=62), only 20% (n=19) reported working full-time and 9% (n=8) working part-time, and 4% (n=4) were unemployed. The majority of patients (51%, n=44) have monthly income less than HK$3,000 (around US$384.60), and 21% (n=18) said their monthly income were over HK$10,000 (around US$1282.05).

The majority of the participants (64%, n=62) have diagnosed with diabetes mellitus for over 5 years, and only 6% (n= 6) of them were less than one year. (Figure. 2a) The cross-tabulation analysis showed that the older age cohorts were affected by diabetes longer period of time and all the participants aged over 70 had diabetes over 5 years. (Fig. 2b) It matches with many previous research that the older adults are more affected by Type 2 diabetes (Gu et al., 2003).
In terms of chronic disease other than diabetes, only 92 participants answered this question, of which 32% (n=29) reported that they have none of other chronic disease. However, 54% (n=50) of the participants have hypertension and 19% (n=17) have arthritis. Other chronic diseases include heart disease (13%, n=12), respiratory disease (10%, n=9), high cholesterol (n=4), cancer (n=2), psychological problems (n=2), kidney disease (n=1) etc. The result matches with the clinical research that
hypertension and high cholesterol are related to diabetes. Psychological problems such as depression, anxiety and cognitive decline also associated to diabetes (Worcester, 2013). The majority of the participants (72%, n=83) did not admit to the hospital due to diabetic complications.

Regarding the use of digital devices, only 84 participants answered this question. Some said they used computer only for documentation (29%, n=24), and some used computer for both documentation and Internet (30%, n=25), the smart phone users were about 29% (n = 24), but most of the participants (38%, n=32) said they did not use any of these devices. However, with the declining of the prices of smart phones and tablets, it is estimated that the smart phone and tablet users will be increased in the future.

From the research, we can identify several characteristics of the people with Type 2 diabetes in Hong Kong. First of all, most of them were older adults age 40 and above, with particularly the people aged 50 or above have longer period of diabetes. Many of them were retired and their monthly income were less than HK$3,000. Most of them have secondary education level and living with their family and children. Many of them have other chronic diseases other than diabetes including such as hypertension or heart disease. Some of them were using digital devices such as computer and smart phone, however, many of them did not use any of them.

In the next sections, I will discuss the results of the aspects of the disease and the challenges of self-management, as well as the perception of using digital technologies in healthcare and self-management.

**7.2.2. Diabetes and self-management**

This section is to discuss the findings related to the disease and self-management in many aspects, including to understand which treatment therapies they used, their knowledge about the disease and risk factors, the perceived challenges in self-management, as well their emotional and social aspects.
Many patients sought different ways in treatment therapy, the most common one was taking oral medication (80%, n=78) and some of them needed to use insulin (22%, n=21), and some sought Traditional Chinese Medicine (13%, n=13), some of them may take both or all of them.

In general, most of the participants (76%, n=73) reported that they have some or many knowledge about diabetes and the risk factors of the disease. However, there were about 20% (n=19) of participants said they only have a few knowledge about it.

In the research, the most challenging in self-management were diet control (62%), followed by doing exercise regularly (35%), checking blood sugar daily (30%), and recording the health data (19%). (Fig. 3a)

![Figure 7.3a: The most challenging parts in self-management](image)

When comparing the age cohorts, it showed that diet control was still the most challenging among almost all age groups (Fig. 3b), particularly age groups of 40 - 69 (37% - 38%). They also regarded that doing exercise regularly were very challenging (21% - 23%). On the other hand, participants who thought to have difficulty in
following up regularly were mainly the participants aged 78 over 70 (17%) compared to the other age cohorts. It may be due to the fact that they forgot the follow up appointments or they could not go to see the doctors by themselves, further investigation may needed. Moreover, this group of participants also regarded that checking blood sugar (21%), take medicines on time (14%), and do exercise regularly (14%) were also challenging for them.

The results showed that diet control and doing exercise regularly were the most challenging self-management tasks of people with diabetes. It also showed that the challenges in self-management were diverse between different age cohorts particularly the participants aged 70 or above, who may be affected by physiological and environmental constraints.

![Figure 7.3b: The most challenging parts in self-management across age cohorts](image_url)

In regard to checking blood sugar, the majority of the participants (71%, n=62) were not checking their blood sugar regularly everyday. When asked the reasons, only 40 participants answered the question and the reasons were they thought that it was no need (50%, n=20), not convenient (35%, n=14), too painful to use (18%, n=7), as well as difficult to use (8%, n=3). However, 18 participants answered with their own answer,
many of them (n=8) reported that they only checked it a few times per week or occasionally because of the busy schedule at work, or the nurse said that it did not need to check it too frequently, or he/she thought that the blood sugar level was more or less the same. Some also said that it was too expensive to use (n=4), or they forgot to use it (n=3). One participant said he refused to hurt himself so he did not want to use it.

The majority of participants (88%, n=81) consider that the disease did not affect very much of their daily life. However, about 10% (n=9) said it did and 2% (n=2) said it affected them very much. When asked which part of their daily life were most affected, diet habit (80%, n=67) was regarded overwhelmingly as the most problematic, followed by social life (20%, n=17) and daily routine (14%, n=12).

Many participants did not think they have many emotional problems that are affected by the disease. About 25% (n=23) said the disease has no effect on their emotions. However, 17% (n=16) people said many, and one patient said it has significantly affected his/ her emotions.

Many participants (23%, n=21) did not feel stressed or worried about self-management, however, about 62% (n=58) felt a little or some. About 11% (n=10) of them said they felt quite stressful and worried about self-management, and 4% (n=4) regarded a high level of emotional stress.

Regarding the social support, most of the participants reported that family and friend's support were important for them (44%, n=41) and some said they were very important (11%, n=10). Only 8% (n=7) of them said they were not important.

In terms of seeking information about self-management, it was found that the sources of information was mainly from the healthcare providers (44%, n=39), and other sources including from the media such as books (28%, n=25), magazines (27%, n=24), newspapers (26%, n=23), and internet (19%, n=17). Information from family and friends were about 15% (n=13) and 18% (n=16) respectively. Some participants reported that they attended course from the Rehabilitation Society of Hong Kong.
However, 27% (n=24) of them said they did not find any information about self-management.

The findings in this section provides a snapshot understanding of the issues and challenges in self-management. From the research, diet control and doing exercise regularly were considered as the most challenging parts in self-management, and checking blood sugar and recording health data were also consider problematic. It also found that age differences can affect how people encountering self-management challenges. It may be because of different lifestyles, physiological conditions, and environment situations in different ages and life cycle. For example, for younger generations, they are usually working full-time and have more active social life, diet control and doing exercise regularly are not easy to achieve. In contrast, the older generations are usually retired, they have more time to spend in the daytime so they can go to do Tai Chi or exercise. However, due to their physiological and cognitive decline, as well as financial constraints, they have difficulty in using the glucose meter to check their blood sugar, as well as follow up with the doctors. Further investigation of the reasons was needed to help to understand the problems and appropriate solutions can be developed.

The results also found that most participants reported that they did not check blood sugar everyday regularly because they thought that it is "no need" and "not convenient to use"; rather the reason "it was too painful to use" and "difficult to use" were relatively in smaller percentages. Moreover, other reasons included "too expansive", "forgotten", and "the blood sugar was more or less the same" were mostly related to the contextual factors such as perception, financial constraints, and physical factors. It showed that the problems in checking blood sugar is largely related to contextual issues rather than the glucose meter itself.

Although most of the participants reported that the disease did not affect their daily life too much, when asked which parts were most affected, diet habits was overwhelmingly regarded as most affected, and followed by social life and daily routine. It may be due to the fact that people with diabetes need to control their diet and food
intake, for some people, they need to alter greatly their diet habit which is not easy to achieve and it matches with the previous result that diet control is the most challenging part.

On the other hand, most of the participants in this research regarded that the disease did not affect their emotions and they did not feel stressed and worried about their disease and self-management, it may be because they have find some ways to control their disease and manage their health, or it may also because they ignored it or did not have the knowledge about it.

This research found that most of the participants have knowledge about the disease and risk factors; however, there were about 20% said they have only a few knowledge about it. It was also found that most of the participants gained their knowledge from their healthcare providers, it indicates that the role of healthcare providers is important to provide health advice and supports on self-management. Many participants would also found information from traditional media such as books and newspapers, and some of them from the Internet. However, it was worrying to find that about 27% of the participants did not seek any information about self-management which may affect how they control their disease in appropriate ways.

On the other hand, it also showed that the supports from family and friends are important in self-management. Considering that in our research, most of the participants were living with their family, family members' supports and understanding can affect how they can manage their disease.

This section have found some important information about self-management, however, some of them were only provided limited understanding, for instance, it was not clear why they perceived diet control and doing exercise regularly were difficult, and their problems in checking blood sugar.

**7.2.3. E-health and self-management**
This section is to discuss the results of the perception of using digital technologies in self-management. It includes to understand what they perceived of using digital technologies to monitor their health by themselves and healthcare providers, tracing their health data and the preference of the digital device.

The positive responds of using digital technologies to monitor their health by themselves were quite high, around 45% (n=42) replied that it could help them to control their disease and improve their health more effectively by tracing the historical graphs by themselves. About 45% (n=42) of them said it might help and only 10% (n=9) said it could not.

Similar results were found when asking if using digital technologies such as Internet or smart phone to monitor their health could help them to manage their health more effectively and efficiently - about 40% (n=37) said it could and 44% (n=40) said it might help.

When asked if it could control their disease and improve their health if the doctors or other healthcare providers could trace their health data everyday and give them guidance accordingly, 63% (n=58) said it could and 30% (n=28) replied it might be.

With regard to the device they prefer to use, only 76 participants answered this question. Smart phone (38%, n=24) and computer (32%, n=29) were the most popular choices, followed by smart watch or smart jewelry (21%, n=16), and tablet (11%, n=8). The less preference was smart clothes (3%, n=2). In the open-ended answer, one participant preferred small electronic appliance. However, some reported that they did not know how to use any of the above device showing that some participants were less familiar with these kinds of technologies and they resisted to use any of them.
In order to understand if the preference differed between ages and genders, the data was compared using cross-tabulation analysis and it was confirmed that the choices were different between age groups and genders. For example, although the choice of computer and smart phone were found in all age groups, they were more preferrable for participants who were aged 40 - 69. On the other hand, the choice of "hanging the device on the wall" were mainly participants who were over 70 years old (36%, 4 out of 7 made this choice). Another choice "to embed the device in other appliances" were also the participants who were 50 - 59 years old (n=3), and 60 - 69 years old (n=3). It was not surprising since the younger generations have been familiar with using computer and smart phone and they require more mobility. In contrasts, many elderly participants have mobility problems and spend more time at home so that they could check and remind them easily. They do not familiar with technologies such as computer or smart phone and this result matches with the research by Charness & Boot (2009). Hence, to design technologies for these group of people, the technologies should be in a form that they are familiar so that they feel easy to operate.

It was also interesting to find that the choice of smart watch or smart jewelry was overwhelmingly by women (n=15), and only one man (n=1) preferred this device. It may be because of the term 'jewelry' or some other reasons, it needed to be further
explored.

Figure 7.4b: The preference of device to monitor health across age cohorts.

Figure 7.4c: The preference of device to monitor health across genders.
7.2.4. Survey summary

This research helps to understand their perceived challenges and their perception of using digital technologies in self-management. It shows that the perceived challenges of diabetic management were most notably diet control, physical exercise and check blood sugar regularly. In terms of using technologies in self-management, most of the participants were positive about the ideas and willing to use them to take control of their health, particularly the younger generations. Nevertheless, the patients regarded that the involvement of the healthcare providers is important in this process so this kinds of device or systems should also need to understand the perception of the healthcare providers and involve them in the design process.

This research also found that the preference of the device were differ between age groups and genders, indicating that when designing systems for different groups of people, it should also need to consider these factors. However, more research is needed to understand the phenomenon deeply.

All in all, the survey provides some useful insights for diabetes self-management system design. It provides a brief and general understanding of the challenges and problems in self-management and the perception of using digital technologies in control and manage the disease. However, it did not provide in-depth understanding of the problems so using a qualitative research could help to fill this gap. Next section I will discuss the findings from the in-depth interviews with some of the participants.

7.3. Interview Findings

7.3.1. The perceived challenges in self-management

As in the questionnaire shown, the perceived challenges in self-management for Chinese people with diabetes were mainly about controlling diet and doing exercise regularly, followed by checking blood sugar and recording health records. The interviews were then focused on understanding these areas.


7.3.1.1. Diet control

In the interview, most of the participants said they have controlled their diet in certain ways, for example, they would try to eat less sugar and rice, or eat plainly meal, and some of them had chosen suitable food according to the advice from their dietitians. However, some of them have a more care-free attitude and they just ignored it:

LU: "I don’t care, I just eat everything."

There were two most frequent answers about the challenges in diet control including 'eat out' and 'self-discipline'.

Most of the patients who found difficulty in diet control were related to eat out, particularly for those who were working and have active social lives such as insurance agents or retail sales representatives, they were usually working late or have high social lifestyle. They complained that it was difficult to order food in the restaurants since there were few vegetables in the dishes, they were usually salty and oily and most of them were not suitable for people with diabetes. They were also not certain which kinds of food is suitable for them. Moreover, they also needed to eat less but more frequently which was difficult to achieve when they were at work.

Some people also said it influenced their social lives such as travelling and friends gathering activities since they did not know how to order food, felt embarrassed and frustrated when their friends did not understand them, or even felt angry because of their disease that prohibit them to eat freely as their friends did. It is in line with previous findings that social influence by friends and family members plays significant role in enhancing or hindering the food choice motive on healthy attitude and behaviour (Wing & Jeffery, 1999; Orji, Vassileva, & Mandryk, 2013b).

LE: "It's difficult to eat outside, sometimes you will eat more. When I went out with my friends, I couldn't resist the temptation, I couldn't control myself."
AU: "When you eat outside, the food you can't eat are usually the food you like to eat!"

KW: "I felt upset when I went out with normal people, they could eat the food but I couldn't eat the food. It affects my social life."

Other problems were more personal and related to emotional and psychological struggles. Many of them reported that they could not control themselves even they understood the health risks:

LO: "When the food was placing in front of you, it's very difficult to discipline yourself."

AU: "All the food that are sweet and tasty are usually not good for health!"

TS: "The more you cannot eat the food, the more you want to eat them!"

TI: "Sometimes you want to release yourself when you have found your blood sugar is under controlled!"

MP: "Because my feet will go into the canteen, and I'll order something I don't suppose to eat. Actually I know it, but my controlling power is weak, not weak, it's poor. Because I feel that I'm not that serious, since my blood sugar is 8 mmol, and I think it's not that high. But recently I found that it reaches 9 mmol, so I bought a glucose meter immediately."

It found that the participants who did not take medications but depending mainly on diet control and doing exercise were more disciplined in self-management and they seeked more information about diabetes and self-management. It also found that some participants who had seen dietitian before had better diet control. However, not many of them had received such advice according to the research, and some said they still
could not help themselves even they had tried it.

7.3.1.2. Doing exercise

The other problem was doing exercise. It was found that "laziness" was the major reason the participants said they did not like to do exercise, other reasons include time issue, work-related factors, no companion, physical problems and environmental factors. The finding is similar to the study by Korkiakangas et al (2011) that they found the barriers to exercise among adults with type 2 diabetes were weather/season, health problems, lack of time, work-related factors and lack of interest, whereas the motivators to exercise include enjoyment from exercise, social relationships related to exercise, encouragement from others, benefits to health, and the aim of weight control.

Some participants thought that they have already walking quite a lot in the day time or doing labour intensive work, so they did not think it was necessary to do exercise at the spared time. Some of them thought that they could not do exercise because their health were not good to do physical exercise.

For working individuals, doing exercise was difficult especially they were busy at work and usually working late, it was difficult for them to spare time to do exercise regularly. For example, a participant regarded that time, social and environmental factors were barriers for him to do exercise regularly:

Why didn’t I do exercise because I have no time to do so. I am usually working very late and when I got home, the fitness center has already been closed. I don’t know why, I just don’t like to go to the fitness center such as "California". It’s expensive. I just have no motivation to go there.

He also thought that there were no goal, no trainer, and no company to motivate him. It is in line with the previous study that goal setting (Consolvo et al, 2009) and coaching (Hanneton & Varenne, 2009) can be a motivator. Moreover, social influence
(Goodman & Foucault, 2006; Korkiakangas et al, 2011) and environmental factors (Hill, et al, 2013; Rhodes & Fiala) have significant influence on physical exercise.

**Social influence** was an important motivation factor in doing exercise. For example, many participants did Tai Chi because they liked to hang out with their friends, and they would go for "yum cha" (eating dim sum in Chinese restaurant) after that. One participant said that her mother-in-law accompanied with her to run in the playground at the beginning for one month, which motivated her to run. However, she dropped it afterwards. Many of them thought that they did not have motivation to do exercise since their friends did not like doing exercise. Some of them also did not like to go to the Elderly Centre or Community Centre since they did not like the people there.

**Environmental factors** were also found significantly affecting the motivation of doing exercise including the physical environment, crowdedness, or weather.

AU: "I feel more natural doing exercise at the playground. There's a group of people there, it feels OK, and I feel happier. I think it looks weird running in the street. Doing exercise is actually good, my blood sugar used to drop 5 mmol after doing exercise in that period."

PW: "I like swimming but during the weekend, there're many children in the swimming pool and I don't like it. I like swimming when there's not very crowded."

Many older adults who were retired usually engaged in some forms of exercises regularly every week, the most common ones were walking, swimming and practicing Tai Chi, Qigong or Yoga.

In sum, the difficulties in diet control and doing physical exercise are related to personal, social and environmental factors. Many participants, especially those have active social lives, felt frustrated when they were eating outsides with friends since they were not sure which types of food were suitable for them. They also did not want to
behave abnormally in front of their friends, which may caused them emotional distressed. On the contrary, some participants using avoidance coping strategies that they just ignored the health risks that may cause. However, it seems that the participants who had attended self-management course or met the dietitian had less stressed about diet control although they thought that they still have some difficulties.

The working participants usually find doing physical exercise regularly was difficult to achieve than the retired participants since they were usually quite busy at work. For those retired participants, they have more time to do exercise, however, social factors such as peer group influence plays important role for the motivation since they preferred hanging out with their own acquaintances, who were not always living nearby or has the same interests.

7.3.2. The use of glucose meter and checking blood sugar level

The majority of them did not check their blood sugar everyday. Most of them checked it around two to three times per week since they thought that it was not necessary to check it daily. Those who controlled their blood sugar by merely controlling diet and doing exercise, on the other hand, tended to check the blood sugar more frequently.

7.3.2.1. Checking blood sugar level

There were different reasons to avoid checking blood sugar level. For many participants, they see checking blood sugar level as education purposes. For example, some participants said they checked it when they ate new kinds of food to see if it would affect the blood sugar level and it would help them to avoid it in the future. Some checked it when they did not feel well to see if it was caused by the low or high blood sugar, or if they needed to take higher dosage of insulin or medications. These information could help them to understand their body and health conditions so that they could take control of their health.

Some of them also had psychological barriers to check the blood sugar since it
hurted when using the glucose meter. One participant said he did not like to make any trauma of his body. Some said that they knew what they ate would increase the blood sugar level and they just avoided to test it if they did. Another reason was that they found the blood sugar level were relatively stable with no significantly change in a period of time, so they did not think it was necessary to do it very often.

The other problem was because of the spatio-tempo reasons. For example, some patients required working outdoor or irregular working hours, they were busy at work or inconvenient to do so, those reasons also affected them to check the blood sugar regularly.

On the other hand, the influence of the health care providers was also a motivation factor. For example, some of them said they did not check blood sugar regularly since the doctors or healthcare providers did not explain why they needed to do so. Moreover, if the doctor did not require to check their blood sugar records during the consultation, the patients were less likely to check and record their blood sugar level, and vice versa. These patients said to record the blood sugar level was only for their own reference because the doctor would not read them. One patient also expressed that due to his blood sugar level was quite stable and in good shape, his doctor did not believe him, which made him felt marking down the data was not a meaningful action. Some also said that the health care providers said it was not necessary to check it daily.

Other reason was related to the product accessories, for example, when the stickers were out-of-stock for some time, the patients did not have the motivation to do it again. The financial factor was another reason. Since the stickers were quite expensive so some of them did not want to use it so often.

7.3.2.2. Use of glucose meter

It was found that functionality, simple and ease of use were the main reasons for people to buy their glucose meter. Other reasons include price, use less blood, not
painful to use, the brand, and easy maintenance and supply of the accessory.

Most of the participants reported that their glucose meter was quite easy to use and it was one of the primary reasons to buy it. However, some patients particularly the elderly found that it was difficult to use. For example, with the same model of glucose meter, most of the participants said that it was easy to use, however, the researcher found that a couple who were over 70 years old thought it was difficult to use and they returned to the patient self-help organization for at least six times for help. The main problem was that they could not figure out the features and could not remember the steps of using it. Similar situations were also reported by some of the volunteers of the self-help organization.

It was also found that most of the participants brought their glucose meter due to the recommendation of the healthcare providers, particularly the elderly people. In Hong Kong. The glucose meter models were relatively homogeneous and lack of choices, and most of the patients usually followed the advice of the health care providers.

The research indicates that the motivation of checking blood sugar is a complex task involving not only the product's attributes, but also users' perception, health conditions, cognitive and physical capabilities, social influence, economical and environmental factors. The result matches with Sharples and his colleagues' (2012) study that the contextual factors affect the use of glucose meter and medical devices substantially. For instance, many participants did not check blood sugar regularly and keep records, however, they saw checking blood sugar as providing information to understand their body and health conditions, as well as educating them about their body reactions of the food and food intake. These information could help them to develop a sense of self-mastery and self-regulation to control and manage their health.

In choosing the glucose meter, the pragmatic functions such as simple and less painful to use are important, however, the contextual factors such as the price of the needles and stickers, the brand, and the availability of the accessories are also essential. It may be due to the fact that many glucose meters have similar functions and appearance,
those contextual factors become essential in making the selection.

Furthermore, using the glucose meter requires a lot of cognitive skills so the user contexts such as age and health literacy seem to affect the use and purchase of glucose meter. For example, since some older people may develop cognitive decline, it is not easy for them to remember how to operate it. In researcher's observations, using a glucose meter involves many steps and different accessories such as stickers, pen, needles, and antiseptic gauzes or cottons, it needs to learn how to use and prepare all the necessary accessories. The researcher was also heard that some patients will reuse the needle by cleaning it with antiseptic in order to save money. Hence, the next generations of glucose meter design should also need to reduce the costs and the requirement of the accessories.

7.3.3. Family and social supports in self-management

The majority of participants said that family support was important to them and their family members would remind them about their diet. Some participants said that their family members even adopted to their diabetes diet. However, family conflict would occurred some times. For example, one participant said she found difficult to cook for her children, sometimes she felt frustrated and angry, and needed to leave home for a while to cool down herself. Other participants learnt to cope with the situation by cooking in different ways for the same dish, for example, she would save some for herself first and then cooked the rest of the dish with more sauce for her family.

Many participants said they needed to take care of themselves since they did not want to become a burden to their family. Participants who were living alone were particularly thought that self-care is important for them since they have to depend on themselves.

The social life was another important issue. Some participants thought that their friends did not understand their situation especially in social gathering activities such as dinning and travelling, which caused frustration and distressed. For example, one
patient felt it was embarrassing when she was dining with her friends since she needed to clean the food in a glass of water before eating since usually Chinese food in the restaurants are using many sauces which could affect the blood sugar level. As she did not take medication and entirely depending on diet control, she felt upset and frustration that her friends did not understand her.

On the other hand, this study found that many of the participants have family history of diabetes, it matches with previous study that if parents have diabetes, their children have higher risk to develop diabetes (Chan & Cockram, 1997). It discovered that participants who have family history of diabetes were more careful about their disease, have more control and engage more in self-management. It may be because those who have seen their family suffered from the disease are more alert and willing to engage into self-management.

It shows that the supports of the family members and friends are important for self-management. It seems that for those who have positive social supports, for instance, understanding, providing encouragement, and adopting the diabetes diet with the patients, could help them better control the disease and achieve positive psychological well-being. Many of them said they needed to keep healthy for not creating burdens to their family. However, a few participants seemed to depend largely on the care by their family rather than their own motivation to manage their health. On the other hand, for those who were living alone and those have seen their family suffered from the disease were more alert and have higher motivation in self-management, showing that personal experience, perception of risks, and perceived self-efficacy could affect the motivation to engage into desirable behaviour.

On the other hand, Charmaz and Rosenfeld (2006) have identified that the invisibility of illness could cause problems in social interaction since their illness is not visible by the others, who may misinterpret the competence and behaviour of the patients. Diabetes mellitus is a chronic disease that is not easily detected from the appearance or inside the body in the early stages, which in fact causes higher potential risks for the patients themselves and is neglected by their acquaintances or caregivers. Hence,
education about the disease and self-care should be enforced to the patients, their families, as well as the society.

**7.3.4. Health literacy and attitudes of self-management**

The gaining of information relates to the health literacy. To obtain information about the disease and self-management is vital since it could help the patients to increase the knowledge to manage their health and gain better control.

It seems that those participants who sought information have a sense of higher self-efficacy and taking more control of their health. For example, a participant said she felt less stressful and upset after she learnt more about diet information from the seminars or friends in the self-help organization. She could even develop some methods in cooking for herself and her family to ease the tensions in diet control. Another participant said he knew how to order food when eating out according to the advice by his dietitian and he also sought many information about it. One participant said she liked to read the experience of the other diabetes patients and knew how they manage their disease, as it could help her to understand more about the disease and alert herself. Many participants who have knowledge of the disease were more willing to engage in self-management, although they may found it difficult to control it strictly.

However, it is recognized that some elderly people lacked enough information since many of them have lower income, lower educational level, they also did not use computer. They are the people who need to take special attention since they are also the group with higher risks.

The previous survey showed that about 20% of the participants did not seek any information about self-management. It may be due to their education level or they did not access to the source of information such as healthcare providers or Internet. Some participants reported that they never seen dietitian before and took any course about it. The previous survey has showed that most of the participants gained information from the healthcare providers, however, some said the information was only general
comments. Since the healthcare providers in the public hospitals in Hong Kong are usually very busy, they may not have time to explain in very details about how to take care of their diseases. Hence, the information from the other source is crucial especially for lower education level and elderly people.

In the interview, it found that some participants actually had accessed to some sources of information such as books and booklets to teach them how to manage their disease, some of them were also attended self-management course. Nevertheless, some of them did not have the motivation to read them or change their behaviour even after the course. It indicates that provide information alone may not sufficient to motivate desirable behaviour change, which is in line with Brown and his colleagues' study (2000) on promoting healthy diet for younger consumers. Hence, it is also necessary to provide appropriate information formats, environment and social supports to encourage motivation and facilitate desirable behaviours.

7.3.5. The perception of e-health in self-management

In the interviews, most of the participants have positive attitudes of using digital technologies to manage their health. Many participants preferred smart phone and computer since they were more *familiar to them*; and many of them chose smart phone because it was *convenient to use*, *provide mobility*, or they could *used it everyday*.

As it has found that the user context have some influences on the perception of using digital technologies in self-management so the interviews could help to provide more understanding of the issues. In general, the attitudes of younger participants towards using digital technologies were more positive, they were more likely to choose computer and smart phone since they have experience in using them and it was also convenient for them.

On the contrary, some of them, especially the female older participants who were over 70 years old, were quite resistance to use computer or any new types of technologies
since they have 'no experience of using it before', 'found it was difficult to use', or 'afraid to make mistakes when using it'. It is in line with the previous studies that attitudes, cognitive capabilities, computer anxiety as well as computer self-efficacy are the factors that affect the acceptance and adoption of technology use of older adults (Charness & Boot, 2009; Czaja, et al, 2006). However, a research by Melenhorst and his colleagues (2006) found that some older adults have a benefit-driven approach towards new communication technology, that is to say, they are more willing to use technology if they perceive it can provide sufficient benefits for them (Melenhorst, Rogers & Bouwhuis, 2006). Hence, the e-health design should reduce the anxiety with aiming at ease of use, providing training to the elderly users, as well as emphasizing the benefits of using the systems or technologies.

For those preferred the device hanging on the wall or embedding on the appliance thought that it was convenient for checking their blood sugar level and health data at home, and it could remind them everyday. It may be because the older participants spend more time at home and if the device is seen as a part of the furniture, they felt less intimidated, and they could check and remind them easily.

On the other hand, it was also interesting to find that for those who prefer smart jewelry or watch were mainly female participants from the survey. The reasons why they preferred these kind of devices include:

- **Safety and ease of mind** - they thought that it was convenient for them, they could carry these kind of devices all the time, and it can serve as an alarm if their blood sugar level or their health are in risk.

  CU: "It can maintain and check your health data such as pulse rate, blood sugar, etc. If it is just for recording, then there's no need to buy it."

- **Aesthetics** - two participants thought that it looked more beautiful when they were wearing these devices. One participant concern about the style of the watch since she did not like big size watches, and she also thought that the look and beauty of the
watch was important since it needs to match with the clothes.

It seems that female participants concerned more about the safety issues. The devices that they carry on their body could provide warning signals if their health are in risk, it would help to provide a sense of safety for them to receive help if necessary. Moreover, the aesthetic appearance of the devices is also important for female participants if it becomes a body accessory since it relates to their self-image. In contrast, it seems that male participants preferred computer, smart phone, or tablet rather than wearable devices, and they did not mention about the safety issues in the interview. It is in line with previous study that men tend to perceive more invulnerable to several potential health threats (Dawson, et al., 2007). However, since this research was conducted in 2012, as the wearable technologies have been developing rapidly so future research may be needed to check if it has been changed.

Furthermore, although both male and female participants preferred devices that are 'convenience' and can 'use it everyday', it differs in forms and meanings in different contexts such as at home or in work, for males or females.

This study indiciates that the concepts of using digital technologies in self-care were gaining positive feedbacks in general and they perceived the technologies could help them to take control their health, remind them or give warning if necessary. The most important features of these technologies should be convenient and familiar to them and match with their daily lives. However, the different preferences of devices in different user groups such as age groups and genders showing that people have diverse needs in self-management. These findings could provide insights for designing for self-monitoring systems.

**7.3.6. Discussion**

The interviews in this part of research has provided deeper understanding the challenges and the perception of using digital technologies in self-management of Chinese older adults in Hong Kong. It shows that self-management is a complex task
which requires not only the patient's own efforts, but also involves social, economical, and environmental factors. It supports the concept of Ecological Models of health behavior that there are multiple levels of influences on health behaviours and it should identify the most relevant potential influences at each level so that more comprehensive intervention strategies can be developed (Sallis, Owen & Fisher, 2008).

The most challenging tasks in self-management were diet control, doing physical exercise regularly, and checking blood sugar and it was found that all of them are influenced by the intrapersonal, interpersonal and environmental factors. For instance, difficulty in diet control is not only because of the individual's own will power or the knowledge about the diet, but also the social influences from the individual's family and peer groups, as well as the environmental factors such as the restaurants' menu and offers. In doing physical exercise, the time and the individual's motivation is important, however, the peer group's influence and the environmental factors such as the facilities and physical settings are also decisive. Regarding to checking blood sugar, the perception and ability of the individual is critical, however, economical factors and the product attributes, the environment to check the blood sugar, and the healthcare providers and peer group influences are all vital in motivations. These influences can be differed for each behaviour problem so to identify them in different layers could help to develop more effective strategies to motivate behaviour change.

The following is a summary of the findings of the intrapersonal, interpersonal and environmental factors of the barriers in adherence in self-management.

Table 7.2. The intrapersonal, interpersonal and environmental factors of the barriers in adherence in self-management.

<table>
<thead>
<tr>
<th></th>
<th>Diet control</th>
<th>Physical exercise</th>
<th>Check blood sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intrapersonal</strong></td>
<td>Demographics</td>
<td>Demographics</td>
<td>Demographics</td>
</tr>
<tr>
<td></td>
<td>Perception</td>
<td>Time</td>
<td>Perception</td>
</tr>
<tr>
<td></td>
<td>Culture</td>
<td>No goal</td>
<td>Fear of pain</td>
</tr>
<tr>
<td></td>
<td>Knowledge</td>
<td>Lifestyle</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td><strong>Interpersonal</strong></td>
<td>Family</td>
<td>Peer groups</td>
<td>Health care</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Restaurants</td>
<td>Physical environment Facilities</td>
<td>Physical settings</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td>---------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Peer groups</td>
<td></td>
<td>Provider Peer groups</td>
<td></td>
</tr>
</tbody>
</table>

The research demonstrates that diabetes self-management requires a lot of skill sets (learn to use and read the glucose meter), time (time to follow-up and self-care), and expenses (different kinds of products related to diabetes care). It also requires a lot of cognitive abilities to learn, monitor and manage their disease. In this regard, it is found that the availability of the resources can affect motivation and influence the behaviour in self-management.

Moreover, resources play significant parts in self-management. Resources compose personal, social, environmental and institutional resources. For **personal resources**, they include physical resources such as biological and health conditions; psychological resources such as cognitive ability including learning and coping styles; financial resources including the costs of medications and different products for diabetes care; time resources including the time to engage into self-care and doing physical exercise, knowledge resources including the source of information and the chance of accessing to adequate information, as well as the technical know-how to use the products and the services.

For **social resources**, they consist of family, peers, and healthcare providers' supports; the knowledge and supports of the community is also important. **Environmental resources** include the physical settings such as sports and exercise facilities in the community, workplace and public areas. The infrastructure of the technologies is also vital when self-care is becoming more digital. Finally, **institutional resources** compose of the healthcare services providing by the hospitals, others include primary care services, health promotion and education, and so on.

This findings show that diabetes management is challenging due to its complexity and the requirement of different resources. As a participant said:
When working, it’s not make sense for us to participate into self-management.... It’s not convenient for people who’re at work in self-management especially when nowadays, more younger people have diabetes and it needs to use a lot of time to conduct self-management such as follow up with the doctor, whereas in the past, diabetes patients are usually older adults. It’s time consuming to do self-management. .... Another thing is stress. You know stress will make the insulin higher.

It may not possible for design professionals and researchers to tackle all the problems as discussed in this section, however, the findings provide a deeper understanding of diabetes management from the user’s perspectives, which could inspire better solutions in chronic care and environment. It also provides insights for developing appropriate self-management systems or services for diabetes self-management and to motivate healthy lifestyle.

Based on the findings and the literature review, some basic criteria of diabetes care services or systems are suggested. They should include two main objectives: 1) to increase the knowledge and abilities of the patients; 2) to reduce the barriers and facilitate health behaviours of the contextual factors. The following is the criteria for diabetes management systems:

Table 7.3. The criteria for diabetes management systems

<table>
<thead>
<tr>
<th>Increase the knowledge and abilities of the patients</th>
<th>Reduce the barriers and facilitate health behaviours of the contextual factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increase knowledge about the disease and risks factors</td>
<td>• Low or affordable costs</td>
</tr>
<tr>
<td>• Facilitate learning of self-management skills</td>
<td>• Easy to access</td>
</tr>
<tr>
<td>• Increase the technical know-how of operating the systems</td>
<td>• Convenient to use</td>
</tr>
<tr>
<td>• Provide trainings and supports</td>
<td>• Easy to operate</td>
</tr>
<tr>
<td>• Tailor to different groups and different needs</td>
<td>• Easy to achieve intended tasks</td>
</tr>
<tr>
<td>• Support meaningful interaction</td>
<td>• Synchronize with the person’s lifestyle</td>
</tr>
<tr>
<td>• Provide a sense of security and locus of control</td>
<td>• Provide context-awareness</td>
</tr>
<tr>
<td></td>
<td>• Provide social and technical supports</td>
</tr>
<tr>
<td></td>
<td>• Provide psychological and emotional supports</td>
</tr>
<tr>
<td></td>
<td>• Promote motivation cues and encouragement</td>
</tr>
</tbody>
</table>
7.4. Summary of the Chapter

This chapter describes the analysis of Phase 2 research where it attempts to discover the perceived challenges in diabetes management and the perception of using digital technologies in assisting of self-management. The research employed a quantitative method first to gain a general understanding of the issues, then interviews were conducted with selected participants to gain more in-depth understanding to explain certain queries in the survey.

It identifies that diet control, doing exercise and taking blood sugar level regularly as the biggest challenges in diabetes management. Many of these challenges are due to personal, social and environmental factors such as eat out, socialize and busy at work. It is also found that different demographics, especially different age and gender groups, perceived the challenges slightly different, and they have different preferences for the types of device in self-management.

Moreover, it recognizes that behaviour change is complex and it involves multiple levels of influences in which the interaction of these influences enhance or hinder the behaviour change. The effectiveness of self-management is affected by the resources availability of the individuals including personal (time, money, skills, knowledge, etc.), social (family, peer, healthcare providers, etc.), and environmental (sport facilitates, working environment, etc.). Hence, the purposes of the diabetes services or systems should be focused on increasing the knowledge and capabilities of the patients, at the same time, reducing the barriers and facilitating the new health behaviour.

Next chapter is to discuss the Phase 3 research, which is an analysis of two kinds of persuasive interactive systems of their persuasive strategies and an evaluation of the systems using the CBS Model. The user evaluation of these systems and an exploratory examination of a design prototype will be discussed in the following chapters.

8.1. Introduction

This part of the research is to analyise two different types of interactive diabetes self-management systems in Chinese and to identify the motivation and persuasive strategies and techniques they use.

The purposes of this part of research are:
- to understand the purposes of these systems
- to identify the characteristics and main features of these kind of systems
- to understand the use of motivational and persuasive techniques
- to analyse the systems using the CBS Model proposed in this study.

8.2. Diabetes Management Systems

There are many types of interactive systems for diabetes management, they can be mainly categorized as education, information, log book, games, and recipes, and a combination of some of them. These kinds of systems are mainly provided in both web sites and mobile applications with the information types are common in web sites and log book types are mainly in mobile applications. The information types are primarily focus on providing information and knowledge for the patients in self-management, which serve as educational purposes. Information includes the causes and symptoms of the diseases, prevention, complications, treatments, medication, diet and exercise, as well as self-management. Some of them also provide recipes and social support such as discussion forum.

The log book type of diabetes management systems mainly help the patients to record their daily blood glucose data and store it or send it to their healthcare providers. The data is either presented in numerical or graphical presentation such as graphs or
charts, or both. Some systems even provide insulin dosage records since how many dosage of insulin taken is based on the blood glucose level. As diet and physical exercise are important for people with diabetes to control their calorie intake and body weight, some of these systems also include daily records of these activities. The diet and physical activities data are mainly recorded manually yet some of them allow patients to record their diet in photos as a form of food diary. Some of the systems using sensor-enabled technologies or Ubicomp technologies to record the patients’ activities, work out information, and numbers of steps by the use of pedometers, or even record the heart rate and respiratory rate during exercise. For example, *Glucose Buddy* was one of the most popular diabetes systems in the United States that allowed users to enter blood sugar numbers, carbohydrate consumption, insulin dosages, and activities on the application manually and store the data for reviewing on their online account. (Figure 8.1.)

![Glucose Buddy](http://diabetes.ufl.edu/clinical-care/meter-software/diabetes-apps/)

**Figure 8.1. Glucose Buddy**

Source: http://diabetes.ufl.edu/clinical-care/meter-software/diabetes-apps/

Many studies have claimed that these kinds of e-health intervention systems can help patients to improve their blood glucose level or better diabetes management (Blanson
Henkemans et al, 2009; Nachman et al, 2010; Liang et al, 2011; Chatterjee et al, 2012; Mukhtar, Ali, Belaid, & Lee, 2012; Vargas-Lombardo et al, 2012), as well as more adherence in doing physical activities or exercise (Nawyn et al, 2006; de Oliveira & Oliver, 2008). Some studies, on the other hand, found that there are some usability issues (Segersta, Kotro, & Vainio-Mattila, 2010) and the effectiveness of these intervention is still inconclusive due to mixed findings (Norman et al., 2007).

Game types of diabetes management systems and weight management systems have also been studied extensively. Many studies used games to motivate diabetic patients (Brown et al, 1997; Aoki et al, 2004), for people to control their diet (Lo et al, 2007), or engage in more physical exercise (Consolvo et al, 2006; Lin et al, 2006; Albaina et al, 2009). The use of games is either for educational purposes such as helping them to understand the disease and the self-management techniques, or motivate them to engage in self-management such as checking their blood glucose and controlling their diet. However, these kind of diabetic systems are mainly for children or teenagers, and there were not many of these kinds of log book diabetes systems to be found in the market, particularly in Chinese.

Other related systems are weight management, sports and fitness, as well as diet assistant systems. These systems usually are aimed at motivating the users to achieve goals in weight loss, physical fitness, or maintaining healthy diet, mainly through recording their diet and physical activity data, so that they can keep track their progress and health conditions. As diabetes management also requires adaptation of healthy lifestyles and maintain proper body weight, hence, recording diet intake and physical activities is also important for people with diabetes.

This section focuses on analysing two most common types of persuasive strategies - narrative and statistics, in diabetes management systems and other persuasive systems. The analysis is divided into two parts: the first part is to analyse their persuasive effects according to the health behaviour theories and persuasive communication theories; the second part is to examine their motivation attributes based on the proposed model by the researcher.
8.3. The Two Diabetes Systems

Two different types of diabetes management systems or applications were used in this study to compare their effectiveness of behaviour change. The first type of diabetes system was a web-based self-management system which was developed by The Rehabilitation Society of Hong Kong. The other type of diabetes systems were mainly logbook type of mobile applications. They included two diabetes monitoring systems and a weight loss control system.

The web-based and mobile-based self-management systems had different purposes and they used different persuasive and motivation strategies. Their features and use of persuasive techniques were both similar and different in many ways. The following is a comparison of these two types of systems in terms of their purposes and features. (Table 8.1)

<table>
<thead>
<tr>
<th></th>
<th>Online course</th>
<th>Mobile applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Provide information of diabetes and taught self-management. Provide paper</td>
<td>For log in and recording data about blood sugar, diet, and exercise; also provided</td>
</tr>
<tr>
<td></td>
<td>records of diet and exercise and goal setting</td>
<td>information about diabetes, nutrition, and exercise</td>
</tr>
<tr>
<td><strong>Strategic approach</strong></td>
<td>Affective oriented</td>
<td>Cognitive oriented</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>Use multimedia such as interactive games, guiz, videos, music, case</td>
<td>Log in and check health data</td>
</tr>
<tr>
<td></td>
<td>scenerios, etc.</td>
<td></td>
</tr>
<tr>
<td><strong>Content format</strong></td>
<td>Narrative</td>
<td>Numeric/ graphics/ statistics</td>
</tr>
<tr>
<td></td>
<td>Gamafication</td>
<td>Didactic</td>
</tr>
<tr>
<td></td>
<td>Didactic</td>
<td></td>
</tr>
<tr>
<td>**Personalization/</td>
<td>Less personal - provide paper record for diet, exercise and goal setting</td>
<td>More personal with personal health records such as weight, height, and health</td>
</tr>
<tr>
<td>tailoring/ customization</td>
<td></td>
<td>condition checking such as BMI</td>
</tr>
<tr>
<td><strong>Health records</strong></td>
<td>No charts or graphs</td>
<td>Provide charts, graphs, and historical records</td>
</tr>
<tr>
<td><strong>Diet</strong></td>
<td>Games about food nutritions; Methods for food converter</td>
<td>Food intake; calorie calculation; food choice and nutrition</td>
</tr>
<tr>
<td><strong>Exercise</strong></td>
<td>Videos about doing exercise</td>
<td>Exercise information; calorie</td>
</tr>
</tbody>
</table>
In the following sections, these two different types of systems are compared, analysed and evaluated to provide with useful insights for understanding their persuasive strategies and their experiential aspects in the system design.

8.4. Analysis of Persuasive Strategies of the Systems

8.4.1. Web-based self-management system

![Figure. 8.2. Web-based self-management system]
The main purpose of this system was for educational purposes, hence, the information about diabetes and self-management were the key features of this site. However, unlike the other websites which merely provide with information, it adopted a multi-modal, multi-media and multi-format approach to make the information deliver in more interesting ways. The use of games, videos, slides, quizzes, questions and answers, as well as stories were found throughout the site to create interesting interaction and made the information easy to digest and remember.

There was also an audio explanation of the information to access people who may have visual impairment to use. Hence, it was assumed that the major target users of the site were older diabetic patients. Besides the information, it also provided some digital and paper forms for patients to set their own goals, record blood sugar level and exercises. However, the online digital forms were still not in use at the time of research, patients could only download the paper forms and fill them on the paper (Note: It was found that it had provided online data entry on the website later on). It comprised a discussion forum but it seemed that it was mainly for people raising questions about the website but not discussing about their disease, therefore this feature was excluded in the present study. Finally, an email reminder would send to the users if they did not use the website over 2 weeks.

Table 8.2. The use of persuasive theories and strategies in Web-based system

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Theories</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative, storytelling (case scenario)</td>
<td>Modelling Identification, Self-efficacy, Social Cognitive Theory (SCT), Self-Determination Theory (SDT), Intrinsic motivation</td>
<td>Reflection, Psychological well-being, Fun and engagement, Self-efficacy, Intrinsic motivation</td>
</tr>
<tr>
<td>Interactive games</td>
<td>Social Cognitive Theory (SCT), Intrinsic motivation</td>
<td>Reflection, Psychological well-being</td>
</tr>
<tr>
<td>Quizzes</td>
<td>Social Cognitive Theory (SCT)</td>
<td>Reflection, enhance memory and understanding</td>
</tr>
<tr>
<td>Questions and answers</td>
<td>Social Cognitive Theory</td>
<td>Reflection, enhance memory</td>
</tr>
</tbody>
</table>
8.4.1.1. The persuasive strategies and health theories of the web-based system

The use of persuasive strategies of the web-based system is discussed in the following:

- **Entertainment-education to enhance motivation and user engagement**
The web-based system was a entertainment-education (E-E) system to facilitate education of diabetes and training of self-management. E-E has the advantages to attract user attention and engagement, and it is an effective means to affect knowledge, attitudes and/or behaviour (Moyer-Guse, 2008). It is especially useful for the receivers with lower involvement of the selected issues.

![Entertainment-education format - Cartoons](image-url)

*Figure 8.3a. Entertainment-education format - Cartoons*
• **Narrative format for facilitating learning and self-reflection**

The content information was delivered in narrative format including case scenarios and games. The case scenarios, as a form of narratives, were presented in circumstances resembling to the situations in daily lives. Narratives and storytelling facilitate information processing and transportation where the audience could immerses into the story. Transportation could reduce counterargument and induce self-reflection that leads to attitude change (Green & Brock, 2000).
Using questions and quizzes to increase self-efficacy

Using interactive games, questions and answers, and quizzes can help to enhance motivation in learning and understanding, as well as long term memories. The gaining of knowledge and skills can increase self-efficacy hence facilitating behaviour change.

Figure 8.5. Interactive game

Figure 8.6, Quizzes
Character in similar demographics

- **Characters with similar demographic for perceived similarity**
  The case scenario and even the demonstration of the exercises employed actors and actresses who were similar to the demographics of people with diabetes in Hong Kong. It aids identification of character in the story, which helps to develop modelling effects and have greater influence on beliefs and attitudes of the presented topics in the story (Cohen, 2001; Igartua, 2010). The increase of perceived of similarity between the source and the receiver can also increase the trust and credibility of the persuader (Kreuter et al, 2007).

- **Multi-media for enhancing motivation and persuasion**
  The system is a multi-media format with the use of highly visual content such as images and cartoons, audio sounds and musics, as well as videos and interactive games. Using multi-modal can enhance memories and recall (Lukosius, 2004). It also found that embedding images and sounds in narratives can enhance persuasive effects (Adaval & Wyer, 1998) and formation of attitudes (Lee & Gretzel, 2012).
Self-management forms for goal-setting and habit formation
The system also provided three types of forms for different self-management tasks: 1) blood glucose level records; 2) exercise records; 3) goal-setting records. The purpose of the self-management forms was to assist the users to form healthy behaviour and

Figure 8.8. Music for relaxation

Figure 8.9. Use of visual images
habits. The goal-setting form was used to encourage the users to set their own goals and guide them how to achieve small and realistic goals step by step. It has found that when goals are more specific and realistic, as well as goals that are set by the individual for his own interests are more effective and successful (Locke & Latham, 2002). However, the forms were only available for printed format at the time of the research (the online forms were available later).

Figure 8.10. Action plan

Figure 8.11. Blood sugar records
In conclusion, the web-based system employed an affective approach where it focused on encouraging behaviour change using persuasive strategies such as narratives, interactive games, multi-media and goal-setting. These strategies can promote intrinsic motivation and positive emotions to encourage interaction and reduce stress. The aim was to enhance self-efficacy by increasing knowledge and skills in self-management. Hence, the system should be assumed to provide higher motivation, induce self-reflection, and increase self-efficacy for behaviour change.

8.4.2. Mobile application self-management systems

Three mobile applications were used in this research, including two applications for diabetes management and one application for weight management. Both of these systems were log book type of systems that required the users to enter the data manually. The mobile diabetes management systems had some similar and different features, all were mainly for recording the health data such as blood glucose levels and helped the users to keep track their health. However, at the time of research, these systems could only be found in either one or the other smart phone system - the Little Diabetes Nurse was only for the iOS system, while the Kiwi Glucose Assistant was only for the Android system.

The Kiwi Glucose Assistant mainly provided features of blood glucose data entry; it also supported other vital signs and health conditions records such as temperature, blood pressures, body weight, HbA1c, and so on. It also allowed the users to enter other health condition information such as headache, medication taken or not taken, feelings, and so on. However, this system did not support diet and exercise inputs, as well as medication or insulin intake. The Little Diabetes Nurse was a comprehensive diabetes management system including a wide range of features for diabetes management such as blood glucose data, diet and physical activity, as well as medication or insulin intake. Both systems provided statistics and data analysis of the blood glucose levels, and the data were presented in numerical and graphical formats such as graphs, charts, and numbers. The major difference of the two systems was that the Kiwi Glucose Assistant also provided textual information about diabetes and
self-management.

Figure 8.12. Kiwi Glucose Assistant

Figure 8.13. Little Diabetes Nurse
The *Weight Loss Assistant*, on the other hand, was a weight management system specially for people who wanted to lose their body weight by controlling their diet intake and do physical exercise. Similar to the two diabetes management systems, it was also a log book type of system requiring the users to enter data manually, and it also provided similar features such as statistics and graphic presentation. This system, however, provided detail information of food and physical exercise, for example, for diet, it provided the nutrition and calories of the food and different types of Chinese cuisines, including the cooking methods and these cuisines were catering for which group of people; for physical activities, the benefits of doing different types of exercise were suggested. Other than this, the system also provided body mass index (BMI), calorie counters, timer, discussion forum, as well as email reminder. It also available in a website to provide more social supports to the users.

![Weight Loss Assistant](image)

*Figure 8.14. Weight Loss Assistant*
The similarities and differences of these mobile systems are compared in the following:

**Table 8.3. The similarities and differences between the two diabetes management systems and the weight management system**

<table>
<thead>
<tr>
<th></th>
<th>Little Diabetes Nurse</th>
<th>Kiwi Glucose Assistant</th>
<th>Weight Loss Assistant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Record health data to control blood glucose</td>
<td>Record health data to control blood glucose</td>
<td>Record diet, exercise, and body weight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide information about diabetes and self-management</td>
<td>Provide information about food nutrition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and exercise to help control body weight</td>
<td>and exercise to help control body weight</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>Blood sugar data records, medication or insulin intake</td>
<td>Blood sugar data records, other vital signs and health data</td>
<td>Body weight, Body Metric Index (BMI),</td>
</tr>
<tr>
<td></td>
<td>records, medication, diet and exercise records, statistics,</td>
<td>records, statistics, data analysis, email report</td>
<td>calories counts, calories burn, steps</td>
</tr>
<tr>
<td></td>
<td>data analysis, average, calendar, full reports, email and</td>
<td></td>
<td>counts, statistics, data analysis</td>
</tr>
<tr>
<td></td>
<td>print report</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data presentation</strong></td>
<td>Graphs, charts, numbers</td>
<td>Graphs, charts, numbers</td>
<td>Graphs, charts, numbers</td>
</tr>
<tr>
<td><strong>Other special</strong></td>
<td>Medication records, blood sugar records</td>
<td>Diabetes information, reminder</td>
<td>Food recipes, food nutrition, suggestions,</td>
</tr>
<tr>
<td><strong>features</strong></td>
<td></td>
<td></td>
<td>web site, discussion forum, email reminder</td>
</tr>
</tbody>
</table>

8.4.3. The persuasive strategies and health theories of the mobile system

The following is discussed the use of persuasive strategies of the mobile systems:

**Table 8.4. The use of persuasive theories and strategies in Web-based system**

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Theories</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didactic information</td>
<td>Self-efficacy</td>
<td>Self-efficacy</td>
</tr>
<tr>
<td></td>
<td>Self-Determination Theory (SDT)</td>
<td>Competence</td>
</tr>
<tr>
<td>Graphs and statistics</td>
<td>Self-efficacy</td>
<td>Reflection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-knowledge</td>
</tr>
<tr>
<td>Personalized data</td>
<td>Self-efficacy</td>
<td>Motivation Decision making</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td>Self-Determination Theory (SDT)</td>
<td>Reflection Autonomy Competence</td>
</tr>
<tr>
<td>Pedometer</td>
<td>Self-efficacy</td>
<td>Reflection Self-knowledge Motivation Decision making</td>
</tr>
<tr>
<td>Tailoring</td>
<td>Self-Determination Theory (SDT)</td>
<td>Autonomy</td>
</tr>
<tr>
<td>Discussion forum</td>
<td>Self-Determination Theory (SDT)</td>
<td>Relatedness Social influence and supports</td>
</tr>
<tr>
<td>Goal setting</td>
<td>Goal setting Theory</td>
<td>Motivation</td>
</tr>
</tbody>
</table>

- **Didactic and non-narrative information for increasing knowledge and self-efficacy**

Both systems provided related information such as diabetes or food nutrition, other than just recording the data of user's activities. The information was mainly presented in didactic and instructional format to provide the knowledge of the disease or the information about food and exercises. The *Weight Loss Assistant* even provided food recipes for weight loss as well as the effects of certain food from the Chinese Traditional Medicine perspective for certain diseases since Chinese people believe that food therapy is important for healing and maintaining health. It also included many colourful photos to increase the visual appeal. The information helped the users to gain knowledge and assisted them in decision making.

![Figure 8.15. Textual diabetes information](image-url)
Figure 8.16. Diet and exercise information

- **Graphics and statistics as visualization for risk communication and self-reflection**

Besides of numerical records, all systems provided visual displays of the data in form of graphs and statistics which helped to gain self-knowledge of the user's health conditions and also communicated risks. For example, the users can check the blood glucose levels in the past few weeks to understand the patterns of their food intake and blood glucose level; or, the users can track their calories intake and energy consumption. For instance, the *Weight Loss Assistant* showed two lines together in a screen - red for calories intake and blue for energy consumption, they were aligning each other in a graph. These lines served as comparison of calories intake, therefore, the higher distance between these two lines indicated high calories intake which could aid the users to be more aware of their diet and exercise level.
Personalization of data aids self-reflection and decision-making

The systems allowed users to enter their personal information such as age, gender, body height and body weight, so that the system could calculate the BMI of the users (the Weight Loss Assistant). These information could help the users understand their own health conditions and make decisions on their diet and exercise according to their needs.

Figure 8.17. Graphics and statistical display

Figure 8.18. Personalization of data
- **Pedometer to record steps for self-knowledge and motivation**
  The *Weight Loss Assistant* was embedded with sensor technology in the mobile system to automatically record the user's steps. It has found that understanding their own walking information could enhance motivation for more walking. For example, in the study by Albaina et al (2009), the pedometer using context-aware technology that transferred the data to a touch-screen frame displaying of a virtual flower which showed a happiness face when the users walked more. It reported to encourage the elderly to walk more. However, it is not knowing if the motivation remains the same without using the metaphor, that is, the virtual flower.

![Figure 8.19. Pedometer](image1)

![Figure 8.20. Goal setting](image2)

- **Goal setting for weight loss enhances motivation**
  The *Weight Loss Assistant* also allowed the users to set goal for their weight loss target. Goal setting was said to be an effective way to motivate behaviour change (Locke & Latham, 2002; de Oliveira & Oliver, 2008; Consolvo et al, 2009). However, it did not give a deadline for the goals.

- **Discussion forum for social influence and supports**
Only the *Weight Loss Assistant* provided this feature and the users could discuss their weight loss goals and the results, and they even could share their recipes with the others. It helped the users to learn the success and failure experience from the others, and fostered a sense of belonging and support. Since people from the discussion forum were ordinary people similar to the other members in the forum, it produced a sense of perceived of similarity, which increased trust and conformity (Kreuter et al, 2007). Social influence is found to be very effective in behaviour change (Grimes, Kantroo, & Grinter, 2010; Mueller et al, 2012).

![Discussion forum](image)

**Figure 8.21. Discussion forum**

To conclude, these mobile applications used cognitive approach with the use of graphs and statistics to promote self-reflection, as well as providing related information to increase users' knowledge for enhancing self-efficacy and decision making.

**8.5. Analyse the Systems with the CBS Model**

This section is to analyse the experiential aspects of the diabetes systems. As user experience will affect user engagement (O’Brien & Toms, 2008) and motivation (Hassenzahl, 2010; Sundar, Bellur & Jia, 2012) in system use, which can influence the
persuasion effects and behaviour change. It applies the CBS Model proposed by the researcher to examine and evaluate the experiential aspects of these systems.

Table 8.5. Analyse the diabetes systems using the CBS Model

<table>
<thead>
<tr>
<th></th>
<th>Rehabilitat-ion online course 復康會糖尿病網上課程</th>
<th>Diabetes Nurse 糖尿病小護士</th>
<th>Kiwi Glucose Assistant Kiwi 血糖管理助手</th>
<th>Weight Loss Assistant 減肥助手</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. CONTENT SUPPORT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- appropriate information</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- provide solutions</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- facilitate reflection</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td><strong>Credibility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- trustworthiness</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- expertise</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- endorsement</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>- authority</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td><strong>B. BEHAVIOURAL SUPPORT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1. Persuasive techniques</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Induction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- goals direction</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- proper encouragement</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>Provide meaning</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- Provide values, purposes, and benefits of using and acting</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td><strong>Prospect</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- promote realistic hopes and possible outcomes</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td><strong>2. Interaction factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- the information, skill sets, layout design, are relevant to the person</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>- the message and the product is able to meet</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓✓✓✓</td>
</tr>
</tbody>
</table>
The analysis shows that the *Web-based system* provided the highest support of them all. It was especially strong in the content part where the information provided in the website was comprehensive and trustworthiness. It provided appropriate solutions and health advice to the patients in many aspects and guided them to conduct self-management in clear, systematic, and easy-to-understand ways such as using a
lots of visual images as well as audio explanations. The aesthetics experience of this website was also rated the highest as it provided multimedia interaction and the multiple formats such as using narrative and games to create higher affective effects, which was more interesting and engaging. The usability and perceived control of this system was also high since the information was basically easy to find and navigate, but it required the users to take some time to finish certain parts before going to the next parts, hence it may not be so convenient if users wanted to find particular information.

On the other hand, the website did not provide personalized features for the users as it mainly provided information. Nevertheless, it offered different forms for users to record exercise and blood glucose levels, and encouraged the patients to set their own goals by writing down on the action plan paper sheets. Another shortcoming was that it did not support very good tracking records, the patients could only check it from the paper sheets. The weakest part of this system was the social connection part where the discussion forum seemed to be only for the discussion of the usability problems of the website rather than questions about the disease and self-management. From the forum’s records it showed that the feedback from the provider was also not very timely.

The Little Diabetes Nurse provided the poorest support overall. Although it was a comprehensive system, it did not provide any solutions and advice to the users and the overall interaction was not very pleasant primarily because it was not very easy to use and find information. It provided historical analysis for showing data on the charts and graphs for users to track their progress. However, it required the users to enter them frequently to see the significant results. There was also lack of credibility as the source of information was not clear. It was purely as a recording tool but time-consuming and difficult to operate. The aesthetics of the application was also not attractive particularly the look of the graphs and charts.

The Kiwi Glucose Assistant and Weight Loss Assistant were both provided medium supports to the users. They were both fairly strong in the content part where they provide information as well as solutions and advice. Moreover, they offered more personalized features, for example, their body weight or health conditions, so that the
users could enter the information according to their needs or plan their own actions. Another strong feature was that the systems could help the users to track their progress in more convenient way by showing graphs and charts of their body weight, calories, as well as steps counts. However, they required the users to enter the data frequently and consistently to produce more meaningful results. Furthermore, it was not clear where the source of information of both systems originated so it affected their credibility.

The *Kiwi Glucose Assistant* was relatively easy to use and enter information due to the simple features it provided. The layout design was relatively clear for patients to find information and followed through. However, the diabetes information display was poorly organized and difficult to read because of the small font size. It had no images and mainly in textual format, the look of the graphs and charts were relatively simple and not attractive.

The *Weight Loss Assistant* was more complex to use due to the wealth of information and features of the application. So it was not that easy to use initially compared to the *Kiwi Glucose Assistant*. This system offered larger and more attractive images of the food and physical activity which were more appealing to the users, however, the font size was a bit small to read from the tablets or smart phones. One of the main features of this system was that it facilitated strong social supports by connecting other users in discussion forum about weight management. It also provided a website (www.shoushen.com) which offered the same features of the mobile system. The website also provided updated information and discussion of weight management, hence, it supported more flexibility of choices and alternative options for the users.

### 8.6. Summary of the Chapter

This section describes and analyses two different types of diabetes management systems. All of these systems provided content information but used distinct persuasive strategies for self-management. The web-based system adopted an affective approach that employed narrative format to provide information and guidance for
self-management, and offered encouragement through actions plans and self-management forms in online environment. The mobile applications were mostly used a cognitive approach which facilitated recording self-management activities and supported with related information to assist intended behaviour. Their use of persuasive strategies and the experiential effects were analysed and discussed.

It shows that the web-based system seemed to be able to provide better user experience and persuasive effects than the mobile applications in general. However, empirical study was needed to examine the proposed concepts and models. In next stage, I will discuss the user evaluation of these systems to understand the user experience and examine which kind of persuasive strategies was more effective in affecting the patients' motivation to use the systems and their willingness to change health behaviour.
9. Phase 4 Research Analysis (A) - User Evaluation of the Persuasive Systems

9.1. Introduction

This phase of research is to understand the user experience of two different types of persuasive systems and identify the motivation and demotivation factors of using these systems and if they can affect behaviour change.

In order to answer the research questions and gain a comprehensive understanding of the key issues and concepts, the objectives of the Phase 4 research analysis were four-fold:
1) to examine which persuasive strategies are more effective to initiate self-reflection;
2) to discover the motivation attributes and the barriers of behaviour change in using the systems;
3) to understand the user values of using these systems;
4) what contextual factors, including user context and use context, affect the user experience of the systems and the motivation to behaviour change.

The qualitative data were analysed in three parts:

The first part was to compare the two types of diabetes systems to see the persuasive effects of these systems; it also helped to identify the motivation and demotivation attributes of the systems and the reasons of attrition.

The second part examined the user needs and values of engaging in these kind of systems. The user values were derived from the mean-end approach of examining the system features of the prototype, as well as the summary of the first dimension.

The third part further discussed the user context of system use and preference. It compared different demographics, involvement level and health literacy, and identified
some issues that might affect the effectiveness of the persuasion and motivation factors of different user contexts.

9.2. The Systems Used in the Research

The two different persuasive systems: a web-based online system (*The Hong Kong Society of Rehabilitation diabetes online course*) and several mobile applications (*Kiwi Glucose Assistant, Weight Loss Assistant or Diabetes Little Nurse*) in the previous analysis were used for the user evaluation. The reason for using these systems was because they were the most common systems adopting different persuasive strategies for diabetes self-management. The web-based online system was mainly using narrative strategies with multi-media, multi-format, as well as multi-model design, which was mainly using affective approach of persuasion. On the other hand, the mobile applications were mainly logbook type systems with the use of graphics and numerical presentation, as well as textual description of information, which were mostly using cognitive approach. The descriptions and the analysis of these systems have been discussed in the previous section.

9.3. Methods

In order to understand how different persuasive strategies affect the motivation and behaviour, two groups of participants were randomly assigned to different systems depending on the devices they had already been using, that is, computers or smart phones. All of them had some experience in using that kind of device for at least 3 months so that they were comfortable in using the device.

In the pre-use evaluation stage, a total of 18 participants, including 10 males and 8 females from the age of 40 to 70 were invited. There were 6 participants (3 males and 3 females) in the computer online group since they mainly used a computer and 12 participants (6 males and 6 females) in the mobile application group. However, one female participant in the computer group could not be reached for the post-evaluation; on the other hand, 4 female participants, who were sisters and friends, in the mobile
group, also withdrew after the pre-use evaluation. So the total number of participants in the post-use evaluation was 13, of which 5 participants (3 males and 2 females) were in the computer group, and 8 participants (6 males and 2 females) were in the mobile group. Due to the different smart phone use in the mobile group, seven of them were using the Android systems (Kiwi Glucose Assistant and Weight Loss Assistant) and only one of them (female) were using the IOS system (Diabetes Nurse).

The participants had been participating in the previous stage of research and were interested to participate in this part of the research. They were using purposive sampling who were specially selected for this research with different demographics, educational background, working status, clinical status, as well the device they were using. Since it has discovered from the previous phase that the user context have affected the challenges in self-management as well as the perception of using digital technologies in self-management, therefore, a heterogeneous group of participants were deliberately selected in this stage of research. They included diverse demographics (age, gender, marriage status), education levels (secondary to university level), working status (employed or retired), as well as clinical stage (duration of diabetes). Many of them also have other chronic diseases such as hypertension, mental disorders, and arthritis.

The following table is the demographics of the participants in these two groups in post-use evaluation.

Table 9.1. The demographics of the participants in these two groups in post-use evaluation.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Website group</th>
<th>Mobile application group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 - 49 years old</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>50 - 59 years old</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>60 - 69 years old</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Education level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Secondary</td>
<td>Tertiary</td>
<td>Working status</td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clinical stage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Years of using a computer or Smartphone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of participants</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

Mixed methods including quantitative and qualitative research methods were used in this research as triangulation. The purposes of using mixed methods were to gain a more comprehensive understanding of the research questions: if different kinds of persuasive systems have different effect in promoting behaviour change and what contextual factors affect the user experience and motivation of system use? The use of mixed methods could compensate for the weaknesses of both quantitative and qualitative research (Creswell & Clark, 2007).

Since people may not express their feelings, emotions, as well as their opinions easily and explicitly, using a questionnaire is useful to discover their perception of the system. Quantitative method was a 7-point Likert scale questionnaire consisted of 23 questions regarding the aesthetics, usability, values, relevance, and the overall satisfaction rate of the system. It was developed based on the concepts from theories of motivation and system engagement discussed in the literature reviews. Another 7 questions were asking about what kind of factors most important to them with this kind of systems. The purpose was to understand the users' perceived values of the system. However, due to the very small number of participants and the study is focused on the qualitative approach, the questionnaire in this case could only be used as a reference and support for the qualitative research.
Qualitative methods contained individual semi-structured interviews and self-report diary. The participants were given a booklet and they were encouraged to record their thoughts, problems or experience during the use of the systems. The qualitative interview was used to gain deeper understanding of their experience from their psychosocial perspectives as well as the context of use.

The intervention and post-use interview was conducted from the period of mid November 2012 to end of April 2013. The interviews were mainly conducted on weekends, and each interview took about one to two hours. Follow up interviews were conducted after about 10 months of the post-use evaluation to check if the systems were still being used and the behaviour would be maintained since habitual behaviour could be formed after 6 months time. The whole process took about 18 months to complete.

9.4. Process

This stage of research was scheduled into three parts: pre-use introduction, post-use evaluation and prototype evaluation.

9.4.1. Pre-use introduction

In the pre-use introduction, the participants were first introduced to the computer online program or the mobile applications. They were given a task list (Appendix D) to help them to familiar with the systems. A measurement converter sheet was given to the mobile group for a reference if needed. All of the participants were also taken a measurement of their body weight and then marked it on the booklet. They could record their blood sugar level, providing that they brought their glucose meter with them. They were encouraged to set their own goal, for example, to loss 3 kilograms during this 6 weeks or so, and then marked it on the booklet. The records were then compared when they came back to the post-use evaluation.
Table 9.2. Phase 4 research schedule

<table>
<thead>
<tr>
<th>Phase</th>
<th>Objective</th>
<th>Research Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Pre-use introduction</td>
<td>● Introduce the systems</td>
<td>● Task analysis</td>
</tr>
<tr>
<td></td>
<td>● To familiarize the functions and the features of the systems</td>
<td>● Observations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Interviews</td>
</tr>
<tr>
<td>● Intervention (6 - 12 weeks)</td>
<td>● Use the systems for self-management in their natural settings</td>
<td>● Self-diary</td>
</tr>
<tr>
<td>● Post use evaluation and</td>
<td>a) Understand the user experience and contextual factors of using the</td>
<td>● Questionnaire</td>
</tr>
<tr>
<td>prototype evaluation</td>
<td>systems</td>
<td>● In-depth Interviews</td>
</tr>
<tr>
<td></td>
<td>● Introduce the design prototype and understand their needs and values</td>
<td>● Design prototype</td>
</tr>
<tr>
<td></td>
<td>in this kind of systems</td>
<td>● Observations</td>
</tr>
<tr>
<td>● Consolidation and follow up</td>
<td>a) To check if the participants were still sustaining their behaviour</td>
<td>● Telephone Interviews</td>
</tr>
<tr>
<td>(about 10 months)</td>
<td>b) To discover the reasons of adherence or attrition</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

9.4.2. Post-use evaluation

The participants used the systems for between 6 - 10 weeks and then they returned for a one-on-one, semi-structured interview. Each interview took one to two hours. All the interviews were audio-recorded and transcribed into Chinese and translated later into English transcripts for data analysis.

The post-use evaluation research was structured into four sections:

**Section 1** - The participants completed a 7-point Likert scale questionnaire which was based on the CBS model deriving from the user experience studies, self-determination theory and well-being theories to investigate how these variables affect the intentions and perception of the system in a quantitative way (Table 9.3 and 9.4)

**Section 2** - They were interviewed with open-ended questions about their user experience and if there was any problems in use affecting the motivation to use or
perform the behaviour (Table 9.5).

**Section 3** - A design prototype was presented as a 'probe' to try to ascertain a deeper understanding of their needs and values in these kinds of systems.

**Section 4** - A follow-up call after 10 months of the post-use evaluation to check if the participants were still using the systems, and if there was any change in their health behaviour, as well as their health conditions.

Section 1 contented 30 questions in total of a 7-point Likert scale questionnaire, of which 23 questions were about the evaluation of the systems and 7 questions were about the preference of the new systems. The first 23 questions were adopted from the study of O’Brien and Toms (2008) regarding the "attributes of engagement", which include: *focused attention, affect, aesthetic and sensory appeal, ease of use, challenge, perceived control, interactivity, motivation, novelty, and social involvement*, plus additional attributes about *autonomy, information and knowledge, relevance, self-efficacy, values and meaningfulness*, as well as *overall satisfaction*. Those attributes were assumed to affect the quality of user experience and engagement in interactive systems (Table 9.3). The last 7 questions were to understand their preference of systems (Table 9.4).

The participants rated the questionnaire using the scale of 1 to 7 with 1 = strongly disagree and 7 = strongly agree. Then they were interviewed about the user experience of the systems. The questions of the questionnaire are shown in Table 9.3 and 9.4.

**Table 9.3. The 7-point Likert scale questionnaire**

<table>
<thead>
<tr>
<th><strong>Aesthetic experience</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Perceived control/ usability</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>
I should be very familiar with this website or application

**Support autonomy**

This website or application can allow me to choose the plan or functions that are suitable for me

**Knowledge**

This website or application can enhance my knowledge about diabetes

This website or application can allow me to learn new knowledge

This website or application can provide me with necessary information and features

**Provide guidance and advice**

This website or application can give me adequate advice

**Value and meaningfulness**

Use this website or application can allow me more effective in my self-management

Use this website can help me to improve my health

**Self-efficacy**

Use this website can make me more confident to manage my disease

**Relevance**

The design of this website or application is suitable for me

This website or application can meet my needs

**Interaction**

This website or application has good interaction with me

**Social connect**

This website or application can allow me to connect with the others

**Overall satisfaction**

I am satisfied with this website or application

I intend to use this website or application in the future

---

### Table 9.4: The most important features they perceived in this kind of systems

| What kind of features are most important to you with this kind of website or application? | 
|---|---|
| 1 | Simple and easy to use |
| 2 | Beautiful and attractive |
| 3 | Timely and convenient |
| 4 | Give me adequate support when I need it |
| 5 | Facilitate me to connect with others |
| 6 | Allow me to choose a suitable plan or features |
| 7 | To enhance my knowledge about diabetes and self-management |

Section 2 was a semi-structured interview with an interview guide prepared to ask
open-ended questions focusing on their experience, contextual and psychosocial aspects of the system use.

**Table 9.5. - Example of interview questions**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Did you find this website/application helpful in your self-management?</td>
<td>Why or why not?</td>
</tr>
<tr>
<td>2. Which feature(s)/function(s) you find is most helpful to you?</td>
<td>6. When do you use the system? Can you describe a little bit how did you use the system?</td>
</tr>
<tr>
<td>3. Which features/functions you like the most?</td>
<td>7. If the discussion forum helpful or important to you?</td>
</tr>
<tr>
<td>4. Did you do more physical exercise after using this?</td>
<td>8. If your family help you to use the system or in self-management?</td>
</tr>
<tr>
<td>5. Did you find it is helpful for your diet control?</td>
<td>9. Do you think you are more confident in managing your disease after using the system?</td>
</tr>
<tr>
<td>10. If we design a new system for you, which feature(s) you think is/are most important?</td>
<td></td>
</tr>
</tbody>
</table>

In Section 3, a paper prototype was shown to the participants to initiate the understanding of their needs and values of this kind of systems. The use of prototype is a probe with a purpose to discover the latent needs of the users and it helps to provide inspirations for the design teams about the information on users' needs and context, it can facilitate the participants to express their needs and ideas and to participate in the process, as well as encourage a dialogue between the users and designers in the design and development process (Mattelma, 2005). The probe allows more understanding of the users' needs and concerns when designing these kinds of products and systems.

In Section 4, all the patients were given a follow up call through telephone interviews 10 months later to check if they were still using the systems and if there were any changes in health behaviour and any improvement in their self-management. This can help to identify the effectiveness of each system and user engagement issues.

**9.5. Data Analysis Procedures**
The data analysis will be divided into two parts: the quantitative and qualitative analysis.

The quantitative data from the questionnaire was computed and analyzed with SPSS software. The data were analysed using ANOVA to compare the website and mobile application groups to see if there was significant differences between the users’ perception of the system use and which system could be perceived as increasing their self-efficacy in self-management. In this respect, the motivation attributes could also be identified. Regarding the preference of system features, T-Test was conducted to compare if these two groups had significant differences. The quantitative data could also serve as triangulation for the qualitative data.

The qualitative data derived from the semi-structured interview was conducted by both inductive and deductive content analysis. Deductive approach content analysis is used for validating or extending the theoretical framework or theory (Hsieh & Shannon, 2005). It helps to provide an in-depth understanding of the phenomenon, extend the existing knowledge, as well as verify the proposed framework. On the other hand, inductive approach analysis is to identify categories as they emerge from the data (Pope, Ziebland, & Mays, 2000). As the researcher intended to compare the results with the proposed framework and also wanted to stay open to new discoveries on the user values, both inductive and deductive content analysis were employed. According to Saunders et al. (2007, p.119), it is not only possible to combine the induction and deduction analysis in a research, but is also advantageous to do so. Bryman and Bell (2003, p.12) also contend that grounded theory includes both induction and deduction elements in an iterative process. The researcher believes that an integrated approach is more appropriate for this study to understand the complex phenomena of the user experience and the persuasive effects.

The aim for analysing ethnographic data is to search for patterns and ideas that help to explain the existence of these patterns (Goulding, 2005). All the qualitative data from the interviews were translated into English transcripts for coding and categorization.
The data were reviewed and coded to identify the key issues, concepts and themes. According to Bradley, Curry, and Devers (2007), "coding provides the analyst with a formal system to organize the data, uncovering and documenting additional links within and between concepts and experiences described in the data." (p.1761) Bradley and his colleagues (2007) suggest five coding types in generating taxonomy, themes, and theory in health service research. They include: 1) **conceptual codes and subcodes** for identifying key concept domains and essential dimensions of these domains, 2) **relationship codes** connect between other concepts coded with conceptual codes; 3) **participant perspective codes** are used to identify the positive, negative, or indifferent about a particular experience; 4) **participant characteristic** identify the characteristics of the participants in terms of age, gender, socioeconomic status, etc.; 5) **setting codes** are used for identifying the characteristics of the settings such as invention versus non-intervention group, etc. In this research, all five types of coding were useful to analyse, compare, and contrast between different groups of participants in understanding their needs and values, motivation, behaviour, perception, as well as experience.

The codes and code structure were finalized at the point of theoretical saturation when no new concepts emerged from reviewing of the data from the sample of participants (Bradley, Curry, & Devers, 2007). After coding, recurring themes were identified and the data was then put into groups for categorization, which was then arranged for thematic headings. For comparison purpose, the data between the two groups were constantly compared and analysed to discover the similarities and differences between them. In the later stage in examining the values of the systems, the data were rearranged again for the thematic framework and forming charts and taxonomy according to their relationships and associations. According to Bradley, Curry, and Devers (2007), taxonomy is a system ideal for multifaceted and complex phenomena classifications for health service research, since interventions are usually implemented in the real world rather than in the controlled situations such as in the laboratory. Hence qualitative research can provide a comprehensive understanding of the complex and multifaceted variables that affect the interventions. Furthermore, themes and theory guide the research to explain the interrelationship of the concepts and predict
phenomena within diverse contexts of health care system (Bradley, Curry, & Devers, 2007).

I will first describe and discuss the quantitative data result, followed by the qualitative analysis of the post-use evaluation and follow-up interviews. The prototyping evaluation is discussed in the next chapter. Despite the observations of the pre-use introduction part were not used for the analysis, they provided some insights on the contextual factors which can enrich the understanding of the user experience.

9.6. General Results

The research period of using the systems of the patients was originally set in about 6 weeks. However, due to unexpected circumstances, for instance, some patients said they were too busy, and one of them went out of town for more than a month, and so on, so it took longer than planned. It was possibly because the research was conducted during the Christmas and New Year period, which is usually the busiest time of a year. So some patients were using the application for 6 - 12 weeks before coming back for an interview. Face-to-face semi-structured interviews were conducted for a majority of the participants, except one participant was using telephone interview since he said he was living far away and was too busy to attend. All the interviews were audio-recording.

There were 13 participants in total in this part of research where 5 patients were in computer website group and 8 patients in the mobile application group. Five female participants were withdrawn from the study. Four of them, all in their 50s, were withdrawn due to the technical problems they encountered during the pre-use introduction stage. Another female participant who was diagnosed with depression in the website group changed her mobile phone number and could not be reached later.

The use of self diary was found to be not a useful tool since almost no participants wrote in the diary, many of them even forgot about it. Only one female participant wrote some problems of the mobile application system on the booklet. Some of them in the website group, on the other hand, wrote on the printed self goal-setting sheets and
self-management sheet with their diet and exercise activities. Two of them even designed their own sheets and saw these records as their homework which they needed to submit when they came to the interview. The reason of this may be because of their literacy level, but also because writing their thoughts and feelings in the diary to be shown to people was not a usual practice of the older Chinese people. Moreover, they thought it was time-consuming to do so. Hence, it should be given more guidance or using alternative methods such as audio-recording or taking photographs for this type of research in the future.

In general, the website group users reported more satisfactory with the system and have positive comments about it. Two participants have finished all the sections of the system, however, one participant regarded it was boring and did not want to use it very often. All of the participants regarded the system was interesting and easy to use and said they will use the system in the future, particularly if they wanted to refresh their memory or check some information.

On the other hand, there was a high attrition rate of the mobile group users, especially the weight loss application. All of the users except one used the applications a few times only. The weight loss application was particularly found problematic and two patients even did not use it at all since they said it was "no use" for them. The glucose application received relatively more positive comments although they still had some design and technical problems, but Interestingly, most of them except one reported that they will use it in the future.

In regard to the weight loss and blood glucose level, the results were not significant. Most of the participants (n = 8) did not change their body weight after the trial period, some of them (n = 2) only slightly lost their weight, and few of them (n = 2) even gained their weight. The measurement of blood glucose level results was unsuccessful due to the fact that most of the participants did not record their blood glucose level on the diary and many of them did not checked their blood glucose level regularly. So the purpose of goal setting in this research was not achieved as planned.
These results may have three possible explanations: 1) the Chinese older adults did not accustom to write on the diary in research; 2) due to the fact that the research did not involve any healthcare provider in user evaluation part, and it was conducted only in a design department, it may give a different perception of the participants since healthcare providers were usually perceived to have more authority so it could lead to higher level of compliance; 3) although the researcher allowed the participants to set their own goals, most of them did not have a higher motivation to change their behaviour prior to the research. It shows that the factors of cultural, social, environmental, and the attitudes prior the research may affect the research result, so they should be considered in the future research.

9.7. Quantitative Analysis and Discussion

The number of participants in the website group and the glucose application group was 5 and 8 respectively. However, one participant from the mobile application group did not use the Weight Loss Management application after the first trial so the total numbers of participants of using this application were only 7.

The results of the three systems were computed using SPSS software and a One-way ANOVA was conducted for the first 23 questions in order to compare the effects of different features amongst these systems. A t-test was conducted for the preference of the new system design between the website group and the mobile group.

For the first 23 questions, the results showed that the means of the website group were generally higher than the other two groups with the weight loss system receiving the lowest means in general (Appendix F). The Sig. column in the table showed that most of the values are greater than 0.05 excepted four values, they were:

Q11 - This website or application can enhance my knowledge about diabetes (0.20);
Q13 - This website or application can provide me with necessary information and features (0.38);
Q15 - Use this website or application can allow me more effective in my
self-management (0.33); and
Q22 - I am satisfied with this website or application (0.12)

It can be concluded that there was a statistically significant difference between the mean number of the three systems in terms of these questions. The Post hoc test was conducted to identify which of these systems were significantly different. The results are shown in the following:

In Q11, there was a significant effect of knowledge of diabetes at the p<.05 level for the three conditions [F(2, 15) = 5.146, p = 0.20]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the website (M = 6.40, SD = 0.55) was significantly different than the weight loss application (M = 4.17, SD = 1.47). However, the glucose application (M = 5.00, SD = 1.15) did not significantly differ from the website.

In Q13, a significant effect about providing necessary information and features also found at the p<.05 level for the three conditions [F(2, 15) = 4.083, p = 0.39]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the website (M = 5.80, SD = 0.84) was significantly different than the weight loss application (M = 4.33, SD = 1.21). However, there were no significantly differ on the glucose application (M = 5.14, SD = 0.38) from the website site.

In Q15, the opinion of the effectiveness in self-management by using the systems was also a significant effect at the p<.05 levels for the three conditions [F (2, 15) = 5.31, p = 0.33]. Again, Post hoc comparisons showed that the mean score for the website (M = 5.80, SD = 0.84) was significantly different than the weight loss application (M = 3.84, SD = 1.33), and no significantly differ between the glucose application (M = 4.86, SD = 1.07) and the website site.

Finally, the Q22 showed a significant effect of satisfactory of the system at the p<.05 level for the three conditions [F(2, 15) = 4.22, p = 0.12]. However, in Post hoc comparisons, it found that the mean score for the glucose application (M = 5.8, SD =
0.79) was significantly different than the weight loss application ($M = 4.00$, $SD = 0.89$) and no significantly differ between the website ($M = 5.20$, $SD = 0.84$) and the glucose application.

Furthermore, the results also showed that a participant found the glucose application as quite satisfactory (6 out of 7 points), however, he did not intend to use it in the future (2 out of 7 points). On the other hand, another participant rated the weight loss application as fairly satisfactory (4 out of 7 points), his intention to use it in the future is relatively high (6 out of 7 points). Although the rating was not very significant between these two factors, it may be interesting to discover the reason why and if these factors have causal relationships.

When comparing the means between the website and mobile group in terms of the preferred system features, the results were similar and there was no significant difference between these two groups (Appendix F). The most preferred features were Q1 (simple to use), Q3 (timely and convenient), and Q7 (enhance knowledge about diabetes and self-management). The lowest one was Q5 (facilitate me to connect with others).

Taken together, these results suggested that the website and the glucose application could have similar effects on self-management. The weight loss application, in contrast, is significantly lacking in the knowledge and information about diabetes and self-management. It is understandable since the weight loss application mainly provided information about diet and exercise for weight management. Moreover, the participants also had a low self-efficacy when using the weight loss application. However, it was interesting to find that there was a significant difference between the glucose application and the weight loss application, indicating that when these two systems were both used by the participants, the weight loss system was far less satisfactory than the glucose system.

Regarding the most preferable features of this kind of systems, the participants generally perceived that simple to use, timely and convenient, and enhance the
knowledge about diabetes and self-management were the most important features. On the contrary, connecting to the other was the least preferable feature. It suggests that the participants may view that the system should be only for individual use and not for social connection.

Next part is to describe and discuss the qualitative findings of the user evaluation.

9.8. Qualitative Findings and Discussion

The first dimension of qualitative analysis is mainly focused on two areas: reflection and motivation. From the literature review, it has found that reflection is essential for initiating a behaviour to change. A person should develop internationalization of the values and meanings of the intended behaviour through self-reflection. However, to maintain the behaviour, the person should also have gained positive experience during the interaction with the systems or the activity. So it is essential to identify the motivational factors of the interaction with the systems. Finally, the data of the follow-up interview were also analysed to identify the long term effectiveness of the strategies and motivation problems.

9.8.1. Reflection, persuasion and increased awareness

In this part, I will focus on discussing the reflection of the participants of these two types of systems and if narrative or graphical format can promote more self-reflection and initiate behaviour change.

As expected, the website group provided more positive comments than the mobile group in general. Although these two groups showed that they have developed some self-reflection, the website group in particular showed stronger and positive self-reflection than the mobile group. Several themes were identified relating to their self-reflections, including: self-awareness, self-knowledge, alert and warning, pay more attention and more careful, as well as self-reflection. Many of these themes are also in line with the "processes of change" of the Trantheoretical
model (Prochaska & Velicer, 1997) indicated in the following table (Table 9.6).

Table 9.6. Reflection themes of the website and mobile group

<table>
<thead>
<tr>
<th>Reflection / self-reevaluation</th>
<th>Website group</th>
<th>Mobile application group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-awareness</strong></td>
<td><em>LG:</em> With this website, I can read more and do more exercise and other self-management. <em>It can help me to be more aware.</em> <em>(TTM - Consciousness raising)</em></td>
<td><em>YM:</em> I didn't know the fat (calories) of the food before I used the apps, after using it, I compare it and know the calories of the food is quite high, I think wow, it's quite high! I hope I can eat less (of that food). <em>(TTM - Consciousness raising)</em></td>
</tr>
<tr>
<td><strong>Alertness and warning</strong></td>
<td><em>LG:</em> I'll <em>remember</em> the information when I eat, there's some psychological impacts. Unless I'm hungry, then I don't care. I have <em>higher alertness, more impression.</em> I'll <em>remind myself</em> to eat more vegetable at least. <em>(TTM - Self-Liberation)</em></td>
<td><em>YM:</em> I will. There're some graphs, it can <em>warn myself</em>, for example, the red line and green line are quite apart. <em>(TTM - Self-Liberation)</em></td>
</tr>
<tr>
<td><strong>Pay more attention and be more careful</strong></td>
<td><em>LG:</em> I can <em>learn</em> much more information. I'm <em>more careful about diet,</em> and have <em>more concepts in doing exercise.</em> I <em>pay more attention</em> on diet and exercise, as well as lifestyle. <em>(TTM - Environmental Reevaluation)</em></td>
<td><em>YM:</em> Because I'll check the records. If it said the blood sugar is high, then I'll be <em>more careful</em> myself. If it shows that the blood sugar is high, then I'll have more <em>self-discipline,</em> I will eat <em>more carefully.</em> <em>(TTM - Environmental Reevaluation)</em></td>
</tr>
<tr>
<td><strong>Self knowledge</strong></td>
<td><em>LI:</em> If I don't check blood sugar, I don't know it causes my blood sugar high. Now I will check it and <em>examine what is the cause.</em> <em>(TTM - Self-Reevaluation)</em></td>
<td><em>YM:</em> It helps me to <em>understand my health condition,</em> it lets me know when is good and when is not so good <em>(TTM - Self-Reevaluation)</em></td>
</tr>
</tbody>
</table>
| **Self-reflection**           | *LI:* The games and tests are quite good, they help me to *reflect.* *(TTM - Self-Reevaluation)* | *MP:* I need to "*take it to my heart*." *(Sign)* I'll go there every day, and give 15 minutes per day to do so, no matter
In the website group, the participants provoked more reflection about their diet and lifestyle. Most of the participants thought that after using the website, they were more aware when they were eating and trying to do more exercise, for example, one participant said he followed the exercise from the website and tried to tell his daughter to do so as well. Gaining awareness is the *Consciousness-Raising* process in TTM that initiate a behaviour change.

One participant said it helped him to reflect and encouraged him to check his blood sugar more often because it could warn himself if he did not control his diet. This is similar to the process of *Self-Reevaluation* where the participant realizing and reflecting on how his behaviour affect his life. Moreover, he also developed a *Self-Liberation* in which he believed he had the ability to change and make commitments to act on that belief:

LI: "I used to check blood sugar very few times, but after using this website, I check my blood sugar more often. I know something I did wrong and I can warn myself. I used to think that living is just living, no need to do so many things. But now I have to submit my homework, I even set my goal to check blood sugar two times (per week). It has a purpose for reflection..... I don't think it is too troublesome, because if you have a problem, you have to deal with it. It is not too difficult to solve anyway." (Website group)

Most of them like the games and testing parts since they were fun, more engaging and helped the participants to reflect and remember the information deeply. They also said it would help them to pay more attention when they answered incorrectly, which would enhance their memory by providing correct answers:
LI: "The games and tests are quite good, they help me to reflect." (Website group)

NG: "The games will enhance your memory, since if you make mistakes, it'll scold you!" (Website group)

Moreover, the participants also realized and learned some positive effects by changing their behaviour from reading the information on the website and answering the questions. It is the Environmental Reevaluation process that they realized how the behaviour affects the physical and social environment in their lives:

LG: "I can learn much more information. I'm more careful about diet, and have more concepts in doing exercise. I pay more attention on diet and exercise, as well as lifestyle." (Website group)

Some of them also developed Counter-Conditioning where the participant were thought to act in substituting healthy ways for the unhealthy behaviour:

LG: "I'll not eat too much. I'll eat selectively, more vegetable and less meat." (Website group)

In general, most of the participants reported that using the website induced self-reflection experience and they were more aware and careful when making the choices of their meals. It shows that they had developed some internalization of what had been learned from the website. It was also related to Dramatic Relief from the TTM that the participants were dealing with the emotions about the problem behaviour and were feeling relieved because of the potential solutions provided.

Nevertheless, one patient said the website was boring and she was not interested to use it. The reason was that she had tried the website before and was familiar with the information in it; since she had done many research about diabetes before when her
mother was diagnosed diabetes decades ago. She also regarded the exercise demonstrations in the website were too simple for her and she had low motivation to follow them. Furthermore, she considered the amount of time was too long to complete a section (about 30 minutes per section) and she could not concentrate since she had household works to do. She could only find the medication information useful. Nevertheless, she mentioned the system was still useful and interesting to use, especially for "people who have just diagnosed the disease or do not have much knowledge about it.":

CU: "It is not useful to me since I have learned the knowledge about diabetes before. .... I think this website is good for somebody who don't know much about diabetes." (Website group)

For her, she would visit the website again if she wanted to check something because it helped her to refresh her memory. It demonstrates that there are different needs with different user context. People with higher health literacy may require more in-depth knowledge and are motivated with different persuasive strategies.

In contrast, the mobile applications received many negative comments, particularly regarding to usability problems which will be discussed in the next section. Most of the participants only used them a few times and one participant even did not use the Weight Loss Assistant application at all. Even though they used the applications, they mainly read the diet information since they regarded entering data particularly problematic.

Only one patient was in favour of the systems as he thought that reading the food information produced some reflections of him and the graphs could help him to gain self-knowledge and serve as a warning to him; however, he said that it was difficult for him to control his diet. He experienced the process of Consciousness raising, Environmental Reevaluation, Self-Reevaluation and some Self-Liberation, however, he did not have enough confidence in his ability to perform the change:
YM: "It's difficult to reduce weight. I want to eat less, but I can't. I'll try to eat less, but just watching the graphs won't help that much. ... Well, I'll try once again."

(Mobile Group)

One participant commented that the graph had no interaction and it did not indicate clearly what it meant. Another participant used the Kiwi Glucose Assistant for several times so that he could read the graph of his blood sugar level in the past several weeks. However, he did not understand the meaning of the graphs and charts and he just ignored it:

NG: "I did nothing, just let it be. It will come down!". "... No, I pretended nothing happened." (Mobile group)

These groups of patients did not initiate much reflection and they had low motivation to use the system and change their behaviour due to the usability problems and not understanding the meaning of the graphs. Many mobile group participants perceived the systems were too tedious to use, the tasks were too difficult to achieve, so the usage rate was low. Regarding the graphs and charts, since most of them used them only a few times or even did not use them, they did not think that the displays of graphs and charts have any effect or significance on them. Since the graphs and charts can only be displayed when they have sufficient data, that is, it requires the users to enter the data of their activities, such as the quantity of food intake and time of doing physical activities, over a longer period of time and in more frequent rate. Moreover, the users also need to have the knowledge to comprehend the meaning of the graphs and charts to yield insights during reflection. The interpretation of the graphs, charts and numbers requires higher numerical literacy and cognitive capabilities, it will have no effect if the users cannot understand what it means to them.

Nevertheless, few participants did show certain reflection after using the systems. For instance, one participant said when he saw the two graphs going widely apart, it gave him an alert of his calories intake. This is the Consciousness raising process of the TTM:
YM: “I didn’t know the fat (calories) of the food I ate before using the app. After using it, I compared it and learned that the calories of the food were quite high. I thought to myself: ‘Wow, it’s quite high! I hope I could eat less (of that food).’” (Mobile group)

Another participant also showed a Counter-Conditioning when reflecting on her unhealthy behaviour and substituting a healthy one.

MP: “I need to ‘take it to my heart’. (Sign) Go there every day, use 15 minutes per day to do so, no matter what, I still need to go there and use it, see if I can do these things.” (Mobile group)

Interestingly, it was found that while the participants in the website group showed more positive emotions and sense of control, the mobile group have more negative emotions and reflections. For instance, many of the website group participants mentioned about how the website motivated them to do more exercise and they were more careful about their diet. It seemed that they have gained more self-efficacy and more confident in managing their disease. In contrast, many participants in the mobile group reflected deeply about their disease and the difficulties they perceived in self-management. For instance, a female participant discussed about her weaknesses on controlling her diet and doing physical exercise, she felt guilty of her lack of self-disciplined since she did not "take it in her heart". Another participant expressed his worries and sense of hopelessness about his disease, although he had managed his disease well. It showed that these participants were worried about their disease; without providing potential solutions, they lacked self-efficacy for a behaviour change.

In conclusion, it demonstrates that the use of narratives and multi-models on the website can promote more self-reflection and increase self-efficacy, so that people are more willing to change their behaviour. The use of narratives is more emotionally engaged and produces resonant with the users. It also reduces resistance and therefore more persuasive in behaviour change. The use of games, quizzes, and Q & A enforced
learning by better memories and understanding, which helped them to reflect and remember the information more easily in their daily lives. The result confirms that storytelling and questions are one of the powerful elements of the reflection experience (Wood Daudelin, 1997). Moreover, the participants were also shown to experience some reflection processes that were identical to the TTM. It showed that the website was able to produce internalization of the values of change.

However, the research also identified that the user context may affect the persuasiveness of the systems as they have different needs such as the needs for information and features. More about this issue is discussed in the following sections.

9.8.2. Motivation attributes

In this part, I will focus on discussing the findings related to the user experience and motivation of the system use, particularly the motivational factors and the perceived barriers of behaviour change. In general, the website group regarded that the website was interesting and easy to use, and they had greater motivation to use the systems and engaged in desirable behaviour. The mobile group of patients, on the other hand, had mostly negative comments. Since the participants perceived the systems difficult to use, which affected their motivation to use them. The self-monitoring part was viewed as most troublesome and problematic for both groups, particularly in the mobile group.

Several themes were identified relating to the motivations and the barriers which are highlighted in Table 9.7. Many of them are consistent with the proposed framework. It was found that the barriers reflecting the needs and motivation of the users, and some of these factors are interrelated.
Table 9.7: Themes from the Qualitative Analysis

<table>
<thead>
<tr>
<th>Motivation Factors</th>
<th>Website group</th>
<th>Mobile application group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
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</tbody>
</table>
| Positive motivation | • Detail and comprehensive  
|                    |   • Updated information regularly  
|                    |   • Easy to understand | • Diet and medication information is important |
| Hurdles of motivation | • Information not updated  
|                       | • Not personalized  
|                       | • Insufficient information | • Too many things  
|                    |                          | • Too complicated | • Not clear |
| **Convenient**    |              |                          |
| Positive motivation | • Can watch it again | • Save time  
|                    |                          | • Keep and check historical records  
|                    |                          | • Integration  
|                    |                          | • Synchronize  
|                    |                          | • Centralize | • Troublesome |
| Hurdles of motivation | • Troublesome | • Clumsy  
|                       |                          | • Time-consuming  
|                       |                          | • Redundancy  
|                       |                          | • Needed do too many things  
|                       |                          | • Not convenient to use |
| **Trustworthiness** | Positive motivation | • The information should be reliable | |
| Hurdles of motivation |                      | • Not accurate  
|                       |                          | • Not reliable |
|                       |                          | • Not complete | • Not professional |
| **Perceived competence** | Positive motivation | • Simple to use | • Quite easy to use |
| Hurdles of motivation | • Too many texts  
|                       | • Too long per section | • Difficult to enter data  
|                       |                          | • Too many steps  
|                       |                          | • Too many texts | • Searching data are difficult and waste time  
|                       |                          | • Problem with registering  
|                       |                          | • Organization of information was confusing  
<p>|                       |                          | • Small fonts, small buttons |
| <strong>Autonomy</strong>      | Positive motivation | • Allow to make my own way | • Not flexible |</p>
<table>
<thead>
<tr>
<th></th>
<th>Hurdles of motivation</th>
<th>Encouragement/sense of hope</th>
<th>Instruction and guidance</th>
<th>Resonant</th>
<th>Attractiveness</th>
<th>Interactive</th>
<th>Goal setting and Self-discipline</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lack of choices</strong></td>
<td></td>
<td><strong>The information can</strong></td>
<td><strong>Discouraging</strong></td>
<td><strong>Similar to their own situations</strong></td>
<td><strong>Not enough instructions</strong></td>
<td><strong>Boring</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Not customized and personalized</strong></td>
<td></td>
<td>provide support**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lack of choices</strong></td>
<td></td>
<td><strong>Encouraging</strong></td>
<td><strong>Not for me</strong></td>
<td><strong>Not match with my level</strong></td>
<td><strong>The cartoon is weird</strong></td>
<td><strong>Need to work hard</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Not customized and personalized</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Not match with my level</strong></td>
<td><strong>The cartoon is weird</strong></td>
<td><strong>Feel guilty because of</strong></td>
</tr>
</tbody>
</table>

### Encouragement/sense of hope
- Positive motivation
  - The information can provide support
  - Encouraging
- Hurdles of motivation
  - Discouraging
  - Annoying

### Instruction and guidance
- Positive motivation
  - Provide solutions
  - Suggestions
  - Explanation
- Hurdles of motivation
  - Not enough instructions
  - No explanation
  - Not provide solutions
  - Explanation not clear

### Resonant
- Positive motivation
  - Similar to their own situations
  - Too many mainland Chinese styles
  - No rapports
- Hurdles of motivation
  - Not match with my level
  - Not for me

### Attractiveness
- Positive motivation
  - Aesthetics
  - Fun
  - Pleasurable to use
  - The colours are nice
  - Novelty
  - Interesting
  - Relaxing
  - Happy
  - Concentrate
  - Enjoyable
  - Look comfortable
  - Interesting
  - Novelty
  - Listen to music
  - Attractive colours
  - Attractive pictures
  - Like the cartoon
- Hurdles of motivation
  - Boring
  - The cartoon is weird
  - The cartoon is not attractive
  - No pictures
  - Monotony

### Interactive
- Positive motivation
  - Interaction is more interesting
  - Facebook is more interactive
  - "Take it to heart"
- Hurdles of motivation
  - The forms need to be printed out
  - No interaction of the graphs

### Goal setting and Self-discipline
- Positive motivation
  - Self-setting goals
  - Eat complementary food
  - Perception of risk - increase self-awareness
  - Have a goal to achieve so need to be self-disciplined
  - Perception of risk - increase self-awareness & willing to be self-disciplined
- Hurdles of motivation
  - Need to work hard
  - Feel guilty because of
### Culture

<table>
<thead>
<tr>
<th>motivation</th>
<th>self weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive motivation</td>
<td>Lack of goals</td>
</tr>
<tr>
<td>• Chinese food</td>
<td>Chinese recipes</td>
</tr>
<tr>
<td>• Food converter according to Chinese food habits</td>
<td></td>
</tr>
</tbody>
</table>

#### Hurdles of motivation

- Do not like to read
- Simplify Chinese
- No English and traditional Chinese
- Some food names and use of the terms were different from Hong Kong
- Did not understand Medicine names
- Difficult to count food quantity
- No western food
- Not international

### Social connection

<table>
<thead>
<tr>
<th>motivation</th>
<th>self weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive motivation</td>
<td>Need rapport</td>
</tr>
<tr>
<td>• Prefer close friends and relatives</td>
<td></td>
</tr>
<tr>
<td>• Like to know other people's experience</td>
<td></td>
</tr>
<tr>
<td>• Need trustworthy</td>
<td></td>
</tr>
<tr>
<td>• Need reliable</td>
<td></td>
</tr>
<tr>
<td>• Prefer close friends and relatives</td>
<td></td>
</tr>
<tr>
<td>• Like to know other people's experience</td>
<td></td>
</tr>
</tbody>
</table>

#### Hurdles of motivation

- The discussion forum is no use for me
- Difficult to type Chinese on the screen
- Not resonant
- No rapport
- Not reliable
- Not trustworthiness

### Seek knowledge

The content information is considered to be the most important part of almost all participants. Many participants thought that the information can increase their knowledge about diabetes and they have greater confidence in self-management. It can also help them to reflect and be more aware about their food and health. For example, a patient with depression in the website group felt that it was very helpful for her to understand more about the disease after introducing the website to her.

Most of the participants in the website group favoured the detailed and
comprehensiveness of the information, and they considered the information was easy to understand. Almost all of them enjoyed the games and testing parts since they could help them to remember the information deeply. They also reckoned it would help them to pay more attention when they answered incorrectly.

LU: "I can remember the information deeply after doing the tests. The information in the tests can remain deeper in my mind. It's easier to absorb because if you're wrong, you can watch it again later." (Website group)

The food part was the most popular part both for the website and mobile application groups. The participants were interested to know the food nutrition and how to control their diet. In fact, many participants in the mobile group reported that they only read the content information without entering the data in the systems.

LN: "... because it's (food converter) important for diabetic patients. You know what to eat in each meal, and how to lose weight." (Website group)

MP: "I like the food and exercise information of the Weight Loss Assistant, the calories, how to cook, etc. I feel that it's very attractive." (Mobile group)

The other part they perceived essential was the information about medications. They could learn about the effectiveness and side-effects of the medications which could help them to understand their body reactions and how to manage their disease. In the study, I realized that the knowledge of medications was quite important for those who have many years of diabetes and have higher health literacy.

The factors affect the information include insufficient information, information quality, information update, as well as the comprehensiveness of the information. For example, some participants in the website group regarded that there had no updated information, and one of them thought the food convert part was too general for her. On the other hand, some participants complained that there were too many food items in the mobile application to search for and the information on the
glucose management application was also not clear.

**Convenience**

One of the most reported barriers was about the convenient to use, especially for the mobile application group. Most of the patients regarded that using the mobile applications were *clumsy, time-consuming, redundant, and needed to do too many things*. They regarded that entering every meal and exercise were too time-consuming for them. For instance, a participant claimed:

> LA: "You need to work very hard for this! ... You can think that if you do it according to the items in this system, how much time you have to spend on it? At least one hour! Moreover, you have to remember clearly what you ate today!" (Mobile group)

Time saving and convenient to use were crucial if they would use the systems. Some participants preferred the systems to be integrated and synchronized with other systems, so that they needed not to enter data in different devices. One of them also considered that to synchronize the data automatically could eliminate human errors compared to entering the data manually.

**Trustworthiness**

Another most commonly mentioned problem is related to trustworthiness, it included *accuracy, reliability* and *credibility*, especially regarding the Weight Loss Assistant application. The problems mainly derived from *incomplete data entry, skeptical about the systematic measurement and information source*, as well as *unsure about the food count*. Many of the participants from the mobile application group considered that it was difficult for them to enter the blood sugar level, diet and exercise data everyday regularly and thoroughly in the systems so the results were not accurately reflecting the truth.
EM: "The most difficult one is diet, since I don't know how many grams the food have. I feel it's not accurate, so I just give it up and don't do it." (Mobile group)

MP: "If I just check it (blood sugar) occasionally, the average number may not be accurate." (Mobile group)

Moreover, they also skeptical about the measurement and information source of the systems:

PW: "I also tried ‘cleaning’. and then entered ‘15 minutes’, it stated it costed a few hundred calories. I entered ‘cleaning floor’... and I thought to myself: "Is it really that much?"... I asked myself, "Is it accurate?" Then I have some queries... I stopped doing it because I felt I was being cheated! Because it didn't reflect the truth! So I think it's a bit... fake!" (Mobile group)

Trustworthiness is one of the critical factors of the motivation. Since they thought that due to the incompletion of data entry and unreliability of the information, the systems were not accurately reflecting the truth about their health, so they lost their motivation to use the systems. It seems that it was especially important for participants with higher education and higher involvement. For example, one participant who had university level education with over 5 years of diabetes, was most concern about the credibility and reliability of the source of information. Another participant with similar education level and longer year of diabetes also questioning the credibility of those mobile application providers.

Perceived competence

The website group generally considered the website easy to use, whereas the mobile group encountered a great deal of usability problems, which affected their perceived competence and motivation. The usability problems are related to the mobile system design and the contextual factors, particularly in the Weight Loss Assistant application.
The mobile system problems included the **usability, design and culture issues**. **Usability** problems were **difficult to enter the data and difficult to find the food names. Design problems** included: small fonts, small buttons, problem with registration, too many texts, and confusing organization of information. **Cultural issues** of the systems included: do not like to read Simplify Chinese, some food names and use of the terms were different from Hong Kong.

Most of them reported they had difficulty to search the information and entered the data due to the huge food database as well as some unfamiliar food names because of the cultural differences. They also not certained about the amount of food intake, the numbers of steps they walked, or which types of exercise to record. It shows that the large food database and the complexity and lengthy of the data entry process were the major barriers of the system use.

**The contextual factors** were related to the difficulty to count the food quantity and food weight, and they did not willingly to check blood sugar regularly every day. Since the systems required manual data entry of the food quantity, it was not a common practice for many Chinese people and it added extra burdens to the participants. Moreover, as discovered in the previous stage of research, most of them did not check their blood sugar regularly due to reasons such as, the low perceived value in blood checking, shortage of money and time, and some of them regarded that it was more convenient for them to record it on the booklet.

TG:" But because I don't have many problems so I use it less, I don't use it very often. I check it usually when I was not feeling well, otherwise, if I feel OK, then I'll just leave it. .... If I feel like my blood sugar is high, or when I feel dizzy, then I'll check it."  (Mobile group)

The usability problems and complexity of data entry were the greatest obstacles of the system use since they reckoned that the tasks were too difficult to achieve. These obstacles reduced their self-efficacy and perceived competence to perform the intended behaviour.
**Autonomy**

Another finding was that there was a great desire to have self autonomy of the participants. It was found that the patients required *flexibility, customization* and *personalization* of the features and information. For example, one patient regarded that it should provide more flexibility for patients to define and record their health since each diabetes case is individually different, and the needs of the severe cases are different from the less severe ones.

Many participants demanded more choices and customized features since they could have the freedom to choose features that suited them. The freedom of choice is important to promote a sense of control which encourages motivation and enhances well-being. For instance, a participant from the website group set his own goals (for example, to check more blood sugar) on the self goal-setting form, and he even designed his own self-monitoring form to suit his needs. He was more motivated to achieve his own setting goals since it gave him a sense of self and locus of control.

**Instructions and guidances**

Many patients regarded that providing *instructions, suggestions* and *clear explanations* were necessary for them to understand how to take actions and solve the problems. For instance, a patient criticized that although the diabetes management applications had information about diabetes and the symptoms, it lacked of suggestions about how to solve the problems. Moreover, the graphs of the mobile applications had no indication and explanation of each entry point which was unclear what it meant to the users, so it could not help them to take appropriate actions such as to take more medications or need strictly control their diet.

The website provided quite comprehensive information and suggestions about diabetes and self-management. However, some patients regarded that it did not provide enough instructions on how to set their own goals according to the individual needs and
requirements, so in the future, it should be provided in the self-monitoring forms.

**Attractiveness**

The attractiveness of the systems was found to have some effects on the motivation of the system use. All the participants in the computer group considered the website *aesthetically appealing* and *pleasurable to use*. They thought that it looked comfortable and was easy to use. They had more positive emotions when in use such as *fun, happy, interesting, relaxing*, as well as *enjoyable*.

On the contrary, the participants in the mobile group have quite different opinions. Some of them regarded the systems interesting because of the novelty. The Kiwi Glucose Assistant was considered pleasing of its colour scheme. However, some thought that it had too many texts and no pictures, which made it monotony. On the other hand, they had different opinions of the Weight Loss Assistant especially the cartoon on the front page. Many of them did not like it excepted one, showing it has personal preferences. However, they generally liked the big food pictures of the application and thought that they were attractive.

The findings were generally consistent with the quantitative results where both the website and Kiwi Glucose Assistant were received higher rating in aesthetic experience than the Weight Loss Assistant application.

**System interaction**

Some participants also reported that higher interactivity of the system led to higher motivation for them to use the system. A participant in the computer group regarded that the website was more pleasant and interesting to use because it was highly interactive than other diabetes websites which solely provided information. A participant in the mobile group complained the graphs of the mobile application were not providing interaction and lacked explanation of each entre point. A female participant also stated that she “took it into her heart” more when using Facebook
since it was more interactive, and she would interact with her friends and know more about their daily lives.

People generally are more motivated with two-way communication than one-way communication. Hence, to provide feedback and higher interactivity both in human-to-human and human-to-system interaction can create higher motivation in engagement. It was in line with previous studies about interaction system engagement by O’Brien (2010). The questionnaire results also showed that the website provided highest interaction and the Weight Loss Assistant had the lowest interaction.

**Resonance**

It was found that people were less willing to engage with the systems or activities if they perceived the systems not resonate with them. For example, a participant from the computer group regarded that the website was boring since it was "not for her" because of the information and knowledge level. Many participants also complained that the mobile applications have many Mainland Chinese elements such as the simplify Chinese characters, the food names, and the use of terms. They regarded that it should have both English and traditional Chinese version since Hong Kong is an "international" city; it should also provide different cuisines from other parts of the world such as Japanese and Western food. The icon of the Weight Loss Management application was also considered to be too childish for them.

**Goal and Self-disciplines**

A few number of patients also reported that they were more self-discipline and willing to compile to healthy behaviour if they had a goal to achieve. For instance, a patient described an experience when she needed to undertake an operation. She was more self-disciplined with her diet before the operation. However, she was relaxing with her diet control after the operation. Another patient also mentioned that when he found that his health was at risk due to the gaining of body weight, which led to high blood sugar and hypertension. He had to set a goal for himself to reduce body weight by
doing more exercise every day. These two cases demonstrated that people perceived a risk that caused them to take actions to reduce the risk in a goal by being more self-disciplined. The perception of higher risk produces higher motivation to take actions to reduce the risk.

EM: "Since I needed to do an operation, so I needed to be self-disciplined and I'd be more alert. Now I use natural ingredient sugar. I drink coffee with this artificial sugar that made of corns. I try to eat complementary food instead." (Mobile group)

EM: "For me, to gain the knowledge about the disease is a good thing, e.g., if the blood sugar is high after I ate noodle, then I'll know that this kind of food will make me sick. But sometimes, I really want to eat it, I'll still eat and not completely forbidden it, unless there’s a goal I need to achieve." (Mobile group)

It is noted that, however, the goal-setting has a higher possibility of success if the goal is set by the people themselves rather than other people set it for them. For instance, a patient in the website group sets his own goals and he had higher motivation to achieve them.

**Physical social connection**

Social support is considered important for chronic disease patients (Sanderman & Suurmeijer, 1993) and the use of virtual communities could support self-management (Barrera, Glasgow, McKay, Boles, & Feil, 2002). So this research also intended to examine the social aspects and if the virtual community can help the participants to be more engaging in self-management.

As consistent with many studies about Asian and Chinese people, family support was important for the patients, for example, during the pre-use interview, two participants were accompanied by their wives and one patient came with her daughter who was a faculty in the university. The two participants' wives, although not participated in the
research, were eager to assist with the use of the systems when necessary. The participant’s daughter was waiting while working in her office until her mother called her.

From the interviews, almost all of the participants (n=11) both in the computer or mobile application groups reported that they did not use or like to use the discussion forum. The reasons include: no time; perception of needlessness and uselessness; do not like to share with strangers; feel not the same with the others; reliability and trustworthy issues; culture problem; and difficult to type in Chinese.

The participants preferred physical contact with their family, friends, and people they could trust rather than strangers. Even though some of them were using social media such as Facebook, they seldom actively engaged in the discussion, not least discussing their disease. It was possibly because Chinese people, especially the older generations, considered that it should keep their sickness to themselves with only close relatives and friends. Some of them also concerned about the reliability and trustworthiness with strangers, one participant (PW: male, around 40 years old) responded:

*I won’t use the discussion forum, it’s not reliable. Because everyone is different. If I put a message on the forum, then there’re ‘N’ numbers of solutions, then who will you trust? I won’t use discussion forums to get the answers, I’ll find some reliable resources such as government, or I’ll only listen to people who have scientific background. You can find some weird ideas on the discussion forum, but how many of them are trustworthy? It’s not reliable. Because these people are only ordinary people and they’re not professionals, how do you justify the truthfulness of this information. (Mobile group)*

The two participants who said they would read the discussion forum have different reasons. One male participant who was aged 69 said reading discussion forum would help him to gain more knowledge, but he seldom used Facebook and there were only a few close friends in his account. Another female participant who was 40 years old, on
the other hand, liked to read discussion forum and used Facebook frequently since she was interested to know the activities and posts from her friends and others. She had checked the discussion forum on the mobile application but she thought that the visitors of the discussion were mainly from Mainland China and she was also skeptical about their answers regarding how fast they claimed to lose their weight. She was interested to know more about how to lose weight since she was going to get married at the end of the year.

The interview explained partly why the social connection was rated the lowest in the questionnaire and it seemed that virtual community was not as useful as the Western countries for the Chinese older adults. It indicates that to provide human to human communication and supports are more important, especially the system should facilitate connections and communications with their family and friends. It may be also because of the geographical characteristics that Hong Kong is relatively small in size compared to other cities in the West so physical connection is preferred. However, further investigation about the social behaviour and their interaction with the communication technologies of the Chinese older adults are needed in the future.

9.9. Follow Up After Post-Evaluation

After 10 months of post-use evaluation, the participants were followed up with a telephone interview to check if they were still using the systems and any behaviour change was occurred. It is found that the attrition rate of the systems was very high. While the website was gaining more positive feedback, only two participants said they were still using it from time to time. In the mobile group, only one participant were still using the glucose system occasionally just for reading the diabetes information. The finding of the follow-up can be found in Appendix H.

The reasons of attrition can be summarized in three main aspects: technical hindrance, incompatible with own lifestyle, and perception of usefulness. Technical hindrance refer to the lost or changed of smart phone, the participants either forgot how to find the application or they have no motivation to download it
again. Many participants refused to use it since they thought that the mobile applications were too time-consuming to use that they were *incompatible with their lifestyle* and created a burden in their lives. Finally, most of the participants thought that the website or applications *were not useful* to them in their self-management so they did not use them again.

On the contrary, for participants in the website group and mobile group who still using the website were because of the *information need*. They either wanted to find new and updated information or just wanted to read the diabetes information. As one participant in the mobile group said he occasionally read the diabetes information of the mobile application because "It's already there!". So the information need is the main drive that the participants returned to use the systems.

In terms of the behaviour change, it was found that many of the participants did not change their behaviour after using the systems and some of them even returned back to the previous behaviour. For example, one participant in the mobile group said he stopped running frequently since his blood sugar level was lower due to the increased of medication dosage. In fact, it was found that *perception of risk* was the major reason that led to behaviour change. For example, one participant in the website group said she did more stretching exercises since her feet were painful and she also had higher blood pressure. For this reasons, her doctor suggested her to do more exercises. The research showed that a change in health condition such as the raise of blood pressure may create warning and awareness of threats that motivate for a change of behaviour. On the other hand, medication effects may also reduce the perception of risk that led to relaxing of self-discipline.

However, a few participants did change behaviour and attitude. For instance, one participant engaged in more physical exercise during the lunch time due to the influence of the other colleagues. One participant previously disregarded the importance of physical exercise agreed that doing exercise would be beneficial for him even though he did not want to compromise it with his own interests in learning web site design.
9.10. Discussion

This part of research is to discuss the persuasive effects and the motivation factors of system use and behaviour change from the research. From the study, several key factors are identified and discussed in the following.

**Persuasive effects of two types of systems**

The research provided an in-depth understanding of the persuasive effects and user experience of two types of persuasive systems in self-management. In general, the website was found to promote more reflections, increase self-efficacy, and greater motivation for behaviour change, as well as achieve overall well-being. The mobile applications, on the other hand, due to many usability and contextual problems, affected the persuasive effects and motivation to use.

The website was generally obtained more positive comments than the mobile applications and it also promoted more reflections and then behaviour change. It proves that narrative form of persuasion is more effective and the use of games and quizzes can enhance understanding and memories so it can help the users more aware in their daily lives. On the other hand, graphical and numerical format could communicate risks, however, it requires a higher numerical literacy of the users or it could not achieve desirable effects. In this case, due to the problem of data entry into the systems, it also failed to induce reflection and the perception of risks. Furthermore, it also showed that affective and positive experience may have higher persuasive effects.

However, the research shows that the persuasive effects of both systems were only short term. There are five possible explanations:

Firstly, it may be due to the fact that some of the patients in the research had been diagnosed with diabetes for a long time, they had developed with certain knowledge.
and skills, that is, they had established self-efficacy and patterns in managing their disease. Hence, the systems did not provide significant values for them especially they have to re-learn new skills and adopt a new lifestyle when using the systems, which was also time-consuming for them. Many participants viewed it was not worthy to put so much efforts to use it.

Secondly, it shows that the systems did not incorporate into the patients’ daily lives and the use context, so there is a lack of relationship between the patient and the systems. This lack of relationship was due to the mismatch between the system design with the user context and the context of use.

Thirdly, the self-management tasks were also perceived as too difficult and time-consuming to perform. As Bandura (1998) specifies, unless people believe they have the ability to produce desired outcomes of their actions, they have a very low incentive to perform or to maintain them in the face of difficulties.

Fourthly, repeated behaviour requires the participants to see positive effects of their behaviour, however, the systems also failed to provide the information about their progress so it reduces the motivation to perform it consistently.

Finally, the self-management tasks in the systems both required following strict disciplinary actions which may be seen as a control that is an external force for undermining motivation. As Pelletier and Sharp (2008) suggest that low motivation or amotivation is caused by controlling events that only produce temporary compliance and short-term commitment. It includes: the events do not supply any rationale for actions, or the challenges to be perceived as too difficult to overcome for the individual, or do not provide solution to the perceived problem (Pelletier & Sharp, 2008).

Yet it also notices some minor changes of attitudes and behaviour of some patients. For instance, one patient previously refused to use a glucose meter due to the psychological barrier of taking blood has developed a habit of checking blood sugar every morning even though he stopped using the mobile application later. One patient
also realized that doing physical exercise was important, even though he said he was too busy in his own interests. Another patient had increased doing exercise partly due to the influence from the social environment even though he used the website less frequently as before. One participant in the mobile group also showed to have gained some awareness after using the applications and she was thinking to substitute her unhealthy behaviour to more healthy ones such as doing more exercise, which is a Counter conditioning process proposed by the TTM.

In conclusion, the major hurdles of the motivation to use are due to the perception of lack of usefulness of the systems, usability problems, and the systems are incongruent with the users’ lifestyles. The systems were perceived to produce burdens in life and they were failed to create value in use.

This study shows that interventions for behaviour change is complex and the persuasive effects of using these systems were only short term. It found that a behaviour change is affected by many internal and external factors. The **internal factors** include such as the patients' intention, health condition change, perception of usefulness and perception of risk. The **external factors** consists of the technical issues, cultures, and the influence of their social and physical environment. The design of these systems should take these factors into account.

**Motivation and engagement attribute in behaviour change**

Several themes were identified in their motivation to use the diabetes systems, including: seek knowledge, trustworthiness, autonomy, perceived competence, provide instructions and guidances, attractiveness, system interaction, resonance, goal-setting, and physical social connection. Some of these factors are in line with the engagement attributes in interactive systems proposed by O'Brien and Toms (2008) such as ease of use, control, feedback, novelty, as well as aesthetic and sensory appeal. It is also in line with the study of Sundar et al (2012) that system with higher navigability, interactivity and customization is more user engaging. In addition, this study also found that seeking knowledge, autonomy, trustworthiness, providing
instructions and guidance, system interaction, resonance, and goal-setting are important for motivation to use in these kind of systems and initiate behaviour change.

This research, however, shows that even the system has achieved higher level of these qualities, it is not necessarily mean the users will use it in the long run. It also depends on how the users perceive the usefulness of the system to achieve their goals as well as the contextual factors including the user context and the context of use.

Nevertheless, the result is consistent with the theoretical framework in Table 5.3. - the Design principles for motivation and persuasive systems that are proposed by the researcher, and it can be proved to be an effective guideline for designing of persuasive systems. It should also be noted that these attributes are interrelated and should be used concurrently to be more effective.

**Content information and information needs**

Content information was found to be important for both groups. Content information is one of the key elements in motivation and persuasion since it helps the patients to understand why they need to change so that they can internalize the values of change. It can also provide a sense of support and increase of self-efficacy when they have gained the knowledge and skills to take control of their health. According to the Knowledge-Attitude-Behaviour Model, increase of knowledge would lead to a change in attitudes which resulting in a change of behaviour (Flegal, 1996). However, some argue that only increase of knowledge may not necessarily influence behaviour change (Oinas-Kukkonen, 2013). This study found that although increase of knowledge and information did not have great impact on behaviour change, it could provoke awareness and provide a sense of autonomy and locus of control of the participants.

Moreover, the format, the source and the quality of information are crucial to determine if the messages are more persuasive and acceptable to the receivers. In this research, it demonstrates that the use of different formats such as narrative, gamifications, and statistics may have different effects on different kinds of users, for
example, the higher involvement or lower involvement in their disease. Hence, the persuasive message should be elaborated according to different kinds of users to be more effective. More detail discussion is in the later part of analysis.

*Usability problems affect positive experience and persuasive effects*

It was found that the log book systems were the most problematic to use, especially regarding the food and exercise data entry. All participants in the mobile group considered great barriers in using these systems so they refused to use them. The problems were due to the usability of the system, dissonance of user culture, habits, and lifestyles. It is consistent with the concept of self-efficacy that people refuse to engage in new behaviour since they perceive it was too difficult for them to perform the action. Many participants perceived using the system required highly self-discipline, a task that perceived as too difficult to accomplish. In addition, although the Weight Loss Management application provided abundant of information about diet and exercise, some of them considered it has too much information that requires extra time and efforts to use.

Self-monitoring is essential for chronic disease patients but a more simple and easy ways are needed for encouraging engagement rather than to create burdens to the patients. It should focus on reducing the barriers and increasing self-efficacy by simplifying the data entry process, providing step-by-step guidance, and enhancing positive experience in user-system interaction.

*Perception of risk affects motivation to behaviour change*

Perception of risk was found to be a critical factor in behaviour change. Many patients changed their behaviour since they perceived a risk or threat of their health, for example, increased blood glucose level or blood pressure. The change of health condition produced warning that induces action, such as doing more exercise. The behaviour change is also dependent on the perceived level of threats - if the level of threat is high, the higher the possibility of behaviour change. On the other hand, the
medication seems to reduce the perception of risk since it was considered as providing a control of the disease. It was found that medication is more important for people who have many years of diabetes rather than for newly diagnosed patients. Such participants regard that medication plays a key role in controlling their disease, in contrast, the newly diagnosed patients thought that they can control their disease by controlling their diet and doing exercise. So to provide the knowledge of medication for the longer year diabetes patients is also necessary.

**Relationships between user satisfaction and future of use**

The study found that there were contradictory between some quantitative and qualitative data. For example, a participant from the mobile group commented the Kiwi Glucose Assistant application was not convenient to use and he would not use it in the future. Nevertheless, he rated 6-point in the system satisfactory level, a quite high rating with 7-point is the highest, whereas he rated only 2-point on future system use. In contrast, another patient who rated lower (4 out of 7) for the system satisfactory level in *Weight Loss Assistant* but he rated higher (6 out of 7) for future system use. It had three possible answers: 1) people tend to give 'polite' answers to avoid giving an extreme rating; 2) people did not understand the question; 3) there may not have relationships between "user satisfactory" and 'future of use".

To investigate the reason, these two participants were interviewed to examine the reasons regarding their answers. The first participant explained that he regarded the system itself was satisfactory, but it was "not for him", so he would not use it. Another participant reported that he regarded the system was not satisfactory to use, but it was useful for him in some ways. This result is in line with the study by Tractinsky and Zmiri (2006) that satisfying and pleasant experience are distinguished. While the perception of usability is better to predict satisfaction instead of pleasant experience, perceived of product's aesthetics is better to predict pleasant experience instead of satisfying experience.

It was interesting to discover that although it is generally considered there is positive
relationship between user satisfaction and subsequent use (Ralston et al, 2007), this study found that the satisfaction of the system may not necessarily predicted future of use. Some studies have found more complex relationships between different variables and future of use. For instance, the DeLone and McLean Model of Information Success (DeLone & McLean, 1992) suggests a close interrelationship between 'use' and 'user satisfaction', that positive experience with use will result in user satisfaction and then increase "intention to use" and "use". Later, DeLone and McLean update their model and suggest that to understand the "net benefits" from the perspective of the owner of the system is necessary. They argue that if the perceived net benefits are positive, it influences and reinforces subsequent 'use' and 'user satisfaction', whereas the lack of positive benefits will result in decreased use and possible discontinuance of the system (DeLone & McLean, 2003). They suggest that to measure the "net benefits" require the researcher to define clearly and carefully the stakeholders and the context of the research. Other studies also found that payment equity (Bolton & Lemon, 1999) and different level of relational of customers (Garbarino & Johnson, 1999) also affect future use of the service.

This finding indicates several issues: 1) the concept of "user satisfaction" is complex depending on different individuals and in different context; therefore it is necessary to understand the meaning of "user satisfaction" in different use and user context; 2) user satisfaction may not predict future of use, rather the perceived of positive benefits and usefulness are more vital; 3) "user satisfactory" may create some positive experiences, by itself it is insufficient for future and long term use. Satisfying experience seems to be the basic requirement of intention to use, however, pleasant experience may be more important for future use since it relates to self and emotional attachment; 4) the products or services also need to build a relationship with the user. The relationship is built on meeting the user's needs and values, developing the resonance, as well as providing benefits and meaning in use. Since the issue of the interrelationship between user satisfaction and future usage needs is beyond the scope of this study, it is suggested to explore in future study.

Finally, this research has demonstrated that if using only one research method may
produce bias results that did not reflect the truth. The use of mixed methods research is not only enriching the understanding of the issues, but it also helps to discover the hidden meaning and perception of the interviewees that could provide a more valuable information for the study.

9.11. Implications and Recommendations for Design

From the above findings, they provide valuable information to understand the motivation and persuasive effects of diabetes persuasive systems. It can provide implications for the design of the diabetes persuasive systems in the future.

9.11.1. Persuasive effects and behaviour change

1. Narrative formats seem more effective to induce reflection and behaviour change
In this study, the use of narrative format seems to be more effective to achieve reflection and persuasion than graphical and numerical format. Participants using the website with narrative format were less resistant and more willing to change their behaviour than the participants from the mobile application group where the applications were mainly using textual description, graphical and numerical formats. However, due to the incompletion of data from the participants, it is not concluded that the effects of graphical and numerical format are truly weaker than the narrative format in inducing behaviour change. Moreover, some of the findings were contradictory due to diverse user backgrounds, contexts, perceptions and past experience, and so on. Therefore, further research on the persuasive effects of different user contexts is necessary.

2. Use of Ubiquitous technologies to display data for communication of risks
The graphical and numerical format could produce reflection and perception of risk provided that the data are available for displaying the graphics. The advanced development of Ubicomp and ubiquitous technologies such as pedometer or sensor
technologies embedded in the smart phones or wearable devices could help to eliminate the barriers in data entry by automatically collecting and storing the data of the users. Users can read the data about their activities which could not only help them to understand the relationships between their health and activities, but it could also communicate of risks. Since perception of risk seems to be a great driving force to change behaviour, with proper design, it can help the users more aware their adverse behaviour so to induce a change of behaviour. However, it should provide adequate suggestions and encouragements since solely perceiving a risk without adequate suggestions and solutions will produce stressed and emotional distressed.

3. Design communication strategies for easy interpretation of numerical data

Many studies show that people may have difficulty in interpretation of numerical probability statistics because of different levels of numeracy and dependent on the specific numbers used to illustrate a risk (Julian-Reynier et al, 2003). It is evident from studies that the perceived helpfulness of the information and the accuracy of perceived risk can be improved by combining visuals with numerical and written information (Lipkus & Hollands, 1999). It is also more effective to interpret the risk information by providing comparisons between the probability of different risks such as presenting of the normal blood sugar level compared with higher blood sugar level. Recommendation are also helpful for the users to take proper actions rather than just displaying of information. As suggested by Julian-Reynier et al ((2003), many people have difficulty in understanding quantitative information. Therefore, to provide with a broader information base using several presentation formats such as absolute and relative risks can help to improve the interpretation and the effectiveness of interventions. Furthermore, to provide training for the users to interpret the numerical statistics is also helpful.

9.11.2. Design principles and guidelines for persuasive systems

The research has identified several motivation attributes that are consistent with the proposed CBS Model of persuasive systems in Table 5.4., with slight modification. It
emphasizes that to provide content, behavioural and social support in the systems are essential to achieve sustain behaviour change. The model can be served as guidelines and also evaluation tool for the persuasive systems that motivate and promote health behaviour (Table 9.8).

Table 9.8.: The CBS Model can be used as design principles and guidelines for motivation and health promotion systems

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<thead>
<tr>
<th>Design Principles</th>
<th>Design guidelines</th>
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<td><strong>1. Content support</strong></td>
<td><strong>Content and information</strong> - the quality, the forms, and the source of information</td>
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<td></td>
<td>● <strong>Exposition</strong> - appropriate information - provide solutions - facilitate reflection - appropriate format</td>
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<td>Does it provide appropriate information to explain the situation?</td>
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<td>Does it provide solutions?</td>
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<td>Does it teach and educate how to solve the problems?</td>
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<td>Does it facilitate a reflection?</td>
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<td>Does the format suitable for the target user?</td>
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<td>● <strong>Credibility</strong> - trustworthiness - expertise - endorsement - authority - verification</td>
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<td>Does the information true and accurate?</td>
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<td>Does the source of the information credible and trustworthy?</td>
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<td>Does the system credible by the authority, expertise, and/or endorsement?</td>
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<td>Does it provide any proof?</td>
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<td>● <strong>Relevance</strong> - the information, skill sets, layout design, etc. are relevant to the person - the message and the product is able to meet one's need - tailoring the content and features</td>
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<td>Does the information and the design elements relevant and related to the users?</td>
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<td>Do the functions and features fulfill the needs of the users?</td>
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<td>Do the functions and features help the users to achieve their personal goals?</td>
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<td><strong>2. Behavioural support</strong></td>
<td>A. Persuasive techniques - techniques that help to direct the users to achieve their</td>
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<td>● <strong>Induction</strong> - goals direction - proper encouragement - praise or rewards - reminder</td>
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<td>Does it employ appropriate techniques to achieve goals?</td>
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<td>Does the use of techniques appropriate for this group of users?</td>
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<td>Does it provide proper encouragement?</td>
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goals - such as praise, rewards, suggestions, coach, goal setting, reminder, etc.

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<th>Provide benefits</th>
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<td>- Provide values, purposes, and benefits of using and acting</td>
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<td>- compare the results</td>
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<th>Prospect</th>
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<td>- promote realistic hopes and possible outcomes</td>
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| Does it provide praise or rewards to encourage the user? |
| Does it allow the user to set or unset reminder? |

| Does it provide the values, purposes, and benefits of using the system or behaviour change? |
| Does it explain why it is significant to change? |
| Does it provide examples to compare before and after the behaviour change? |

| Does it promote realistic hopes? |
| Does it explain the possible outcomes? |

| Does it convenient to use and easy to access? |
| Does it easy to use and operate? |
| Does it provide clear guidance to direct the users from one step to another? |
| Does it help the user to understand the process to accomplish the task? |
| Does it reduce the efforts for users to accomplish a task in the system? |
| Does it facilitate accomplishment of the tasks in manageable way? |

| Does it provide personalized and customized features to the users? |
| Does it provide flexibility for user to set their own goals and features? |

| Does it look attractive to the users? |
| Does it fun and pleasurable to use? |
| Does it able to induce emotional attachment? |
| Does it achieve emotional and intellectual satisfaction? |

| Does it promotes novelty and arose interest? |
| Does it responsive and interactive? |
| Does it constantly update the information or the content? |
| Does it provide appropriate challenges? |
| Does it help the users to know their progress of their activities? |

| Does it facilitate the users tracking the information of their own |

| B. Interaction factors - system design and features that help the users to achieve their goals - performance of the system |

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### 9.12. Summary of the Chapter

The research analysis of this part is focused on the user evaluation of two types of diabetes persuasive systems in order to discover the persuasive effects and the motivation and demotivation factors in system use. Both quantitative and qualitative data analysis were conducted in detail with inductive and deductive analysis in order to gain deeper insights and for triangulation.

For the persuasive effects, it showed that narrative format seems to induce more self-reflection, self-efficacy and positive thoughts. In contrast, the graphical and didactic formats produce less self-reflection and self-efficacy, largely due to the usability of the systems. Moreover, positive and affective experience are also shown to increase the persuasive effectiveness. However, the result demonstrates that the effects are only short term since both systems did not meet the needs of the participants and compatible with their lifestyle, and they perceived the tasks were too difficult to accomplish.
For the motivation factors of the system use, it identified many attributes to facilitate behaviour change. They include: *seek knowledge, trustworthiness, autonomy, perceived competence, provide instructions and guidance, attractiveness, system interaction, resonance, goal-setting*, and *physical social connection*. The content information was regarded as essential for the participants since it could increase their sense of locus of control of their disease. However, merely gaining knowledge from the content information may not necessarily affect behaviour change. Some additional motivators and enablers are needed to encourage in adopting and maintaining of the new lifestyle. Hence, both content, behavioural and social support are needed in persuasive systems. The results show that the motivation attributes and features are in line with the proposed CBS model, which can be a useful guidance for design of persuasive systems.

The study also identified other issues including the perception of risk and the relationships between user satisfaction and future of use. It was found that the perception of risk has great influence on behaviour change - the higher the perceived of risk, the more likely a behaviour will change. Nevertheless, the perception of risk is dependent on individuals. On the other hand, the study also recognized a deviant in quantitative results relating to user satisfaction and future of use. It realized that user satisfaction may not necessarily predict future of use, rather, the perceived benefits, pleasant experience, and how it relates to the users in terms of user values and meanings are more vital for future use.

Finally, the study also identified that contextual factors are influential to the persuasive and motivation effects, they include the internal state of the participants', the external environments such as social and physical environment, as well as the interaction between the user and the systems that creates user values in use. In the next part, I will discuss the use of a design prototype in research to uncover the user needs and values in system use. The contextual factors including context of use and user context will be discussed in the following chapter.
10. Phase 4 Research Analysis (B) - Design Prototype

10.1. Introduction of the Design Prototype

This part is to discuss the research of the design prototype and the findings. It will first explain the reasons of using design prototype in this research and the process of how the design prototype was developed, then discuss the finding of the research. It provides insights of the user perceived values of self-management systems, which assists designers to develop more effective and satisfying systems for self-management.

10.1.1. Why use design prototype in this research

The reasons of using design prototype in this research have two-fold: 1) to supplement the shortcoming of previous research methods; and 2) understand the user values of self-management systems.

1. To supplement the shortcoming of previous methods. Since the previous research methods focus on two types of existing diabetes systems, which could provide understanding of the usability and experience problems of the existing systems, then inform for future improvement and development. Nevertheless, these systems did not provide the answers of ‘why’ the users want to use the systems in the first place. As discussed in the literature review (Session 5.5) that values and meanings are what motivate people interact with the products/systems, and maintain the interaction in the long run (Cockton, 2006; Hassenzahl, 2010) since they are the needs and wants of the users that drive the interaction.

2. To understand the user values of the self-management systems. According to Cockton (2006), the field of design is moving from focusing on usability to investigate the needs and wants so as to identify unmet needs and develop innovative design solutions to achieve intended worth or values. He contends that the value of the product/service affects the enduring interaction and it is more important than the usability, fit to context, and inherent qualities of interactive systems.
In this regard, to provide design prototype in research helps to gain more insights from the participants concerning their needs and values to inform future design of these kinds of systems for self-management and achieve long term behaviour change.

The use of prototype in research is a tool that helps to understand the user needs and values of the system as the users participate in co-design process. It is derived from the concept of participatory design that users are the experts of their experience and they play an active role in the design process (Visser, Stappers, van der Lught, & Sanders, 2005). This is a methodology that employs novel ideas to trigger and encourage people to consider the future by using images, which assists users to think more freely and creatively so their wishes and ideals can be disclosed (Brusberg & McDonagh-Philip, 2001). According to Suri (2003), to understand the user's thoughts, dreams and aspirations are more important than solely inspiration, since to know the inner states of the users is the most vital aspect of user-centred design. The aim of the prototyping of this research, rather than as a means to observe users' behaviour, is used as an "aid for imagination" (Kurvinen, Koskinen, & Battarbee, 2008, p. 47) to explore the user needs and values of the design.

By using the approach of probing, the users discuss their feelings, attitudes, experience, and to visualize their actions and contexts through the introduction of the prototype, which can help to discover their latent needs and desires. Tuulimattelma (2005) has identified four reasons for using probes in research: 1) to provide inspiration to the design team; 2) to obtain information of the participants; 3) to promote participation and; 4) to facilitate a dialogue between the participants and the design team. The use of probes can also help to develop empathetic insights of the designers or researchers that is essential in developing human-centred design (Mattelmäki & Battarbee, 2002; Tuuli Mattelmaki, 2008).

According to means-end theory, product attributes is a means for consumers to obtain desired ends, that is, the perceived value results of these attributes, which can determine if the products will be used (Gutman, 1997). Hence, to use a mean-end
approach enables the researcher to understand the user's deeper beliefs, meanings and perceived values by digging underneath the users' surface knowledge about the product attributes and functions of the products or services (Gutman, 1997; Nurkka, Kujala & Kemppainen, 2009). It can use the technique "laddering" in the interview by probing the participants why something is important to them so the researcher can find a link between the key perceptual elements of the product attributes and perceived values and meanings (Nurkka, Kujala & Kemppainen, 2009). This study used a design prototype as a probe for investigating the users' needs and values in health preventive systems.

10.1.2. How the design prototype was developed

The design prototype was developed according to the concept of self-management systems (Session 2.3.5), theories of motivation and psychological well-being (Chapter 3), as well as considering the findings from the surveys and interviews in Phase Two (Chapter 7).

First of all, according to the literature review on Session 2.3.5, the major objectives of self-management system should focus on: to monitor health, to manage health, and to promote health, with promoting health as the primary goals. Hence, promoting health with motivation of health behaviour is vital in self-management systems. From the literature review of motivation and health behaviour change theories, motivation and psychological well-being rely on fulfilling of self-detemination (autonomy, competence, and positive social relationship) and self-efficacy is essential in behaviour change. Hence, the design strategies of the systems should be focused on achieving these goals.

Secondly, from the research finding of Phase Two (Chapter 7), it was discovered that people with diabetes are generally having problems in diet control and doing physical exercises, as well as recording blood sugar. Hence, the system design should also provide tools and features for users to accomplish these tasks.
Thirdly, as the growing matured of the wearable and ubiquitous technologies, it is becoming easier for the people with diabetes to monitor their health and understand their health conditions.

Based on the above, a design prototype was developed with comprehensive attributes and features by the researcher to provide supports in these areas. The concept of the design prototype was drawn from the CBS model that was integrated with the content, behavioural and social aspects. It is aimed for providing knowledge to increase self-efficacy, motivate behaviour change, as well as facilitate social influence and support. Due to a limitation of time and resources, the design prototype was only use paper prototype in the research. As the main purpose of the design prototype was for probing user needs and values, the interaction and usability aspects were ignored in this part of study.

The design prototype was displayed in the form of PowerPoint on an iPad and it was shown to the participants after their post-use evaluation interviews. The participants were explained the attributes and features of the proposed system, and they were asked about their likes or dislikes, as well as their views of the prototype. Since one of the post-use evaluation interviews was conducted by telephone and it was not able to show the visual design to the participant, so only twelve participants were interviewed in this part of the research. Each participant took about 20 minutes to more than one hour in the interview and they were all audio-recorded.

I will first describe the design features and attributes of the prototype, followed by the findings of the in-depth semi-structured interviews, then the analysis and discussion of the findings. Finally, a general discussion of the Phase 4 research, including the quantitative and qualitative research, is provided.

10.2. Design Features and Attributes of the Prototype

The prototype contained multi-levels of features to support different aspects in self-management (Figure 10.1). It surrounded the concepts of three major areas:
providing information, facilitating behaviour change, as well as supporting social connections, as these are important factors in self-management. To support multi-channels of interaction, it included a website and a mobile version for different users. A watch-type of wearable monitoring device was provided for users to wear on their wrist to check vital signs such as heart rate, pulse rate, blood pressure and blood sugar. A pair of shoes sensors can also record the users’ health and activities. All the data can be transmitted to their computer or smart phone, their family, and/or healthcare providers.

Figure 10.1. The components of the design prototype system
Figure 10.3. My Diet (Nutrition information)
Figure 10.4. Shoe sticker sensors (Information can be stored and send to different devices and stakeholders)
Figure 10.5. My Friends (Social support group)

Figure 10.6. My Friends (shoe sensors to notify the activities of friends)
Figure 10.7. System architecture of diabetes system prototype
The system included three main design objectives: \textit{to manage}, \textit{to monitor} and \textit{to promote health}. Instead of focusing on providing logging functions, the design stressed on promoting and supporting healthy lifestyle and assisted with monitoring and managing features for the users to control their health. It aimed to increasing the knowledge of healthy diet, exercise, and self-management tasks, while motivating them to perform the desired behaviour by hedonic features and social supports with the aids of technologies. The system is also intended to integrate the different self-management tasks into one to make it more convenient to use. The main features of the proposed diabetes management system are shown in Table 10.1.

\begin{table}[h]
\centering
\caption{Main features of the proposed diabetes management system:}
\begin{tabular}{|l|}
\hline
\textbf{Managing} \\
\hline
\textit{Health information} \\
\hspace{1em} Information about food, nutrition, and exercises. \\
\hspace{1em} Information about health news. \\
\textit{Health record (My Health)} \\
\hspace{1em} The health records about blood glucose, blood pressure, cholesterol, and weight can be stored on the phone or website. \\
\hspace{1em} The records can be transferred to their private physicians, caregivers, health care providers and family members under strict privacy measures. \\
\hline
\textbf{Monitoring} \\
\hline
\textit{Help emergency alarm} \\
\hspace{1em} For user to seek help if needed. This feature is linked to emergency centre which connects to the hospitals and physicians, so if they receive help signals, they can act quickly to rescue the patients. The rescue people and health care professional can check the patient’s historical health records so that they can provide necessary treatments for them. \\
\textit{Reminder} \\
\hspace{1em} A set alarm to remind the user when, what and how many to take their medications. \\
\hspace{1em} A set alarms to remind the user to take blood sugar tests. \\
\hspace{1em} Appointment reminder to remind them the appointment with their doctors. \\
\hline
\textbf{Promoting} \\
\hline
\textit{Diet control (My Diet)} \\
\hspace{1em} Provide diabetes recipes everyday and change every week. The users can also check the recipes in the past and mark their favorites for future reference. They can also share their comments with the others. \\
\hspace{1em} Check the food calories and nutrition from existing list or individual item calculation. \\
\hspace{1em} The food intake can be recorded. \\
\textit{Exercise and weight management (My Exercise)} \\
\hspace{1em} Information about the relationships of exercise and food intake. \\
\hspace{1em} The user can use a sensor similar to the 'Nike+ Sportband' to monitor their heart beat, blood pressure and even body weight. \\
\hline
\end{tabular}
\end{table}
Managing features included medication information and reminders for medical appointments, taking medication, checking blood sugar and doing physical exercise.

Monitoring features included blood sugar, blood pressure and vital signs records; a sensor technology underneath the shoe pads to monitor the health conditions and activities. The users can keep the records in their own device or on the website, or transmit their records to their family or healthcare providers under security measures. According to the interview on Phase Two, diabetic patients could experience sudden health condition change such as hypoglycemia, so to provide emergency supports was necessary for them. The system provided an emergency call that could connect to the hospitals, healthcare providers, as well as their family members.

Promoting health features consisted of features that provide food information, encourage physical exercise, as well as facilitates social connections. The detail description of how to employ these features to promote healthy behaviour is discussed in the following.
a) **Food information** - Knowledge and information is vital in self-management. The system provided food information such as calories and nutrition that were most commonly consumed by the Hong Kong Chinese, including those commonly offered in canteens and restaurants. Healthy diet recipes were also offered to suggest healthy choices for them.

b) **Interactive games** - Some interactive games in the form of entertainment persuasion were also included since using games was found to be an effective way for motivation and promoting health behaviours (Lo et al, 2007; Grimes, Kantroo & Grinter, 2010; Deterding, 2012). The health games were used as an entertainment-education message to increase the users' knowledge of the disease and self-management. It could also consider using games and rewards to motivate them to do more exercises and check blood sugar.

c) **Shoe pad sensors** - To encourage physical exercise, sensors were attached underneath the shoe pads to automatically record the physical activity data and health data of the users such as their heart rate and respiration rate, as well as their energy consumption. The sensor is a kind of Ubicomp tools to collect personally relevant data which serves as personal informatics helping people to gain more knowledge about the relationships between their health conditions and their activities. These kinds of personal data could be used for self-reflection to assist people to become more aware of their own behaviour and lead to behaviour change (Lin et al, 2006; Li, Dey & Forlizzi, 2011).

d) **Social support group** - Social influence is found to be crucial to motivate physical exercise (Far, Silveira, Casati, & Baez, 2012). So the system was built in a social support group for the patients to include other diabetic patients to support and encourage one another. To facilitate connections between peer groups without travelling, users could connect remotely with their peers through their wearable device or smart phone using real-time displays and connection. They could invite other members to do exercise together in their own nearby environment without meeting physically, but still feel that they were doing exercise together since they could also
chat with each other while doing exercise. The concept was to eliminate the transportation time and money with the purpose of encouraging more exercise by reducing the costs of travelling. A healthcare provider was also included as a facilitator to monitor the patients in non-obstructive ways so as to provide adequate feedback if needed.

e) Reminder - Finally, it consisted of reminders for assisting the users to adhere with the medication treatments or the goals they set for themselves such as doing exercise and checking blood sugar. They could choose to set their own reminders and terminate it in their own decisions.

The following section discusses the findings of the design prototype.

10.3. Findings and Discussion

It was discovered that the preference of the participants was quite diverse, although some of the preferences were more popular than the others. In general, the participants welcomed the design. Some participants regarded it was quite comprehensive and could be useful if it was an integrated system including all other data in one. However, two participants, especially the older ones, regarded it had too many things in the system and it required them to do too many tasks so it increased the pressure in their lives. For them, the system was considered as a burden instead of assisting tool for self-management.

When asked which features they favored or perceived as most beneficial, most of the participants regarded that the sensor attached underneath the shoe pads was most useful to them, followed by the food information parts and medication information. It was also found that the idea of remote connection and the members of the social support group had quite diverse opinions. The most important findings of the research are discussed in the following.
10.3.1. Sensors underneath the shoe pads

Almost all patients welcomed this feature, especially it could record the data automatically without too many efforts on their sides. They regarded that to recording the data of their health and activities was helpful, the reasons include: checking progress, gaining knowledge about their activities and health, keeping historical records and monitoring. They considered that it could helpful if they could check their progress and health conditions, it could also motivate them if they knew how their activities related to their health conditions. The finding was in line with previous studies that personal informatics could help to promote self-reflection (Lin et al, 2006; Li, Dey & Forlizzi, 2011). Besides of using the data as self-knowledge, one participant also mentioned that it could also help the others to monitor their health when they were weak and needed assistance.

CU: "I think it’s quite good. For example, it can record how much you walk, no need for me to enter it myself. I think it could have more motivation to me, at least I don’t need to do a lot of pre- and post- works. If I can read it later, for example, if I know that if I walk half an hour then I can burn how many calories, it would be helpful. But I’m not sure if I can do it."

LG: "Yes, it’s useful because I can check it any time I want. Since sometimes when I went hiking, my heart was beating very fast. I prefer to go hiking once a year. My friends can walk on a very steep mountain, but I have to take a rest from time to time. ... I can check it. How long does the record keep? It’s better to read it year by year, and you can delete or print it out to keep records."

TG: "The stickers in the shoes are good. Because I’m getting old, we need more data, it can help ourselves. But it may not useful when it goes to a certain level, since you can’t walk. ... It’s necessary when getting old."

Some participants also raised a concern that it was not useful if they were swimming as it could not record the vital signs and calories burn when it was only attached to the
shoes.

LE: "Yes, it's good, but it can't be used in the water. Because swimming is also an exercise, but I can't set it up! I don't know the pulse and others."

The use of ubicomp technologies by automating data collection seemed to be generally accepted by the participants as a recording and monitoring function for their health conditions. Knowing how their activities related to their health could generate self-reflection, increase self-efficacy, as well as a sense of locus of control since it allows them to take necessary actions to better manage their disease. The automated data capture rather than manual data entry could reduce the burden of data collection and increase motivation in system use. However, whether the automating data collection will sustain the motivation to engage in self-management is unknown and needs to examine in the future.

10.3.2. Food information and recipes

Many participants regarded that the food information was very important for them. The food nutrition could help them to know which kinds of food were suitable for them, and it was especially beneficial when they were eating out, this feature could help them to check it from their smart phones. Some of them, especially female participants, found the recipes very useful for them and they could have more choices in cooking delicious food for their family instead of just offering them plain and tasteless meals.

CU: "I like the recipe part, since I only eat very simple normally, the food is just plain, not necessarily attractive food. If there're recipes then they help me to know that actually some gourmets can be very delicious, very simple is helpful. It's better to design it in simple and delicious ways, then I don't need to cook vegetable every time."

Some of them expressed a concern about the reliability of the food nutrition information and whether it was up-to-date. One of them also suggested providing
healthy food restaurants data. Nevertheless, one participant rejected the healthy recipes since he thought that they were only for people who have poor health and needed to strictly control their diet:

TG: "This is only suitable for people with poor health, only suitable for people who need to count what they eat. (Researcher: Do low sugar and low calorie recipes useful to you?) If those people are fat, they need to lose weight, and they eat a lot, then it needs to be kept monitoring. If you're fine then no need. ... You know it yourself, just don’t eat like normal, then it's OK. Honestly, if you work more, then you eat more .... If you don’t work much then you eat less. I won't use it myself. Because as far as I know I got diabetes, I lost dozens of pounds, it's just simple as that."

The study shows that the perception plays a significant role to determine if the patient are willing to engage in self-management. The attitude of technology use is also essential since some of them did not regard technology could help them and they rather considered it is more about one's own will power and self-determination.

10.3.3. Healthcare providers and social support group

It is interesting to note that participants have quite diverse feedback of this idea, especially about the type of group members of the support group. It is also discovered that ages and genders may affect the attitudes of doing exercise and having supportive group.

10.3.3.1. Social support group

Some of the participants regarded that the support group was helpful and if the group members were diabetic patients, they would understand their situation more than other people who do not have the disease, so they could share their information and experience and encourage each other.
TG: "It's good to have diabetic patients, the ordinary friends don't care! Diabetic patients can share their information and experience."

CU: "But the friends are better to have the same disease, we have the same needs, otherwise, it won't have great effects. It's better they're also people with diabetes, we can encourage each others, just a common friend may not be very helpful. If they're common friends, then it's better to have friends who like to do exercise. But I don't have a friend who likes to do exercise."

However, some participants rejected the idea that the group was only available for patients since they reckoned that it was not easy to find so many diabetic patients, and it was more fun doing exercise with their friends. One participant even strongly disregarded the idea of only including people with diabetes since he thought that doing exercise is not only beneficial to the diabetic patients but also for everybody including his family and friends.

LI: "We can do exercise, whether you have diabetes or hypertension or not, no need to do it with all the people with diabetes. Besides, there're not so many people with diabetes to do exercise at the same time at the same place. We should go together to do exercise, no matter if you have diabetes or not, no need to restrict to patients. Your family and friends can go together."

LI: "There's no need to do exercise with all the people with diabetes. I think it's not necessary. Doing exercise is not an encouragement, it is good for the health. You want to encourage your children, your wife to do exercise, not necessarily only people with diabetes, it is necessary for everybody."

Some participants also scrutiny about the rapport with the other patients in a group since they may lack of trust with each other if they were strangers, or they may not have common interests.

PW: "It depends how many rapports you want to get, for me, it's not that
relevant. I think it's quite individual base, unless the person knows you very well. If they're not and only a group of 'Free to join" people, it depends on how much interest. ... This is to say if they're all diabetic patients and have joined this group, it depends on if they've known you well or not. If they're not, then if you need to go with people you never seen before, will you willing to go? What do you base on to build that trust? It may if you've known them well."

LA: "... many elderly men and women can't motivate me to talk with them because we can't resonate with each others, we are in different level."

In general, many of the participants prefer a mixture of patients and their close relatives or friends. It is in line with the previous stage of research that they prefer people who were closer to them rather than strangers. They concerned that having the other diabetic patients in the group may not help if they do not like to do exercise. Rather, **having their family and friends in the group can motivate and support them.**

MP: "I think it's OK to open it for public. There're also diabetic people in the open group. There're some people don't do exercise spontaneously, if there's somebody else, then we can do exercise together. Since I have many friends who don't have diabetes, if he (her boyfriend) wants to support me, then he can't enter it."

NG: "Of course it's better to be mixed! Because some people may not have diabetes but they want to enter. Or some people don't have diabetes, but their family members have. Their family members may not know how to use it, then they can help their family members. It's for everybody." ...."It can encourage to each other, then everybody is healthy. It's better than only do it by yourself, many older adults also being by themselves.... If they're not older adults, they don't have this disease!"

LE; " If it's specially for diabetes, then of course it's better they're patients. But if it's especially for other people or other types of disease, in order to prevent other
diseases or encourage for doing more exercise, then both are needed. But I find that there’s very few friends of mine like to go swimming."

Although many studies consider using patient self-help group is useful for building mutual supports and set examples of the other patients (Korl, Sanderman & Suurmeijer, 1993), this study shows that it may not be the whole true. It seems that the idea of building a supportive group only including patients requires a more careful examination. It may be because the identity of 'patient' has negative connotations and people do not like to be identified as one, and they desired to be included in the society as able people. It is in line with previous studies by Harris, Waschull and Walters (1990), Molinari and Riva (1995), as well as Wilkinson (2008) that the patients in their research saw other patients negatively, and they may be ambivalent to people in a similar group. For instance, a study of Molinari and Riva (1995) showed that the obese participants generally rejected to be associated themselves with and seen by others as other service users. They accepted the label as patient as they described they were ill, but it was not necessarily considered it as permanent identity. They also identified themselves in the groups of families and friends rather than the other service users, thus, it could allow them to maintain a more favourable self-identity. People with diabetes are in many ways living as abled people, and looking like abled people, excepting that they need to be under long term medical treatments. Hence. they demand a more positive self-identity to differentiate themselves from the negative connotation.

On the other hand, although they conceived that people having the same disease could be more understanding and able to share information with each other, the issues of trust and rapport play more significant role. According to Social Identity Theory, a social identity is a part of an individual’s self-concept derived from the perceived membership in a relevant group (Turner, John, Oakes, & Penny, 1986). The sense of belonging to a particular group is an important source of pride and self-esteem (Tajfel, 1979). The support from their family and friends and to have a normal social life seems to be more important for their social well-being. As noted by Wilkinson (2008), "As participants reported feeling vulnerable and helpless it may be that social identity was
most salient in order to gain or maintain membership within a powerful or valued group allowing a positive self-concept." Therefore, in the future of designing this kind of systems and other caring model, it is necessary to educate and involve the family and caregivers to build empathy and understanding of the patients so as to provide a better caring service. It is also noted that an inclusive society requires a mutual understanding with one another by eliminating the barriers between the abled and disabled.

10.3.3.2. Remote connection with others

The concept of remote connection is also obtained diverse answers. For example, a 69 year old male participant thought that this kind of remote was not suitable for older adults since it was too troublesome and time-consuming for them. The older adults would just go to the park nearby their home and gather with their friends and other people to do exercise. Since they like to hang around with people in their neighbourhood rather than friends who live far away. Hence, their circle of friends and living environment affect their motivation in doing exercise.

For him, he preferred doing exercise by himself and go to the club house in his estate rather than the park since he thought that those people were not in common with him. On the other hand, his reason for not doing regular physical exercise since he considered that usually those people need to do exercise regularly had experienced a serious illness, it would be detrimental to them if they do not do so.

LA: "(Researcher: Do you do exercise regularly?) Very few. Usually people doing exercise are those who experienced a serious sickness, they’ll die if they don’t do exercise! I’m an exceptional one since I focus all my energy into web site design. .... I know my body is not good...."

Denial and excuse as it seemed, people were motivated by things that were more meaningful and provided higher values for them.
In contrast, a 40 year old female participant thought that this feature has been useful for her since knowing someone similar to her living nearby would be encouraging. She could also invite her friend who lived far away from her to do exercises together remotely. This kind of interactivity seems to be more motivating for her.

MP: "It's good! For example, if you know there's somebody who's similar to you living nearby. (Researcher: How about doing work out in a distance?) It's good. Actually, this one is not only for people with diabetes, it's good for others too. I can introduce my friend, for instance, she lives in Kwai Fong, and I live in... We can make an appointment, but not necessary come out together, we can do it near our homes, and it can be more interactive."

This finding demonstrates that social supports are more complicated for Chinese older adults than the younger generations who are accustomed to use social media and digital technologies in communication. They have different communication needs and patterns than the younger generations. Moreover, some people like to do exercise solo or with very close friends rather than with a group of people, it seems especially true for the male participants. The social relationships, the communication needs and patterns require to be further investigated to gain more understanding how the use of social influence could motivate exercise and other behaviour.

10.3.3.3. Healthcare providers

The concepts of the role and responsibilities of the healthcare providers in the group is also differ. In general, the participants welcomed the idea and they thought that the healthcare providers are more professional as they possess medical knowledge, who can act as a consultant to provide advice and suggestion, or as a coordinator to coordinate with the other members, he could also monitor, remind, as well as induce positive thinking to the patients in the group.

NG: "He's the consulting part.... It's always good to have a leader! If we have any question, we can ask him. Case manager can help you to answer your
questions. .... Good! If not, then where do people go to when they have questions?"

PW: "Yes, because if there is a case manager who acts as a consultant, it will interact with others, it will have advantages, it can act as a coordinator. Or it does not necessarily he acts as an advisory role, but one of the patients can be a coordinator, who can give some suggestions. He can be quite experience and has a role to take. If there is a person who has medical background will be much more recognizable, he can monitor the group."

LE: "... at least it has someone to remind other patients, to give positive and proactive thinking to them."

A participant thought that having a healthcare provider in a group was important since solely gathering other diabetic patients in a group would be no cohesion and it had no meaning for him.

PW: "I think that the most important thing is to know what the reason of doing it. If there's only people with diabetes gathering together, there's no cohesion, then it's no meaning. If there's a case manager, then it can be more useful."

However, two male participants disliked the idea since they thought that if the healthcare provider was monitoring them, they would lose their autonomy and would be under controlled.

TG: "If it's for people who don't move, then it's good. But I don't like to be monitored. I don't need it now.... I don't like to be controlled."

The study shows that to have a healthcare provider in the supportive group is important since it provides a sense of security and confidence to the patients. However, the participants regarded that the role of healthcare providers should be rather a passive one - to give advice or remind them if necessary, rather than take too much
control of their lives. Hence, it should be more careful to consider and apply the concept of healthcare monitoring in the system so as to avoid a sense of invasion and being controlled.

10.3.4. Games

The concepts of applying gamification in the system also differ among users. For example, some participants felt excited with the ideas of using games and rewards, they regarded that it would provide a higher motivation to use the system since it would be fun, relaxing and encouraging.

MP: "I think it's interesting, it's useful because I can be relaxed. Since my sickness already made me feel.... I can't say unfortunate, it needs to be self-disciplined. Because I saw many apps are only allowed for data entry. But if there's some games to play, for example, this one adds that one will expose.... then I get the scores! I think it's fun!"

NG: "It's encouraging. You can launch some events and have rewards. If people get how many points, then they can go to travel for free, it's organized by groups, or the association organizes it. To have how many points and discount, then it's attractive! Then you'll doing harder, and get more points."

However, some thought that it was not particularly useful and did not provide encouragement to them, and they were not motivated by monetary rewards. They thought game was only a tool, it was not the main purpose they use the system.

TG: "It's good if it's necessary. But if I need to check more (blood sugar), I'll spend more money, then I'll get more pain, so it's equal off!"

LE: "If you want other people to be more active, it's useful. For me, I don't really care, it may be useful for other people."
One participant even rejected the idea and he said he would not use it if it was a game-like system:

PW: "I don't think (game) is a great drive for me. I think that health is more important than these things. I think there's not many incentives for me to use this thing." ...."You know your health by mainly reading the data. Since you have coped with the situation, that's why using a badge or not is not.... A patient's psychology is not using this kind of things. I don't think that it's a good method to motivate them, to achieve their health purposes."

It was found there were different goals of these two groups of patients. For the first group of patients, the main drive for them was to "remaining in a relatively healthy state" and the use of the system was to allow them to gain self-knowledge by tracking their health records, so that they could control their health more effectively. In contrast, MP and NG as another group of patients who preferred the game-like system and their main drive was to "making the tasks seem more interesting and less difficult to achieve", reading the graphs and historical records provide less meaning for them, so if the system was entertaining and providing rewards could motivate them to use the system.

The differences of goals of these two groups of patients may be explained by different needs and motivations in different phase of coping and behaviour change. It is worth notice that the former group of patients had diagnosed with diabetes for more than 5 years, some even longer, but MP and NG had only 3 - 5 years of diabetes. Li and his colleagues (2011) found that people's information needs changed in two reflection phases - the discovery and maintaining phase. People in discovery phase are more concerned in understanding the relationship between their health and activities, while people in maintaining phase are more focused on sustaining their health and behaviour. In this research, it seemed that the former group of patients had developed strategies to cope with their situation, so maintaining health was intrinsic motivation for them and it was the value they perceived of this kind of systems. The latter group of patients, on the other hand, were still exploring and trying to cope with their
situations.

It was also possible that the former group of participants was using *problem-focused coping strategies* to deal with their situation and they had higher involvement and motivation in sustaining their health, by contrast, the latter group of participants were using *emotion-focused coping strategies* and had lower involvement in managing their health. Due to the scope of the study, this study will not dig down for this issue, however, it shows that different coping strategies and levels of involvement may affect the goals and motivation of the system features. For instance, since the former group of patients have higher involvement and motivation in maintaining their health, their purpose of using the system was mainly pragmatic goals - to help them to sustain their health. On the contrary, the latter group of patients pursued more hedonic goals - to motivate them to engage in tasks that perceived as difficult to achieve. It supports the ELM and previous studies that it should use different persuasive strategies in system design for self-management to promote and sustain behaviour change (Pelletier & Sharp, 2008).

**10.3.5. Medication information**

Most of the participants regarded that medication information such as the effectiveness and side-effects are important for them since it is closely related to their disease, these kinds of information can help them to take control of their health. For example, one participant thought insulin injection is the "panacea" that can solve all the problems and prevent complications derived from diabetes. They also required updated information of medications. One participant even suggested that it should be developed for physicians since when they have gained more knowledge, they can treat their patients better.

The finding is similar to Wilkinson's (2008) study that if the participants hold that medication is the only form of treatment they may perceive other inventions as the only forms of assessment or they would consider that it is meaningless to perform. Since medication was perceived as the vital part of treating their disease, some of them
did not perceive doing exercise or controlling diet as very necessary for them. For example, they did mention that they were careful with their diet or do some physical exercise, but considered them as only as forms of assessment to their disease.

However, one participant confessed that she did not take diabetes medications on time, she would rather more adhere to hypertension medications. Since she thought that the risks of hypertension such as stroke was more serious than the risks of diabetes, and she could control the diabetes by herself.

MP: "The worst is that I think if I take the med., I'll have to take it the rest of my life, this kind of thinking is like engraving in my heart. I feel that hypertension is more serious, because people scared me that if I don't take the hypertension drugs I'll suffer from a stroke. People scared me if I don't take the diabetes drugs then I'll develop eye problems, will lose my legs. But I feel that losing my legs and glaucoma are quite far away, because having stroke, stroke can happen during 30 something years old, it can happen during 40 years old, this makes me more nervous, and have a higher awareness, so I can't miss it. I'm getting more nervous recently, because we're all in poor energy, it's dangerous if the blood pressure is high." (Note: Her mother was in the hospital due to the complications of diabetes)

It is worth noticing that she had already taken the self-management classes and she should understand the risks of diabetes. However, it showed that the perception of risk level may be more important for people to take action than solely provide information alone to influence behaviour change. Furthermore, it is also found that the participants who were diagnosed with diabetes for a longer time concerning more with the medication than the newly diagnosed participants. It may be because the newly diagnosed participants thought that they could control it using other means of intervention such as diet control or doing exercise.

10.3.6. The most important attributes and features in the system
In the final part, the participants were also asked what attributes and features they considered as most important in this kind of self-management systems. The interview findings were consistent with the questionnaire that the participants required "simple and easy to use", "timely and convenient", and it can "enhance their knowledge about diabetes and self-management" by providing new and updated information, especially medication information. In addition, "reliability", "accuracy", "customization and personalization", as well as "centralized and integration" were also found to be important features in this kind of systems.

Many participants also required that the system could record their activities since these kinds of data help them understand their health status and how their activities such as diet could affect their health.

Finally, some participants also concern about the cultural issues, they prefer more international languages and food information. One participant also suggested to provide information such as how to handle diabetic feet, which exercise or sport will hurt, etc. The comparison of the questionnaire results and interview is shown in Table 10.2.

Table 10.2.: Comparison of the questionnaire and interview results of the important features of self-management systems the participants preferred

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple and easy to use</td>
<td>Simple and easy to use</td>
</tr>
<tr>
<td>Timely and convenient</td>
<td>Timely and convenient</td>
</tr>
<tr>
<td>Enhance knowledge about diabetes and self-management</td>
<td>Enhance knowledge about diabetes and self-management</td>
</tr>
<tr>
<td>Customization and personalization</td>
<td>Reliability</td>
</tr>
<tr>
<td>Aesthetics and pleasant to use</td>
<td>Accuracy</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
</tr>
<tr>
<td></td>
<td>Customization and personalization</td>
</tr>
<tr>
<td></td>
<td>Centralized and integration</td>
</tr>
<tr>
<td></td>
<td>Culture - trilingual, international</td>
</tr>
</tbody>
</table>

Many patients regarded that aesthetics was not important to them, they rather
concerned more about the practical aspects such as convenient and easy to use. Nevertheless, another patient who had less than 5 years of diabetes, stressed that it should be fun, attractive and aesthetically appealing. As indicated in the above, patients with higher involvement may be more concerned about maintaining their health with the aid of pragmatic features, patients with lower involvement are rather more motivated by hedonic features. However, many studies have argued that aesthetics is related to the perception of self (Tractinsky & Hassenzahl, 2005; Hekkert & Leder, 2008), usability (Tractinsky, Katz & Ikar, 2000; Hassenzhal, 2004, 2008; Lavie & Tractinsky, 2004; Norman, 2004), and quality (Tractinsky, 1997; Tractinsky et al, 2000; Norman, 2004). As noted in many studies, participants usually stated usability as the primary reason in system use rather than aesthetics, this aspect is required to use other research method in the future study.

Other findings showed that all of the participants did not consider the importance of social aspects in this kind of systems. It echoes with the previous interviews that most of the participants in this research did not use virtual community for social supports. It may be because of the cultural norm that sickness is a personal matter for Chinese people, especially the older generations.

The research also discovers that although each of the participants had their own preference, one distinguished theme was found - autonomy, that is, it allowed them a flexible, freedom of choice, and personalized information and features that matched with the participants' wants and needs, especially amongst the male participants.

HD: "I hope to find other websites like this kind, I have more choices, and it can deliver the best results." (website group)

LU: "The system can allow me to make my own way, it has schedule, it has guidance, it can give you advice of which items and what to do with it etc. It can be customized, if we enter our information such as age, job, and time, it can provide personalized suggestion. ..." (mobile group)
It is in line with the research of Kalyanaraman and Sundar (2006) that customization can affect the attitudes toward the website. They found that if the website provides greater customization, the attitudes towards the site are also more positive. The higher the individualized information that matches with the users' stated preference, the more significantly positive attitudes are compared with the control version where none of the users' stated preference was matched with the information provided to them. In addition, they also found that perceived relevance and perceived involvement also substantially related to the tailoring levels and attitudes toward the portal.

In the agency model of customization, Sundar (2008) contends that customization, as self-as-source, will motivate greater engagement with content which can lead to positive attitudes since it relates to a positive sense of self and self-identity. The model proposes that technological variables such as interactivity, modality and navigability enhance a sense of user agency, which will increase content attention and results in augmenting the user's experience and effect. Furthermore, by enhancing users' ability through customized interaction can shape individual identities, which will generate positive affective responses and attitudes toward the website.

All in all, to provide customized and personalized content and system features can produce more satisfying and pleasurable user experience resulting in increase of motivation and involvement. Since to supply choices and the opportunities for self-direction enhance intrinsic motivation and create a sense of autonomy that is critical for psychological well-being (Ryan & Deci, 2000). Moreover, to provide tailored messages in the content and features for different users can help to internalize the reasons of the desired behaviour which produces self-determined motivation and influences behaviour change as well as maintenance behaviour over time (Pelletier & Sharp, 2008).

10.4. User Needs and Values in Diabetes Persuasive Systems

Values and needs can direct and motivate behaviour since they are goals and needs important to the individuals that guide their lives and behaviours (Schwartz, 1994;
Kujala & Väänänen-Vainio-Mattila, 2009). The user values of the system determine if the users will use the product or service over time since it should be perceived as helpful to achieve their goals. Cockton (2004b) has specified that designers should understand the stakeholders' values they hold in a system and then deliver these values to them. While values and needs, sometimes are not explicit, the use of mean-end approach by using product attributes in design prototype can help to discover them.

Through in-depth examination from different stages of the research and the design prototype, the users' needs and values of diabetes system can be identified into six categories. They are **pragmatic, self-reliance, incorporation, hedonic and affect, trustiness, and social relatedness** (Figure 10.8).

**Pragmatic values**

Pragmatic values are values that meet the utility needs. They include: *usefulness, ease of mind, ease of use, and economy in use*. **Usefulness** refers to the system features that are perceived as useful and beneficial. Perceived of usefulness is one of the major reasons for long term use. However, perceived of usefulness can be differ individually. In this study, many patients revisited the website since they wanted to obtain useful and updated information. Information need seems to be vital for some patients in the study. Moreover, providing advice and solutions are also considered as useful. **Ease of mind** refers to the security needs and a sense of reassurance due to possible sudden health conditional change. Hence, a system that supply with emergency, reminders and warning signals could help the patients to feel ease of mind. Centralization of information is also considered promoting ease of mind since the information can be integrated for easy to extract and reference. **Ease of use** refers to the usability of the systems. Simple, easy to use, and convenient are essential for saving time and efforts to perform. Finally, self-management can be costly for diabetic patients, for example, checking blood sugar every day, so the **economy in use** is also an essential factor for long term use.

**Self-reliance values**
It was found that the participants demanded a high level of self-reliance that are related to self and self-worth. They include three subsets: autonomy, self-knowledge, and identification.

To support autonomy was very important to the patients as when they feel a sense of locus of control of their health and environment, it can enhance their psychological well-being. They also demand a system that provides flexibility and freedom of choice, as well as personalization and customization features that suit their needs.

Self-knowledge is significant since learning new knowledge and knowing their own health condition can increase self-efficacy and help them to know how to control their disease. They need to learn the relationships between their activities and their health by tracking their health data so that they learn how to control and manage their disease. Learning and seeing progress are innate human needs for self-growth and development. Increasing knowledge that relates to their health therefore is intrinsic motivation. The information needs are, however, different for people in different stage of coping and behaviour change.

Identification refers to the self-concept of their self-identity and sense of self-worth. From the interviews, the patient's sense of self and self-identity was found important to their psychological well-being. They showed some psychological struggles with their identity as 'patients'; and between the desired behaviour of being self-disciplined with the actual behaviour that were not. Some patients were shown to refuse a negative connotation of the patient identity and they tried to distinguish themselves from other diabetic patients as "not the same" to protect their own self-identity. The feelings of having sufficient information and knowledge, autonomy, and locus of control can enhance the sense of self-worth.

Incorporation values

Incorporation values refer to the relevance and tailoring to their needs and lifestyles.
**Relevance** refers to the information that is relevant and useful to the participants in terms of their abilities, interest, problems at hand, and so on. In the study, the participants lacked of motivation and interests since the information or the systems were seen as not relevant to them. Hence, to understand the needs of different user groups and **tailoring** the features and information can enhance the persuasive and motivation effects.

**Hedonic and affection values**

Hedonic values are affective and emotional values that participants seek in using the systems. *Fun, attractive, pleasurable to use* are regarded as vital for some if they want to use the systems. They are especially essential for low involvement patients. Aesthetics and sensory appeal are the first impression of the systems, they are largely unconscious, they determine whether the patients want to use and engage it further.

**Trustiness values**

The trustiness values include both from the system itself, its provider, as well as the source of information. *Expertise, credibility, reliability and accuracy* are important attributes of the systems the users will value. **Expertise** is about the professional knowledge of the providers. **Credibility** relates to the authority of the providers, for example, whether the providers are recognized bodies such as government, hospitals, or healthcare providers. **Reliability** refers to the source of the information that is truthful, consistent and accountable. **Accuracy** is mainly referred to the source of the data provided and generated by the systems. Many patients queried the accuracy of the data generated from the systems were inaccurate so they lacked motivation to use.

**Social relatedness values**

Social relatedness values in this research seem to be indirect since most of the participants did not conceive that these kinds of systems are used for social interaction. Physical social supports seem to be more essential for most of the participants in this
study excepted a very few. In the study, two themes have been identified of the social aspects: Interconnection and social inclusion. Interconnection refers to the social interaction and relations with the others, it includes rapport and social relevance. Some participants reckoned that a sense of rapport with the others is essential for them to engage in a supportive group. Moreover, they also like to be friends with those who are perceived similar to them, whether their age, interests, or background. Therefore, social relevance is also an important point to consider when designing the social support group to be more effective.

It has a strong indication that the diabetic patients demand social acceptance with other people. They refuse to be identified as "patient" per se and they distinguish themselves from the other diabetic patients. They would rather to be treated as normal people, have their normal circle of friends and live as ordinary people. On the other hand, they also wished others had an empathetic understanding of their needs and situations. They prefer to connect with people they could trust and rapport rather than with strangers. Social inclusion is crucial in designing healthcare systems that they will not feeling to be stereotyped and isolated from the others. The system should be able to facilitate communication and supports from their family, friends and healthcare providers.
Figure 10.8. User values in diabetes systems
10.5. Discussion

The finding about the user values is similar to the previous part about the motivation to use. Many criteria such as pragmatic values (useful and usable), hedonic and affect values (desirable), as well as trustiness values are noted, in addition, the values of self-reliance, incorporation and social relatedness are also found. The pragmatic, trustiness, hedonic and affective values are mainly related to the products and the systems; on the other hand, self-reliance, incorporation and social relatedness are more related to self. The finding is similar to the concept developed by Hassenzahl (2003) that the motivation for products use is based on fulfilling two basic universal human needs: pragmatic needs and hedonic needs which include stimulation, identification and evocation. According to him, while pragmatic goals are essential, they have no meaning by themselves since the hedonic goals are the major motives behind the interaction.

In this study, I refer hedonic to affection and aesthetic needs, and stimulation and identification as part of self-reliance to distinguish the needs of pleasure and the sense of self. The study found that the needs of self-reliance are prominent since to manage their health by themselves seem to be the main reasons why they engage in the interaction. The sense of self-reliance by having autonomy, knowledge, and positive self-image are critical. The sense of positive self-image is derived from the experience of competence and sense of locus of control, but it also relates to the social interaction with the others. As the pragmatic values are the instrumental values that support the achievement of hedonic values (Hassenzahl, 2003), in this case, the consideration of how to achieve self-reliance and promote social relatedness are the primary goals in the design.

Previous studies have shown that people with diabetes need to encounter a great deal of psychological, social and behavioural adjustments in their lives (Paterson, Thorne, & Dewis, 1998). Some of them may have psychological struggles, for example, they have to balance between the demands that are sometimes contradictory, such as controlling and being controlled by the diabetes; accepting oneself that they are a patient and yet
maintaining a positive self-image and live a normal life, and so on (Paterson, Thorne, & Dewis, 1998). A study from Koch et al (1999) of women diabetes type 2 found that women had negative experiences of diabetes and they need to cope with depression and fatigue resulting in social isolation. They also viewed that living with diabetes are stressful since it requires them to keep a constant caution. This research has also found similar results in the Chinese women participants while men seem to be more able to cope, but possibly because Chinese men did not want to show too much of their emotions and feelings. Nevertheless, the feelings of stress and anxiety were still found in the interviews of the male participants.

Although many studies reported that to provide supportive group is important for adherence (Hörnsten, 2004), this research found that the idea is more complicated. Some participants were positive about to join a support group with other diabetic patients since they thought that people with similar disease can better understand their problems. Nevertheless, many participants preferred to have their friends and family in the support group, some of them even refused to join since they thought that these people may not have rapport with them. It may be explained by the self-identity problem as mentioned before, it may also because they regarded that family and friends can provide emotional supports than the strangers. Further study is needed to examine if it relates to the cultural context or other variables.

10.6. Implications for Design

The research identifies the perceived value of the diabetes systems, most of these values related to the psychological well-being, which prove that these values are universal. It has found that besides of the pragmatic values such as usability and usefulness, the values of self-reliance, social relatedness and trustiness of the systems and the sources of information are important in diabetes systems. Simplicity is key since diabetes management is a complicated task and putting the data all the time in the application would just create burdens to the patients and affect their motivation in self-management. The hedonic and affective of the systems, on the other hand, encourage user engagement of the systems. Moreover, the system should incorporate
into the patients' lifestyle; the future systems that are seamlessly integrated into the people's lives using ubiquitous technology would be useful in self-management. More studies and understanding using contextual inquiry or ethnography research are necessary to design diabetes systems to suit the target users' lifestyle.

This research has demonstrated that the use of design prototype with the mean-end approach is able to discover implicit needs of the users that may not be found otherwise. It is useful to gain richer user insights in the initial stage of the design and development process.

10.7. Summary of the Chapter

This section examines the user values by adopting the mean-end approach in the form of a design prototype of diabetes system. The features and attributes of the diabetes system were described and introduced to the participants and their views were analysed. The use of design prototype helped the researcher to dig deep down to understand the user needs and values of diabetes systems. Six main categories of values are identified including: pragmatic values (useful and usable), hedonic and affect values (desirable), self-reliance, incorporation, trustiness values, and social relatedness as the important values the people with diabetes consider in the diabetes systems. Since these values can affect their motivation to use the systems so understanding these values is important for developing diabetes systems.
11. Phase 4 - Research Analysis (C): Contextual Factors

11.1. Introduction

In the previous sections, the motivation attributes and the user values in diabetes systems are identified. Besides the factors directly affecting the use of the systems, it also discovered there are some contextual factors influence the motivation and persuasive effects. These contextual factors are worth examining in order to provide a detailed and thorough understanding of the system use and the motivation effects and how the systems help to motivate and sustain behaviour change.

The context analysis is divided into two main parts: the context of use and user context. Context of use refers to the relevant information of a user's given situation. It includes spatio-tempo, physical environment and technological infrastructure. User context is related to a larger context of the users such as the user's needs, interests, abilities, pre-existing attitudes, motivations, and cultural factors (Oinas-Kukkonen & Harjumaa, 2008a; 2008b). It was found that the users' demographics, perception and health literacy, as well as cultural factors have effects on the needs and motivations. These contextual factors are discussed in the following.

11.2. Context of Use

11.2.1. Spatio-tempo and physical environment

The problems in context of use were mainly related to time-lapse and distraction in this study. For time-lapse problems, many participants were using the systems in the evening since they were too busy at work during the daytime. In the mobile group, many participants were not able to record every meal in the daytime so they were either marked it on the booklet and entered the data in the evening, or just guessed what they ate that day or days before. In this case, the data did not accurately reflect the dietary intake and energy consumption. It was also time-consuming for them to
entre the data. In terms of the physical environment, many participants watched the website at home, for example, for the housewives, it was difficult for them to concentrate since they were usually distracted by household works or people around. These context of use problems can affect the experience and persuasive effects of the systems.

11.2.2. Technical infrastructure

The problems related to technical infrastructure include *phone configurations* (Difficult to find the applications and download them in some smart phone brands; The Chinese fonts were distorted in some smart phone configurations); *technical issues* (Difficult to type the Chinese texts); and *lack of necessary equipment* (for example, no printer to print out the paper forms).

It was found that some of the interface design and configuration of some smart phones were not sufficiently adapted to different users' needs. On the other hand, the website required the users to download the printed self-management forms which was also problematic for many older adults who have no printer at home. For instance, one patient needed to print the forms in the library, which was not only caused him time and money, he also forgot where to put the filled forms when he came back for post-use evaluation. Eventually, he felt discouraged to use the website. Therefore, to understand the technological infrastructure of the target users is essential to maintaining user engagement.

11.3. User Context

There are several user contexts affecting the needs, persuasive effects and motivation. They include demographic differences, stages of disease, health literacy and cultural factors, as well as emotional and psychological needs.

11.3.1. Demographic differences
Demographic differences such as age, gender, and education level can influence the behaviour in self-management and technology use. For different age cohorts, the most notable differences are related to physical issues, attitudes towards technology and social behaviour.

*Physical issues* are the essential part to be considered especially when designing these diabetes systems for older adults. The physical problems are related to the physical body as well as cognitive capabilities. Physical problems included eye problems and physical body movement. Some of the participants reported that they were not able to browse the website for a long time due to eye problems and back problems. On the other hand, the fonts and buttons on the mobile applications were too small for them to read and press.

LI: "I usually watch TV at night, and watch it (website) after 10pm. I watched a bit, then I got up and walk a bit. Then I watched a bit TV. Because I have problems with my back, I can't sit for a long time. Moreover, my eyes are also not good, they're quite tired. Because I have presbyopia and astigmatism, my eyes were tearing when I watched it for a while. Furthermore, my computer is quite small, I brought a wrong one." (Website group)

CU: "I feel bored because there're too many texts, I need to read in a very concentrated manner and my eyes were tired." (Website group)

YM: "Usually I just walk. My feet are sore, I can't run, no exercise. ..... I can't do exercise to reduce weight." (Mobile group)

Cognitive capabilities were mainly due to the cognitive declines. For example, the participants forgot the features on the mobile applications introduced during the pre-use section so they did not use them; they also did not understand the navigation of the mobile application. One participant forgot the user password of the website even though she had written it down on the booklet during the pre-use introduction. Her son helped her to re-register again, however, she was still quite confused and I needed
to assist her to find it. Although the website has provided email checking, many older adults do not check their email very often since they thought it is difficult to read and use because of the small font sizes and type Chinese. Many of them said they only use computer few days per week.

In fact, many digital systems were very difficult for the older adults to use since these systems ignored the physical issues of these people. However, as these groups of people are more vulnerable to diabetes and other chronic diseases, the design of e-health and persuasive systems should take these issues into account.

In terms of the **attitudes toward using technologies** in self-management, the younger age groups were more receptive about the ideas. Although many older adults doubt about the idea, they generally have positive attitudes about it especially if the healthcare providers are involved. For example, in the research, many older participants were interested in using the Ubicomp technology that can record their steps automatically through the sensor of their shoe pads. They replied they will purchase these devices if they are useful to them. It demonstrates that older adults will like to use and are willing to learn the technologies provided this is perceived useful and not difficult for them to use.

However, it has found that the needs of using technologies may be different among different age groups. For example, while many of the participants over 70 years old chose devices that can attach to the wall or embedded in other electronic devices, the younger age groups prefer smart phones. It means that the older adults over 70 years old prefer the devices integrated into their living environment since they mostly stay at home while the younger age groups prefer mobile devices to computers since they are still actively engaging in social and outdoor activities.

For genders, the **perception of safety, visual appeal and technology use were different between male and female participants in this study. Women participants seem to be more concern about safety than men do. Many of them chose smart jewelry or watch because they thought these devices 'can warn them or other people can help them**
immediately’. Men participants, on the other hand, mainly chose smart phones or tablets since "it’s convenient" and they can carry it quite often. This finding is in line with previous studies that females tend to perceive themselves more vulnerable to potential health threats than males (Dawson, et al., 2007). Female participants were also more concerned about the aesthetics of the devices that put on their body.

On the other hand, elderly male participants seem more keen to learn and use new technologies such as smart phones and tablets, whereas elderly female participants were not. Many women said they used computers because they needed to use them at work. Some of them even said that they deliberately avoid using computers at home since they did not want to spend too much time on the computer. This finding shows that elderly female participants preferred more physical social interaction and they demanded basic functions and features of technologies. It seems that female older adults perceived technology as a tool mainly to fulfilling pragmatic goals such as communication and task accomplishment, in contrast, male older adults required more technical and complex features. Due to the small sample size in this study, more research with larger number of participants is required to confirm the findings.

**Social interaction** is another difference between the older and younger age groups. As reported in the finding, older adults prefer physical social interaction with their close friends and relatives. They spend less time in discussion forums and social media than the younger adults since social relations in the physical world are more important. They are also dependent more on closer families and friends to obtain social supports than virtual community especially related to sickness. In contrast, the younger adults, particularly females, are more engaged in social media and open for virtual social relations. Therefore, different social strategies for different age groups should be employed for persuasion and social supports. However, it is not knowing if the use of social media for social supports in chronic disease management among the Chinese younger age groups is equally effective as in the western countries.

**11.3.2. Stages of disease**
The stages of disease are also found to influence the needs of information, the features of the systems, as well as the goals and motivation to use the systems. This study discovers that the motivation of newly diagnosed diabetic patients is to *discover* the relationships between their health and activities, by contrast, the longer diagnosed patients are to *maintain* their health.

The need of information may be also different between the newly diagnosed patients and longer diagnosed patients. The research found that the need of information for the newly diagnosed patients is high since they wish to gain knowledge in managing their disease. They also intend to *discover* the relationships between their diet, activities and blood sugar level. Hence, the goals of using diabetes system is to help them to understand the relationships between their health and activities. For patients who have longer years of diagnosis, updated information about new treatments and medications were more concerned. They checked their blood sugar level less frequently and checked it when they felt sick or wished to obtain new information about their health and activities. Hence, the main goals of this stage of patients are to *maintain* their health. For example, the newly diagnosed patients check their blood sugar more frequently since they wish to check how their diet intake affects their blood sugar level. When they have discovered a pattern of their health situations and developed a way or lifestyle to cope with their disease, they reduce the frequency of checking blood sugar unless there is a change of health situations, or they intend to discover new information such as trying new food.

This finding is in line with the study by Li et al (2011) that the participants experienced two phases in personal informatics: *discovery phase* and *maintenance phase*. People in the discovery phase were trying to understand their behaviour by collecting data for self-reflection. People in the maintenance phase are trying to maintain their behaviour but they would go back to the discovery phase if their health condition changes.

However, not every newly diagnosed patients has high motivation, that is, high involvement. For low involvement patients, the information need is not as high and the self-management tasks they required are less difficult to accomplish. Therefore, the
system for these patients should be using affective strategies and the self-management
tasks should be simple and relatively easy to perform. Such patients should better use
gamification persuasive strategies and external motivations such as rewards and
reminders. On the other hand, for high involvement patients, detailed guidelines and
information are useful for them to understand their health and activities so as to
develop a strategy to cope with the situations.

11.3.3. Health literacy and involvement

Health literacy refers to the knowledge about the disease and self-management. The
level of health literacy was also found to affect information needs and motivations.
Higher literacy persons demand more cognitive and detailed information to maintain
their health which is regarded as intrinsic motivation. For lower literacy persons, by
contrast, the use of simple and affective information is more effective. For instance, a
patient who had more than 10 years of diabetes and kept searching for new diabetes
information required more detailed information about the graphs and medications in
the systems; whereas a patient who was diagnosed diabetes in around 4 years required
simple information and was more motivated by games and rewards. On the other hand,
while the patients who had low involvement regarded games and rewards were
motivating for them to use the systems, the longer years of diabetic patients or those
who had high involvement did not think such were important for them.

Previous studies (Haddock, Maio, Arnold, & Huskinson, 2008) have revealed that the
need for cognition and affection is related to the persuasive outcomes. Individuals who
are high in need for cognition are more successful in eliciting attitude change when
presenting details, beliefs and factual information; in contrast, individuals who are low
in need for cognition prefer simple messages.

This finding is also consistent with ELM (Petty & Cacioppo, 1986) that high
involvement individuals are more receptive of central route of persuasion such as facts
and figures as they tend to seek detailed information to carefully evaluate the content
information, and low involvement individuals are more influenced by peripheral route
of persuasion such as attractive images or environmental cues. This indicates that individuals with higher health literacy and higher involvement are more influenced by cognitive messages and detailed information; in contrast, individuals with lower health literacy and low involvement are more motivated by affective messages and simple information.

As this study shows, patients in different stages of disease and health literacy, as well as the level of involvement have different needs, goals and motivation, the diabetes systems using one-size-fits-all approach is problematic. Rather, the systems should be designed to tailor for different groups of users to be more effective.

11.3.4. Cultural issues

Cultural issues in this research are related to the *lifestyles, languages, food names* and *food culture*. The study is focused on discussing the culture problems related to food and lifestyles since it was found to be most problematic in self-management as well as in the system use.

First of all, many participants complained it was difficult to measure the food quantity and food weight, especially when they were eating away from home since there was usually no information about the food calories and nutrition in the restaurant menus. The food count problem is possibly due to the eating habits and food culture of the Chinese people, including the food itself, how individual food items are cut and cooked, and how dishes and meals are served (Newman, 2004, p. 105). For instance, in a Chinese meal, each dish is usually served on individual platter or bowl, and each meal usually contains a staple and several dishes. People take several morsels of the serving dishes in their own bowl of rice. Sometimes, they are also served with soup in a meal. The soup sometimes contains vegetables or noodles. Therefore, it is difficult for the patients to know and enter the amount of food they ate in each meal, and this affects the accuracy. Moreover, since many Chinese older adults in Hong Kong still live with their children or grandchildren, this might also cause conflicts among the family members since it requires the whole family to adjust their food taste and choices,
unless they have strong family supports or there are other solutions to tackle the problem.

The food counts particularly caused adverse motivation since the participants perceived them a great barrier to use the applications. In fact, all of the participants in the mobile application group resisted the logbook systems. As one participant said:

LA: "I have to spend a lot of time to do so. How do you count how much you eat? You also need to first convert it before registering it. This makes the entire process very difficult." (Mobile group)

Other problems are related to food names, food types, use of terms as well as the choice of food, since some of them are different from Hong Kong. The use of language was also a problem, not only because of the use of simplified Chinese in mobile applications, but also because some of the participants requested us to provide an English version since "Hong Kong is an International city".

The findings demonstrate that several issues should be taken into consideration: 1) the food and exercise log in practices mainly developed in the western countries may not suitable for other cultures due to distinct food cultures; 2) the cultures shaping the Chinese in Hong Kong and Mainland China are also very different; the systems should be tailored for different cultures to be effective.

11.3.5. Emotional and psychological needs

It was found that there were some emotional problems of the participants, including fears, worries, guilt and depression, which were particularly reflected in the mobile group participants. For instance, many patients were concerned about the information such as the effectiveness and side-effects of the medication since they thought medication was important to control their disease from complications. They would rather spend money on purchasing medications or devices that they perceived can control the disease more effectively. Knowing the medication information may
provide locus of control and a sense of hope of their disease. For example, TN had about 10 years of diabetes and he preferred spending money for some expensive diabetic medicines since he thought that the ones from the public hospitals were not effective. He also preferred to take insulin injections since he thought that it is the "panacea" that solves all the problems with diabetes. The medications seemed to help him reduce stress, which was derived from the feeling of uncertainty.

TN: "It's like squeezing orange juice, at the end you need to take injections. ..... I think insulin injection is the simplest way. After insulin injection, the complications will almost be.... It should be better to take an injection. No need to bother that much - problems with eyes, amputation that kinds of complications, is that right? Do you think it's true?" (Mobile group)

He also showed a sense of guilty and helplessness when he talked about his mother who also had diabetes and was living in the elderly home. He blamed the healthcare providers for checking his mother's blood sugar too frequently in a day, which for him was unnecessary since "checking blood sugar was hurtful" and "she had already taken medications".

In contrast, another patient MP, who had about 3 - 5 years of diabetes, confessed that she had a problem adherence in the diabetes medicines than hypertension medicines. She perceived that once she took the medicines, she would need to take them for the rest of her life. However, she adhered to hypertension medicines because she perceived the risks of hypertension were higher than diabetes. She thought that the complications of diabetes seemed to be 'imminent' and she could control it by herself. She thought that the diabetes complications such as eye problems, heart disease, and amputation were problems for the older people, but stroke could happen to younger ones. When she realized that she could not control herself well, especially in diet control, she felt guilty:

MP: "Sometimes I feel quite guilty, I feel weird. (Researcher: Why is that?) I didn't feel guilty when I was eating, but feel guilty after, very strange." (Mobile
The disease also affected her sense of self - she was depressed and struggled in her love relationship. It was fortunate that she seemed to gain supports in her relationship.

MP: “I didn't tell him I have diabetes in the first 2 - 3 months when we're dating. You know I have hypertension, high blood sugar that the 3 'highs', but I was afraid to tell him that I'm sick. "I am already 40 years old. How many years I have to take care of myself?" (She talked to herself) I felt very down, depressed, I felt very negative. I wonder if I should tell him my situation? But then I thought I have to tell him since he needs to know my health conditions. Although we are just dating and not getting married soon, we'll get married at the end of the day, we're not 20 something years old. So I finally told him, saying that I need to follow up with specialist clinics. As expected, he said "then we eat less together." But we're just saying it (without doing anything)!” (Mobile group)

The above cases showed that the diabetic patients have many psychological and emotional needs and struggles that require special attention and need to be considered when designing the systems. The website group participants had more positive emotions, especially having feeling a sense of self-efficacy and sense of hope than the mobile group participants, although the emotional problems were not exclusively for the mobile group of participants. This is consisting with the Emotional arousal in the Social Cognitive Theory that aversion emotions such as fear could impede the success of the new behaviour and perceived self-efficacy in coping challenging situations. The long term feeling of guilty and failure to control their diet can produce a sense of self-defeated which may cause stress, depression, demotivation, and even abandon being to take actions. The emotional problems, therefore, although not directly affect the interaction with the systems, have impacts on people's perception and motivation in using the systems. The design of these systems should provide encouragement and be simple for patients to achieve tasks instead of creating burdens to perform.

11.3.6. Perception and intention
Finally, the perception and intention of the participants before using the system would also influence their motivation and the experience. For example, one participant regarded that the mobile applications were for people who were seriously ill. Since in his perception, "those who need to do exercise and reduce weight are people who are very sick and need to strictly control their diet and do exercise or they will die". He thought that he was not in this situation so he had no need to use it. He also had negative comments and strong criticism of the system. Another participant also thought that diet control and physical exercise were not necessarily useful for diabetic patients since his brother still had a serious diabetes situation even he did so. He also had pessimistic thoughts about the diabetes situation hence he refused to use the weight loss application. This findings are in line with the study of Kan (1990) that prior thought and intent significantly influence the persuasive effects. People with weak prior thought and intent rated the credibility and effectiveness of the persuasive messages lower.

On the other hand, the goals of interaction can also affect the motivation and experience. One participant who had instrumental goals in mind for the diabetes management system resisted the idea of using games in the system:

PW: "It's because the functions of all the apps I use are mono. I feel that this is a recording app, I don't understand why there are games there. I absolutely won't use it." (Mobile group)

This is also consistent with the study from Hassenzahl and Ullrich (2007) that active instrumental goals will not only impact experience but also subsequent retrospective judgments. Hence, the participants should be educated and recognized the values of the interaction to reduce their resistance and enhance their experience. It is also highly useful to understand different goals and intentions of the users for using the system to achieve better results.

11.4. Discussion
The study shows that context of use and user context such as demographics and health literacy have effects on the reception of persuasive messages and the behaviour. This is in line with Audulv et al (2012) that there are different needs in self-management integration depending on the individual’s internal values and their unique context, which affect their intention and capability in self-management. Moreover, it is also consistent with their study that patients experience different stages in integration of self-management, where the needs in each stage to cope with their disease are different (Audulv et al, 2012).

The demographics such as age, gender, and education level differences can also influence the behaviour and perception in self-management and the use of technologies. For example, younger participants are more adapted to use new technologies; and the female participants seem to have different behaviour in self-management than the male participants, and they also have different goals and perception in using technologies. More in-depth study is needed in the future regarding how different demographics behave in self-management and their acceptance of persuasive technologies.

There is also a relationship between level of involvement, health literacy, as well as the types and details of information people seek. For instance, people with higher involvement tend to have higher health literacy, and tend to seek more detailed information and pursue more pragmatic goals in system use; by contrast, people with lower involvement had lower health literacy, and they tend to seek more hedonic goals in system use, that is to say, the system with more hedonic features may increase their motivation to use it. It is in line with the Elaboration Likelihood Model (ELM) that people with lower involvement are more affected by hedonic and affective messages, whereas people with higher involvement tend to be affected by cognitive and factual messages (Petty & Cacioppo, 1986).

This research also recognized that financial reward is not necessarily an effective way to motivate behaviour change. Many patients who had higher involvement were not
motivated by financial rewards but maintaining their health or staying with close friends. Hence, for higher involvement patients, peer group influence and information to help them maintain their health should be more effective. In contrast, for lower involvement patients, games and rewards are more effective to help them understand the values and build up a habit.

It demonstrates that one system cannot fit all and different strategies need to be used in the system design. The persuasive self-management systems are more effective if they are tailored to the needs of patients in different phases of behaviour change to achieve desirable results (Petty & Cacioppo, 1986; Audulv et al, 2012). For the patients who are in the discovery phase or at the beginning of the disease, the goals of system design should be aimed at increasing the self-efficacy and knowing how the patients’ activities affect their health. A more hedonic and interesting ways of interaction is more persuasive in helping these patients to cope with their situations by gaining more knowledge about the disease and their health, and guiding them to conduct self-management in easy ways. For patients who are in the maintaining phase or have developed coping strategies, the goals should be helping the patients to maintain and manage their health in more effective ways.

All these findings provide a more holistic picture of people with diabetes of their user experience and their latent needs and values in these self-management systems. These findings enable us to develop a more comprehensive framework that is more capable for designers and developers to tailor their strategies to meet the needs of the people with diabetes. The most important goal is to help them to understand the values and benefits to change and to provide tools to enhance their skills and self-efficacy in self-management.

11.5. Implications for Design

1. Develop user profile and persona
   This study demonstrates that persuasive systems should be tailored for different user groups since they have diverse needs, abilities, motivations and behaviour patterns.
The use of user profile and persona are necessary to identify different user needs and perceived values. The user profile should include not only demographics such as age and genders, but it is also required to include physical and psychosocial characteristics such as: *health literacy, stage of disease, working states, level of involvement*, as well as *culture and lifestyles* (Table 11.1).

**Table 11.1: User profile in persuasive systems.**

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Psychosocial characteristics</th>
<th>Physical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Level of involvement</td>
<td>Physical</td>
</tr>
<tr>
<td>Age</td>
<td>Health literacy</td>
<td>Mental</td>
</tr>
<tr>
<td>Education</td>
<td>Culture</td>
<td></td>
</tr>
<tr>
<td>Working status</td>
<td>Lifestyle</td>
<td></td>
</tr>
<tr>
<td>Stages of disease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Different design and communication strategies for patients with different stage of disease, and level of involvement**

This research has identified that participants have different kinds of goals and involvements. Highly involvement participants tend to follow the central route and are goal-directed, they know what kind of information they are looking for and will carefully evaluate the information. In contrast, the lower involvement participants tend to follow the peripheral route and are better motivated by hedonic features. Therefore, different design and communication strategies should be employed when designing the diabetes management systems. Using functional features with detailed and up-to-date information is necessary for high involvement patients; in contrast, utilizing emotional cues and facilitating exploration and creativity are more effective for low involvement patients. Designing easy to accomplish goal-setting and step-by-step tasks allows patients to engage in successful self-management more easily. When they have internalized the values and benefits of conducting self-management tasks, they can develop intrinsic motivation. On the other hand, previous studies also found that when people have developed internalization, autonomous response is more dominant to maintain the behavior, therefore, convenience and reducing time to
perform is more important in this stage.

Based on the findings and the concepts from the literature review, a framework called *Transitional Persuasive Design* for designing persuasive systems in different stages of behaviour change is proposed in Table 11.2. The framework is integrated with the model of design structure of persuasive system in Figure 5.4. It incorporates the behaviour change processes into the persuasive systems, where different design strategies can be used to create more effective persuasion and motivation.

To design a persuasive system, it should be first identify the target users, their characteristics and the context of use. To design for users in different stages, it requires the use of different kinds of content information as well as design tactics. For instance, in the initial stage, the purpose should be to arose attention and awareness of the problems. Thus, the information should be focused on the causes and consequences, as well as the risk factors if the problems are not given proper attention. The message should be delivered in more interesting ways and an easy to understand manner. It should provide enough time for users to explore the systems or applications to gain more understanding about the issues. Once the users have awareness of the problems, the next stage is to encourage actions. The information should be focused on providing solutions and suggestions, the messages should be encouraging and suggestive, goal-setting may be used to help achieve targets. Usability, simplicity and easy to use are the key design features in this stage. In the maintenance stage, it should focused on maintaining interest and reinforcing repeat actions. Thus, the information should be regularly updated to maintain interest. Convenience, simplify and ease of use are essential for facilitating repeat actions. The use of alerts, reminders and/or warnings may be useful for maintaining behaviour. However, when users have developed a habit of the behaviour, they may not need frequent reminders, and it should also provide options for choices.

The framework provides a brief guidance of design tactics for persuasive systems in different stages of behaviour change. However, these tactics are not fixed and may be overlapped in different stages, depending on the user context and the context of use.
Table 11.2.: A Transitional Persuasive Design framework for different stages of behaviour change

<table>
<thead>
<tr>
<th>User Context + Context of Use</th>
<th>Methods to influence</th>
<th>Methods to motivate</th>
<th>Methods to maintain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Types of methods</strong></td>
<td><strong>Why</strong> - Why need to change?</td>
<td><strong>What</strong> - What to do to support the chance?</td>
<td><strong>How</strong> - How to do to implement the change and maintain it?</td>
</tr>
<tr>
<td>Purposes</td>
<td>Make people to aware that a problem exist, help to internalize it</td>
<td>Support and facilitate new behaviour</td>
<td>Reinforce the desired behaviour and constant support and motivate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Content</strong></th>
<th>Information</th>
<th>Functions or features</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information</strong></td>
<td>The causes and consequences, the risk factors.</td>
<td>Attract attention and interest. It can be serve as education and training.</td>
<td>Provide interesting formats to convey the message. For example: Narrative, gasification, informational, facts and figures, documentary, reports.</td>
</tr>
<tr>
<td><strong>Functions or features</strong></td>
<td>Help in decision-making, e.g., goal setting, suggestions, problem solving.</td>
<td>Help in decision-making, e.g., goal setting, suggestions, problem solving.</td>
<td>Provide motivation to take the action. For example, case studies, analogy, discount, promotion, etc.</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>How the goals can be achieved and maintained - more specific of what, when and how.</td>
<td>Maintain interest and encourage repeat action.</td>
<td>Provide information about the development. For example: Graphs, charts, reports, diaries, analogy, discussion forums.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Interaction</strong></th>
<th>Information architecture</th>
<th>Navigation</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information architecture</strong></td>
<td>It should facilitate understanding.</td>
<td>Exploration - it should help to reinforce the knowledge and internalization</td>
<td>Provide visual appeal, interest to attract the users. Multi-sensory seems to be more effective in convey message.</td>
</tr>
<tr>
<td><strong>Navigation</strong></td>
<td>Usability is a key to facilitate people to achieve their goals.</td>
<td>Intentional - should be simple and easy to achieve the goals, e.g., easy to fill in information.</td>
<td>Same as the initiate stage.</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>Simple and reduced steps and processes.</td>
<td>Goal oriented - timely, convenient, and instant feedback is the key.</td>
<td>Provide continuous stimulation of the senses.</td>
</tr>
<tr>
<td><strong>Sensory</strong></td>
<td>Use more encouraging words.</td>
<td>Use key points with lesser texts, more encouraging, give</td>
<td></td>
</tr>
<tr>
<td><strong>Semantic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.6. Summary of the Chapter

This section discusses the findings related to the contextual factors, including context of use and user contexts in the user interaction with diabetes persuasive systems. It has discovered that diabetic patients have diverse needs and concerns affecting the persuasive effects and the use of the systems. Context of use includes the spatio-tempo, the physical environment and technological infrastructure. In the user context, the factors such as demographics, physical, psychosocial, emotional, health literacy and stage of disease, as well as pre-use intention and perception all have significant affects in the user experience and motivation. Hence, the diabetes persuasive system should not design one system for all. Rather, understanding the contextual factors such as the physical and cognitive capabilities, the psychological and emotional needs of the users, and the context of use such as their physical environment is essential to developing more personal fit and desirable systems that can relate to the users in their lives. A system that can relate, incorporate and resonant to the users’ psychological and physical needs is more successful to motivate behaviour change over time and enhance well-being.

This research also shows that using a variety of research methods can discover the users’ needs and the genuine problems in their lives. The use of ethnographic inquiry and design probe research methods can provide in-depth understanding of their needs, their lives and their interaction with the systems. More different research methods can be used in the future to enrich the understanding of the users and their environment.

Finally, a framework is proposed to designing persuasive systems for users in different stages of behaviour change. The framework focuses on the different user needs in different stage of behaviour change, it provides a design guideline for using various design strategies in communicating messages and encouraging interactions in different stages to enhance the persuasive and motivation effects.
12. Conclusions

12.1. Answering the Research Questions

This study started by exploring the different theoretical understanding of healthy behavioural change particularly sustainable behavioural change. It conducted four phases of research from a preliminary study to understand the background of the issues where the researcher conducted field studies and interviews with the stakeholders including the patients and the healthcare providers. Then, the researcher conducted an explanation study by using a survey and in-depth interviews to comprehend the perceived challenges in diabetes management and the patients’ views of using digital technologies for self-management. From this understanding, the researcher searched for possible solutions to motivate desirable behavioural change and improve self-management by using different kinds of persuasive diabetes systems for user testing and evaluation. Finally, a design prototype was developed to help generate more insights for user needs and user values for these kinds of systems.

This study has provided deeper knowledge about the lives, perceptions, and psychosocial aspects of people with diabetes in Hong Kong related to the self-management and persuasive technologies through mixed methods research. It has provided a comprehensive understanding of people with diabetes and how using different types of persuasive systems affect the persuasive and motivation effects of behavioural change. With thorough research and analysis, the research has answered the research questions in the study, which are described in the following.

1. Diabetes management and healthy behavioural change:

It recognises that behaviour change involves a series of stages, from awareness to becoming a habit. In this process, different key determinants are involved in each stage. Four determinants are crucial in health behaviour change; they include self-reflection, self-efficacy, positive experience, as well as perceived values, which play important
parts to lead behaviour from one stage to the next. For sustaining behaviour change, the individuals were required to first develop internalisation of the changing values through self-reflection. Next, they needed to have self-efficacy and perceived a value to perform the new behaviour, that is, they needed to believe that they had the ability to change, and the new behaviour is more valuable and beneficial for them to reach a better situation than the existing one. For instance, many participants who had previously internalised the values of healthy behaviour, such as doing exercise, demonstrated themselves to be more persistent regarding the behaviour. This is consistent with the Self-Determination Theory that internalization of values is vital for long-term behavioural change (Williams, Deci & Ryan, 1998). Moreover, positive experience can help to reinforce the new behaviour, but the social and physical contexts, as well as the resource availability of the individual, are also essential for the new behaviour to be maintained in the long run. This study was in line with the previous studies of Prochaska and Velicer (1997), Williams, Deci and Ryan (1998), Rothman, Sheeran, and Wood (2009), that different determinants are required in different stages of behavioural change, and using the stage paradigm in intervention design to match the needs of the participants is more effective to promote and maintain behaviour change over time.

On the other hand, the perceived usefulness and value of the systems are the reasons that could sustain motivation in system use. The design prototype discovered the perceived values of the system, including pragmatic and usability factors, hedonic attributes, and perceived trustiness of the systems, which are mainly related to the properties of the systems. Additionally, the values of self-reliance, incorporation and social relatedness were found to be crucial because they related to the self and lives of the users, which are the core values affecting whether the systems will be used (Figure 10.8).

The findings are in line with Hassenzahl (2003) that an interaction with a product or system involves both pragmatic and hedonic goals, where the key motivation is to achieve the hedonic goals, while the pragmatic goals are essential to facilitate the interaction at the beginning. Hence, the properties of the systems are preconditions
and should support the core values that help the patients to handle their self-management more effectively and efficiently. At the same time, the systems also need to satisfy a higher level of psychological needs of desiring self-reliance and self-development, mastery of one’s environment, and positive social relationships with others.

In the research, it was found that perception of risk is a critical factor for triggering behavioural change. The participants who felt that their health was at risk were more likely to change, such as doing more exercise. This is in line with Julian-Reynier et al. (2003) that feeling a threat and harmful consequences of adverse behaviour might cause individuals to take action to reduce or control it. The perception of risk level, however, may depend on individuals who have different value systems about risk and health. For example, one participant did not comply with diabetes medication rather than hypertension medication since she perceived that the risk of hypertension was higher. However, it is noted that people who perceive a risk without offering appropriate solutions will worry and suffer emotional distress as shown by some participants in the mobile application group. Hence, it is essential to provide adequate solutions in the persuasive systems.

2. Persuasive and motivational effects in diabetes system design

The research intended to study different persuasive communication strategies and how they can promote self-reflection that leads to motivation for behavioural change. It discovered that narrative forms of content are more persuasive, reduce resistance and promote self-reflection to induce attitude and behavioural change than the graphical form, which is in line with the study of De Wit et al. (2008). This confirms that narratives have powerful persuasive effects as studied by Kreuter and his colleagues (Hinyard & Kreuter, 2007; Kreuter et al., 2007). This study also illustrated the Elaboration Likelihood Model (ELM) that hedonic and affective attributes are more effective in persuasion for participants with lower involvement (Petty & Cacioppo, 1986). On the other hand, the graphical and statistical forms require higher numerical literacy and constant manual data input, which hinders their effectiveness in
persuasion and motivation. In the future, autonomous data input for graphic and statistic presentation is needed to gain more insights.

Although gaining information may not necessarily induce behavioural change, the information is found to be important for participants. Obtaining information gave the participants a sense of self-efficacy and locus of control and they felt more confident about controlling their disease so it is essential to be included in the diabetes systems. It was found that the information needs differ between newly diagnosed and longer diagnosed patients. The newly diagnosed patients need to understand the effects of the disease and obtain the skills of self-management; and they want to comprehend how their activities affect their blood glucose level through the data. In contrast, longer diabetic patients usually have established a healthy pattern of activities, and they rather demand up-to-date information, especially information on medication to control their disease. These findings are in line with the study of Li et al. (2011) that people experience a discovery and maintenance phase in personal informatics; in each phase the information needs are different. It was also noted that information should be presented in an appropriate format for different kinds of users such as high or low health literacy users to achieve the best results. For example, simple and effective formats are more suitable for low literacy patients. Furthermore, other motivational features such as rewards, reminders and suggestions should also be used especially for lower motivation patients to encourage the intended behaviour.

On the other hand, a positive user experience was found to affect persuasion and motivation effects significantly. A positive user experience can be created through several motivational attributes including: knowledge, trustworthiness, autonomy, perceived competence, instructions and guidance, attractiveness, resonance, system interactivity, goal-setting, and physical social connection, which are important for diabetes management systems. In the research, usability issues were found to be the most crucial factors hindering the effectiveness of persuasion and motivation since it produces negative user emotions, which reduces user attention and engagement, and amplifies the problems at hand. A positive user experience in the diabetes systems can increase hopes and a sense of self-efficacy, whereas a negative user experience reduces
them, so it not only affects the motivation of system use, but also psychological well-being.

Based on these findings, a CBS model of design principles and guidelines for persuasion and health promotion systems is proposed (Table 9.8). The model consists of three major components in persuasive systems, including the content support, behavioural support and social support. It stresses that content is one of the important components to promote behavioural change since it helps to internalise values and builds self-efficacy; on the other hand, the behaviour and social components help to facilitate, motivate, empower, and sustain the new behaviour. It is noted that these components are always intertwined and support each other in the interaction of the persuasive systems only that one component may be more prominent in different stages of behavioural change.

The research also recognises the user needs and user values of the diabetes management systems. They include pragmatic, hedonic and affect, self-reliance, incorporation, trustiness, and social relatedness. These values are crucial to determine if diabetes patients are willing to use the systems over time, since they are the goals of interaction. Hence, the systems should be designed in such a way as to facilitate the interaction to meet these goals.

3. Contextual factors in persuasive design

The research demonstrates that contextual factors, including user context and context in use play vital roles in persuasion and motivation for behavioural change. It recognised that several user contexts, including age, gender, clinical conditions, duration of disease, health literacy, level of involvement and prior attitudes, as well as experiences, are all influenced by the persuasive effects and the required features and attributes of the systems. For instance, while people with higher literacy and/or higher involvement require more information and a comprehensive system design, people with lower literacy and/or low involvement require simple information and hedonic features. From these findings, it is suggested to consider not only demographics, but
also psychosocial and physical characteristics when developing the persona of persuasive systems (Table 11.1). In addition, a framework of designing motivation and persuasive strategies for different stages of behavioural change is proposed to design more effective persuasive systems (Table 11.2).

Figure 12.1. Model of Design User Experience for Sustaining Behavioural Change

All in all, a theoretical model was developed to describe the relationships between user experience and the design for sustainable behavioural change (Figure 12.1). The model highlights the process of behavioural change and different design objectives and user experiences are required in each stage to achieve the desired results. Designers need to understand the be-goal of the individuals in each stage, that is, why they want to
interact with the system, and how, the do-goal, the design can create a certain experience to meet their needs. Hence, the goals of the user experience inform the design strategies, and the design goals and tasks need to be tailored in each stage to create an intended experience.

In the initial stage, the design is to arouse self-awareness and elicit self-reflection; affective strategies with hedonic features such as games and narratives are more effective for promoting inspiration and aspiration. Inspiration experience helps to achieve self-reflection, and aspiration experience provides the benefits to change. The use of games and narratives are more user engaging that facilitates transportation and identification, and produces a meaningful experience.

After that, the individual needs to gain self-efficacy, that is, be confident that he/she can perform the new behaviour or the change will not happen. Hence, the systems should focus on empowering the individual to accomplish the tasks. Providing simple and easy to achieve tasks are more likely to encourage new behaviour. During this process, a positive experience of the new behaviour can reinforce the behaviour. The positive experience is created through the motivation attributes discussed in the previous chapter (Table 9.8).

When the behaviour has become a habit, autonomous experience is more important to assist repeated behaviour. The autonomous experience can achieve self-reliance and the system should allow higher flexibility and personalisation since the individual has mastered the skills, and the integration of the system into the individual’s life helps to create an autonomous experience. At this stage, reminders and updated information can provide continuous engagement. For the behaviour to be maintained, social and environmental supports are more essential than the system alone, so the systems should facilitate effective social interactions and adapt to the environment to support the change.

In the whole process, the user needs to experience a sense of self-determination, that is, he/she should experience autonomy, competence, relatedness, and sense of self-worth.
during the interaction with the system because they are the intrinsic motivation and the sources of psychological well-being. Self-determination experience is vital for self-reflection to occur, and it is essential for the behaviour to be maintained over time.

Throughout the process, meanings and values are created and they will be reinforced with the growing of positive experiences. The new behaviour is then developed and maintained if the experience remains meaningful and valuable to the individual. However, it is noted that the behaviour can lapse and a return to the initial stage of behavioural change is necessary. In this regard, updated information and social supports are helpful for regaining the lapsed behaviour.

Finally, it is essential to understand the user context and context of use when designing persuasive systems for behavioural change since these factors influence the persuasive and motivation effects. For diabetes systems, special attention should also focus on the clinical conditions and duration of disease for different needs and information required.

In conclusion, this study has provided a comprehensive understanding of designing diabetes systems that are aimed at sustaining behavioural change. It adds new knowledge to the field by recognising the behavioural change process and the relationships between the user experience and the design strategies for behavioural change in each stage. It also identifies that the perceived values and meaning are important for behavioural change so understanding them can help to design persuasive systems that are more effective.

Nevertheless, human behaviour is complicated and especially behaviour related to health and diseases. The field of design is just beginning to understand this behaviour and how the design artifacts have a direct or indirect influence, whether positive or negative, on our health and well-being. These understandings are crucial since designers have been one of the major creators of the contemporary world. Unless we understand the influences, we cannot design for a positive change, not only the behaviour of the individuals, but also the environment, the organisations, and most
importantly, the cultures, the systems, and society at large.

Moreover, the notion of design as an intervention is an extension of designers’ role in the 21st century. Design is no longer just seen as serving a commercial act for corporations to make profits, but has a wider and profound effect on human lives and well-being. Designers nowadays should be more actively engaged in tackling individual, social and environmental problems, and strive to enhance humans’ physical and psychological well-being through creative design solutions and interventions in the form of products, services, systems, and environment.

In terms of designing health behaviour-related systems, this study has shown that diabetes management and health behaviour are complex issues affected by many factors including personal, social and environmental. The use of technology alone is not able to facilitate a positive and sustained change but requires a more holistic collaboration amongst different stakeholders. Hence, building a persuasive system for chronic management or other health behavioural change is more effective in cooperation with professionals from other disciplines such as healthcare providers, and even the patients and their family members in the form of a co-design since they are important to provide professional and social supports in the process.

Finally, I realize I have more questions than the answers that were set at the beginning when the study commenced. I hope this study makes a modest step forward to a human-centred design practice that is truly beneficial to human beings and the world.

12.2. Reflection

This research took many stages and a total of about 18 months to complete. I started with a little knowledge about the people with diabetes to gain a deeper understanding of their feelings, thinking and how they live their lives. During this period, I spent many days visiting the Self-Help Patient organisation, and I had several interactions with the participants and it helped me to be able to gain their trust and develop an empathetic understanding of them. I found that gaining the participants' trust and
building good relationships with them were very important in the research since they would open up if they thought that you were sincere and trustworthy. It is suggested that showing respect, sincerity, and understanding, and being non-judgmental of their situation were essential to gain trust from the participants.

The use of questionnaires in the initial stage was also useful since it helped me to obtain a general understanding of their situation and it was easier to start the conversation with the participants before they shared their feelings and thinking with me. In qualitative research, the interaction of the researcher and the participants are reciprocal; therefore, the attitudes and behaviour of the researcher will affect the quality of the research. The researcher should also be sensitive and careful when studying vulnerable participants such as patients and older adults to avoid harmful feelings or any misunderstanding.

Furthermore, I also realised that when conducting interviews, the researcher also needs to possess some skills in regard to asking questions since people may not tell you the truth due to politeness, privacy, not understanding your questions, and so on. So knowing how to ask the correct questions is an important skill for researchers, especially in qualitative research.

On the other hand, doing research with older adults is also an issue. In this research, the use of a diary was problematic since most of the older adults refused to write their experiences and feelings down in the diary that was provided to them. Those very few who wrote in the diary only recorded the problems in a few lines, or they considered their task was to record the activities for the researcher to check, i.e. homework that needed to be submitted. The possible answers are that firstly the older generations of Chinese people do not like to express their feelings in public, as mentioned in the research findings. They do not feel comfortable about recording their feelings and emotions for strangers to read especially the male participants. Some of them just wrote down "technical information" such as their diet and exercise in the period of study instead of writing down their feelings and experience.
Secondly, it may also relate to the literacy level. In Hong Kong, many older adults, especially people aged 60 and above, did not receive higher education as the younger generations do now. Many of them received secondary level education or lower, so it is difficult for them to write and input information on a computer. They also write and read slowly due to physical problems such as eye problems, arthritis, and slow movement. Furthermore, some of them have cognitive decline, which affects their memory and concentration.

Thirdly, it is also possible that writing in the diary seemed to be a difficult or time-consuming task for them so they just ignored it. People in Hong Kong are always under time pressure. In this research, many older adults, even in their 60s or have retired, are still actively engaged in work or different kinds of activities. So writing a diary may be extra work they would rather not do.

The use of a cultural probe of Chinese older adults, therefore, should take these conditions into account in the future. It should employ simple and easy to accomplish tasks such as taking photographs and recording using their smart phone. The researcher should also provide more instructions and guidance on the tasks so that the participants can easily follow. Researchers should note that interviewing and researching elderly people should be different from other age groups since they have special needs. The use of different research methods for this group of people is needed to achieve better results.

Finally, through this research, I have come to understand that people with diabetes have to face many challenges in their lives, including personal, work, social and even their love lives. They need to seek a balance in their lives and manage their disease, which is not an easy task for many of them. For example, a participant with depression refused to see the doctor since she was too engaged with her work and she thought that she could not keep her promise to maintain her blood sugar level when she saw her doctor. She also withdrew from the research later on. This study shows that diabetes management is very complex and particularly for people with special health conditions such as mental problems, depression, and so on, they need more human intervention
and healthcare professional support in their self-management rather than just relying on technologies alone. Future studies for these kinds of people will also be useful to provide more understanding in the field.

12.3. Validity and Reliability

Guba and Lincoln (1981) considered that while all research to be considered worthwhile must have "true value", "applicability", "consistency", and "neutrality", the same criteria for quantitative research is not applicable to qualitative research since the nature of knowledge of these approaches is different. The quantitative approach is based on the rationalistic paradigm that true value is derived from a “single tangible reality that an investigation is intended to unearth and display” (Lincoln & Guba, 1985, p. 294), whereas qualitative inquiry is based on the naturalistic paradigm where the naturalistic researcher makes “the assumption of multiple constructed realities” (p. 295). They proposed to refine the criteria of qualitative inquiry to credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). They recommended using specific strategies to achieve trustworthiness, such as negative cases, prolonged engagement and member checks.

Johnson (1997) discusses three types of validity in qualitative research including descriptive validity, interpretative validity and theoretical validity. Descriptive validity entails the qualitative researcher reporting the account with factual accuracy. Interpretive validity refers to the qualitative researcher accurately understanding and reporting the participants' viewpoints, thoughts and attentions, as well as experience in the research report. Theoretical validity refers to the degree that a theoretical explanation developed from a research study fits the data and, therefore, is credible and defensible. To promote research validity in qualitative research, Johnson (1997) suggests that several strategies can be used and some of them are described in Table 11.
Table 12.1. Strategies used to promote qualitative research validity
(Adopted from Johnson (1997, p. 283)

<table>
<thead>
<tr>
<th>Validity in qualitative research</th>
<th>Strategies to promote validity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive validity</td>
<td>Investigator triangulation.</td>
<td>The use of multiple investigators (i.e., multiple researchers) in collecting and interpreting the data.</td>
</tr>
<tr>
<td>Interpretive validity</td>
<td>Participant feedback (member check)</td>
<td>The feedback and discussion of the researcher's interpretations and conclusions with the actual participants and other members of the participant community for verification and insight.</td>
</tr>
<tr>
<td>Low inference descriptors (verbatim)</td>
<td></td>
<td>The use of description phrased very close to participants' account and field notes. Verbatim (i.e., direct quotations) are a commonly used type of low inference descriptions.</td>
</tr>
<tr>
<td>Theoretical validity</td>
<td>Extended fieldwork.</td>
<td>When possible, qualitative researcher should collect data in the field over an extended period of time.</td>
</tr>
<tr>
<td>Theory triangulation</td>
<td></td>
<td>The use of multiple theories and perspectives to help interpret and explain the data.</td>
</tr>
<tr>
<td>Pattern matching</td>
<td></td>
<td>Predicting a series of results that form a &quot;pattern&quot; and then determining the degree to which the actual results fit the predicted pattern.</td>
</tr>
<tr>
<td>Peer review.</td>
<td></td>
<td>Discussion of the researcher's interpretations and conclusions with other people. This includes discussions with a &quot;disinterested peer&quot; (i.e. with another researcher not directly involved). Discussions with peers who are familiar with the research also help provide useful challenges and insights.</td>
</tr>
<tr>
<td>Others</td>
<td>Researcher as &quot;Detective&quot;</td>
<td>A metaphor characterizing the qualitative researcher as her or she searches for evidence about causes and effects. The researcher develops an understanding of the data through careful consideration of potential causes and effects and by systematically eliminating</td>
</tr>
</tbody>
</table>
"rival" explanations or hypotheses until the final "case'" is made "beyond a reasonable doubt." The "detective" can utilize any of the strategies listed here.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangulation</td>
<td>&quot;Cross-checking&quot; information and conclusions through the use of multiple procedures of sources. When the different procedures or sources are in agreement you have &quot;corroboration.&quot;</td>
</tr>
<tr>
<td>Data triangulation</td>
<td>The use of multiple data sources to help understand a phenomenon.</td>
</tr>
<tr>
<td>Methods triangulation</td>
<td>The use of multiple research methods to study a phenomenon.</td>
</tr>
<tr>
<td>Negative case sampling</td>
<td>Locating and examining cases that disconfirm the researcher's expectations and tentative explanation.</td>
</tr>
<tr>
<td>Reflexivity</td>
<td>This involves self-awareness and &quot;critical self-reflection&quot; by the researcher on his or her potential biases and predispositions as these may affect the research process and conclusion.</td>
</tr>
</tbody>
</table>

In this research, I was the sole researcher who conducted all the research and coding. For some research, a single researcher is sufficient and preferred to conduct all the coding; this is particularly true in studies where the researcher needs to build an ongoing relationship with the participants to collect quality data. Since the researcher is the instrument in the qualitative research, he or she is involved in data collection and the analysis process that is so intertwined that they should be integrated within a single person (Bradley, Curry, & Devers, 2007). It took many phases in this research to contact the participants and build trust and relationships with them so as to collect quality information. It would have been difficult if multiple investigators were involved, particularly privacy and sensitive issues. To promote Descriptive validity, I took many measures such as the interviews were audio recorded, transcribed and quoted. The negative cases were reported and analysed. The research also underwent critical self-reflection of the research processes to disclose the issues during the research.

In terms of Interpretive validity, I used low inference descriptors in the form of verbatim, that is, direct quotation of the participants to ensure that the interpretation
was accurate. Moreover, participant feedback was also obtained during the last stage of research to seek agreement from the participants that their thoughts, feelings, viewpoints and experiences were accurately understood. The participants were able to discuss, explain and reflect on the statement they made. I also collected data over time and interviewed the participants on several occasions, so the results are more trustworthy than one-time data collection.

In Theoretical validity, extended fieldwork was used to study the participants' behaviour for a period of 12 months. I started by going to the field and conducting participatory observations in their environment and also participated in some events to understand their lived experience. Follow-up interviews were conducted to track the participants' behaviour after the post-use interviews. In so doing, it can reveal more valuable information and help to refine and explain the phenomenon in a more detailed and intricate way (Johnson, 1997). Theory triangulation (Denzin, 1989) was also used to explain the phenomenon being studied by examining different theories and studies by other researchers. It could provide more insights of the behaviour and help to develop a more cogent explanation (Johnson, 1997).

Finally, triangulation methods were employed in which both qualitative and quantitative research methods were used to compare and enhance the validity of the findings. Triangulation refers to "using two or more sources to achieve a comprehensive picture of a fixed point of reference" (Padgett, 2012, p. 208). Triangulation by data source can be used for confirmation by convergent data from surveys, field notes and interviews, which can reduce bias and the results are more trustworthy. The use of triangulation methodology can provide a more comprehensive understanding of the subject matter and enhance the validity and reliability of the results. Finally, it helps to provide an in-depth and holistic understanding of the phenomenon being studied.

12.4. Contributions

This study has resulted in several contributions to the field of study. First of all, it is
one of the first studies to examine using digital technologies for diabetes self-management especially for Chinese adults in Hong Kong and China. It is also one of the first studies in Hong Kong and China to investigate the persuasive technology design concept for sustainable behavioural change to promote a healthy lifestyle and diabetes management in the Chinese community. It paves the way for future study to gain deeper understanding of the subject matter and helps in designing more effective and user-friendly diabetes management systems for Chinese people with diabetes.

Secondly, this study compared two most common persuasive systems and examined the effectiveness of two types of persuasive strategies in self-management. It identified the importance of user context, including age, gender, cultural, psychosocial, health literacy, and motivation, which help to provide more details in persona development and deeper insights for designing persuasive systems in the future.

Thirdly, it demonstrates that content plays an important part in persuasive systems, especially in the initial stage, to promote long-term behavioural change, which adds knowledge for the field to improve system design. Moreover, it also shows that different persuasive communication strategies in different formats for target users are necessary to maximize the persuasive effects.

Fourthly, it recognised the user needs and values of these systems from the user perspective, providing valuable insights for developing diabetes management systems for Chinese adults with diabetes.

Fifthly, this study identified the relationships between user experience and the behavioural change processes. A model was developed to illustrate how different user experiences are needed in each stage of behavioural change that can provide guiding concepts in persuasive system design.

Finally, this study also developed several models and frameworks for long-term behavioural change design, which could serve as guidance for developing persuasive systems to support behavioural change over time. The knowledge in this study is not
only beneficial to the field of design, but also other disciplines including, for example, healthcare and health communication.

12.5. Limitations

There were several limitations in this study, including the use of methodology and the findings, as well as the study itself.

- Use of methodology

In the use of methodology, first of all, the number of participants in this study was small – a total of 13 participants in the user evaluation and design prototype research. The small number of participants may not include all the experience and feedback from the larger diabetes population; for example, the mobile group was dominated by male participants. Moreover, the diabetic patients in this study were relatively successful in controlling their disease since they had not developed any complications so far. Nevertheless, the samples in this research were specially selected to represent different demographics such as different age cohorts, health literacy, education, as well as working status. The diversity of demographics has provided a broader view of the users’ needs and concerns, as well as the problems they perceived when using these systems. The research not only discovered some common needs of diabetic patients, but also identified individual differences according to age, gender, lifestyle, perception, health literacy, and so on. As an exploratory nature of this study, it provides some general concerns of the diabetes systems and paves the way for further studies. A larger scale of study including more diverse user groups is suggested in future studies.

Secondly, the research was only limited to two types of persuasive strategies and also using existing systems that could not be changed or tailor-made to include special features according to the wishes of the researcher. For example, I was not able to fix the bugs of the system during the study and had to ask for help from the developer of the system to fix them; the mobile systems were only available in simplified Chinese; I was also not able to add or delete some features in the systems. Nevertheless, the use
of existing systems did show some critical issues that may not be detected when using a prototype, for instance, the technical problem as mentioned before, the contextual factors, and the lack of support for the health care providers may all affect the motivation to use the systems.

Thirdly, the design prototype was in paper format due to the limitation of time and resources; it was not able to identify the interaction and user experience aspects of the prototype. Nevertheless, even with the use of a paper prototype, the user needs and values were discovered, which could provide valuable insights for future design.

Moreover, the participants in this research were only given the systems for use over a specific duration. Hence, it did not show how the use of different forms of information presentation, in this case narrative or graphics, affect the health behavioural change processes since it is not the purpose of this study. In the future, one could consider conducting research of the health behavioural change processes from self-reflection, to action and form a habit by using a series of persuasive and motivation strategies.

- The research findings

In terms of the research findings, firstly, the research period in this study was about 12 months, which was relatively short compared to requiring a long-term, lifetime self-management of a diabetic patient. However, as a habit can be formed in 6 to 12 months’ time, this study demonstrated in the follow-up research how the participants' behaviour has or has not changed regarding their motivation to use the systems. This is valuable information that is rarely studied in the related literature, which could also give insights for future studies.

Secondly, the research mainly relied on self-reporting. I was not able to watch and observe how the participants used the systems in their natural environment and could only rely on what the participants said and the information they provided. The participants also failed to provide photos or writing regarding their daily activities and emotions about diabetes and the diabetes systems as I originally planned. Furthermore,
I could not check the participants' physical health data, such as blood sugar level, HbA1c, BMI, as well as cholesterol due to safety concerns. Nevertheless, I recorded the body weight before and after the user evaluation section for comparison. Moreover, this research used a variety of research methods, including quantitative and qualitative research to verify the findings and it is believed that it can provide a more thorough understanding of the participants’ behaviour. In the coming future, with the prevalence of smart phones and cheaper technologies, recording of images and voices is much easier to conduct. It is expected that the same kind of research can be conducted easily by the participants, and researchers should also give more specific guidance to the participants in the future.

Thirdly, the use of smart phones in self-management was relatively new to the Chinese older adults in Hong Kong at the time of the research. Many older adults may not be familiar with using smart phones, which could affect their motivation to use them. With the prices of smart phones decreasing, many older adults can own and use the devices and become more familiar with using them, so it may affect their perception and motivation to use them.

• The study

Finally, due to the fact that this research was conducted by a sole researcher, there was a shortage of resources including time, money and manpower. Future study could benefit from more resources, for example, to develop a digital design prototype, which could be able to develop different kinds of persuasive strategies for user testing and better understand the user experience and persuasive effects.

12.6. Recommendations for Future Studies

Several recommendations are suggested according to the limitations of the study:

• More stakeholders and diversified sampling
It is suggested that future studies should include a larger number and more diverse demographics of participants such as different age groups and different stages of the disease to gain better understanding of their barriers and self-management behaviour, as well as the use of technology. To study the patients with lower motivation and those who have developed complications are also helpful to obtain an in-depth understanding of the persuasive effects of the systems and what kinds of features are most essential for these types of patients. Moreover, the study of people with different stages of disease would also be valuable to comprehend different needs and the features required of the systems. One may also consider studying participants with other chronic illnesses such as heart disease or chronic pain to see if the framework is equally applicable to them. Quantitative research is also recommended to investigate a larger diabetes population to test the findings in this study.

In the future, it would also be useful to study the perception of caregivers and healthcare providers regarding the use of e-health in self-management in Hong Kong. They may also be invited as part of the e-health system to give emotional and/or clinical support to the patients. After all, a good healthcare system is not about technology, but supportive infrastructure. The involvement of healthcare providers in future research would also help to check the blood sugar level of the patients before and after the research so that more detailed results can be obtained.

- **Provide clear guidelines in contextual inquiry**

The use of the systems in the future should be in Traditional Chinese, and consider the cultural aspects such as food types and food names to eliminate the effects that may be caused by cultural issues. Furthermore, researchers should provide a clearer guidance to the participants in the culture probe. When doing research with older adults, care should be taken that the tasks are simple and easy to perform as well as avoiding tasks that require long-term memory since some of them may have cognitive and memory decline.

- **Study persuasive processes**
Future research can examine the health behavioural change processes by using a series of persuasive and motivation strategies to see if different strategies affect behaviour in different stages, for example, using narrative strategies to promote self-reflection at the beginning, and then introducing graphical and statistical strategies for recording their daily activities to help the patients understand the relationships between their health and their behaviour. It is also suggested that other forms of persuasive strategies be examined such as motivation quotes, social influence such as social media, peer group and healthcare providers’ involvement, or a combination of different strategies.

- **Test the models in other types of behavioural intervention**

It is also recommended to apply the models and frameworks in other types of behavioural intervention such as smoking, gambling, or wasteful behaviour to see if the framework is equally applicable to other behavioural intervention design. This can help to enrich the design concepts and broaden the applications in different fields of behavioural change and intervention. It would also be useful to compare cultural differences and different types of behavioural intervention in the future.

- **Study social and environmental problems**

This study about design for behavioural change is focused on the individual level and how technology-mediated persuasion can assist the change. However, as indicated in the literature review and the findings in this study, behavioural change and chronic management are complex and involve different levels including social, environmental, and institutional, so future study should also examine how these factors and their interactions affect behavioural change and chronic management.

For example, in the research, it was found that most of the older Chinese adults did not like to engage in virtual communities for social support. They preferred family members, close friends, and people they can trust in the physical world. Hence,
understanding their social interaction, such as family, friends, and healthcare providers, can provide valuable information to enhance the healthcare experience as well as support behavioural change. Furthermore, the study of using social media and social relationships of Chinese older adults is also needed to develop a more humane social support system to enhance social well-being and improve health over the long term.

- **Research the existing users of persuasive systems**

At the time of the research, the diabetes persuasive systems in a Chinese version were new and very limited in the market, so it was difficult to find existing users to conduct research on. It is suggested that in future studies research be conducted on existing users of these systems to help to gain valuable insights since they will have rich and stable experience and interaction with these systems. A comparative study of new and existing users, as well as Chinese and Western countries’ users may also provide interesting findings.

- **Develop a business model for diabetes self-management systems**

Due to the limitation of time and resources, as well as the scope of the study, this thesis was not able to develop a business model for diabetes self-management systems. In the future, it is suggested that a business model be developed that connects the patients, their family members, as well as the healthcare providers in a system, which can build infrastructure to facilitate effective chronic care and maintain healthy behavioural change.

- **Ethical issues**

A future study should also examine the ethical issues which are largely ignored in the persuasive systems and behavioural change studies (Oinas-Kukkonen, 2013). Many important issues need to be recognised and considered in the research, for example, the intention of the senders such as the developers and designers, the user's
voluntariness regarding change in using the system, if there is any potential harmful side-effect to users or other stakeholders, potential ways of abusing the system, the designer or researcher bias, and so on. All these issues need to be carefully considered during the planning process and the details should be clearly revealed to ensure a creditable and quality study.
Appendix A: Persuasive Systems Design Model (PSD Model) (Oinas-Kukkonen & Harjumaa, 2008; Torning & Oinas-Kukkonen, 2009)

Table 1. Primary task support

<table>
<thead>
<tr>
<th>Principle</th>
<th>Example requirement</th>
<th>Example implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Reduction</strong></td>
<td>Mobile application for healthier eating habits lists proper food choices at fast food restaurants [24].</td>
<td>System should reduce effort that users have in regard to performing their target behavior. Smoking cessation web site provides an interactive test which measures how much money a user will save with quitting.</td>
</tr>
<tr>
<td><strong>2. Tunneling</strong></td>
<td>System should guide users in the attitude change process by providing means for action that brings closer to the target behavior. Smoking cessation web site offers information about treatment opportunities after a user has answered an interactive test about how addicted (s)he is on tobacco.</td>
<td>Personal trainer Web site provides different information content for different user groups, e.g. beginners and professionals.</td>
</tr>
<tr>
<td><strong>3. Tailoring</strong></td>
<td>System should provide tailored information for its user groups.</td>
<td>Web site for recovering alcoholics presents a user such stories which are close to one’s own story.</td>
</tr>
<tr>
<td><strong>4. Personalization</strong></td>
<td>System should offer personalized content and services for its users. Users are able to change the graphical layout of an application or the order of information items at a professional Web site.</td>
<td>Heart rate monitor presents a user’s heart rate and the duration of the exercise.</td>
</tr>
<tr>
<td><strong>5. Self-monitoring</strong></td>
<td>System should provide means</td>
<td>Mobile phone application</td>
</tr>
</tbody>
</table>
A system that helps track one’s own performance or status supports in achieving goals. | for users to track their performance or status. | presents daily step count [3].

**6. Simulation**
Systems that provide simulations can persuade by enabling them to observe immediately the link between the cause and its effect. | System should provide means for observing the link between the cause and effect in regard to their behavior. | Before and after pictures of people who have lost weight are presented on a Web site.

**7. Rehearsal**
A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world. | System should provide means for rehearsing a target behavior. | A flying simulator.

**Table 2. Dialogue Support**

<table>
<thead>
<tr>
<th>Principle</th>
<th>Example requirement</th>
<th>Example implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8. Praise</strong></td>
<td>System should use praise via words, images, symbols, or sounds as a way to give positive feedback for a user. Mobile application which aims at motivating teenagers to exercise praises user by sending automated text-messages for reaching individual goals. [24]</td>
<td>Heart rate monitor gives a user a virtual trophy if they follow their fitness program.</td>
</tr>
<tr>
<td><strong>9. Rewards</strong></td>
<td>System should provide virtual rewards for users in order to give credit for performing the target behavior.</td>
<td>Game rewards users by altering media items, such as sounds, background skin, or a user’s avatar according to user’s performance. [21]</td>
</tr>
<tr>
<td><strong>10. Reminders</strong></td>
<td>System should remind users of their target behavior during the use of the system.</td>
<td>Caloric balance monitoring application sends text-messages for their users as daily reminders. [10]</td>
</tr>
<tr>
<td><strong>11. Suggestion</strong></td>
<td>System should suggest users certain behaviors during the system use process.</td>
<td>Application for healthier eating habits suggests children to eat fruits instead</td>
</tr>
</tbody>
</table>
greater persuasive powers.

| 12. Similarity | People are more readily persuaded through systems that remind themselves in some meaningful way. | System should imitate its users in some specific way. | Slang names are used in an application which aims at motivating teenagers to exercise. [24] |

| 13. Liking | A system that is visually attractive for its users is likely to be more persuasive. | System should have a look and feel that appeals to its users. | Web site which aims at encouraging children to take care of their pets properly has pictures of cute animals. |

| 14. Social role | If a system adopts a social role, users will more likely use it for persuasive purposes. | System should adopt a social role. | E-health application has a virtual specialist to support communication between users and health specialists. [19] |

| Table 3. System credibility support |
|---|---|---|
| Principle | Example requirement | Example implementation |
| 15. Trustworthiness | A system that is viewed as trustworthy (truthful, fair, and unbiased) will have increased powers of persuasion. | System should provide information that is truthful, fair and unbiased. | Company Web site provides information related to its products rather than simply providing advertising or marketing information. Company Web site provides information about their core know-how. |
| 16. Expertise | A system that is viewed as incorporating expertise (knowledge, experience, and competence) will have increased powers of persuasion. | System should provide information showing expertise. | Company Web site is updated regularly and there are no dangling links or out-of-date information. |
| 17. Surface credibility | People make initial assessments of the system credibility based on a firsthand inspection. | System should have competent look and feel. | There are only a limited number of and a logical reason for ads on a company Web site. |
| 18. Real-world feel | A system that highlights people or organization behind its | System should provide information of the organization and/or actual | Company Web site provides possibilities to contact specific people through |
content or services will have more credibility.

| 19. Authority | System should refer to people in the role of authority. Web site quotes an authority, such as a statement by government health office. | E-shop shows a logo of a certificate which assures that they use secure connections. |
| Third-party endorsements | System should provide endorsements from respected sources. | Web site refers to its reward for high usability. |
| Verifiability | System should provide means to verify the accuracy of site content via outside sources. | Claims on a Web site are supported by offering links to other web sites. |

Table 4. Social Support

| 22. Social learning | System should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior. | A shared fitness journal in a mobile application for encouraging physical activity. [3] |
| Social comparison | System should provide means for comparing performance with the performance of other users. | Users can share and compare information related to their physical health and smoking behavior via instant messaging application. [21] |
| Normative influence | System should provide means for gathering together people who have the same goal and get them to feel norms. | Possibility to challenge relatives or friends to quit smoking from a web site via email or text message. |
| **25. Social facilitation**  
System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them. | System should provide means for discerning other users who are performing the behavior. | A shared fitness journal in a mobile application for encouraging physical activity. [3] |
| --- | --- | --- |
| **26. Cooperation**  
A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate. | System should provide means for co-operation. | The behavioral patterns of overweight patients are studied through a mobile application, which collects data and sends it to a central server where it can be analyzed in detail. [10] |
| **27. Competition**  
A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete. | System should provide means for competing with other users. | Online competition, such as Quit and Win (stop smoking for a month and win a prize). |
| **28. Recognition**  
By offering public recognition (for an individual or a group), a system can increase the likelihood that a person or group will adopt a target attitude or behavior. | System should provide public recognition for users who perform their target behavior. | Personal stories of the people who have succeeded in their goal behavior are published on a Web site. Names of awarded people, such as “quitter of a month”, are published on a Web site. |
Appendix B - Phase 2 Survey Questionnaire

**Project title:**
An Aesthetic Experience Approach to Designing Monitoring Systems for Chronic-conditioned People to Support Self-care - The Case in Hong Kong

**Questionnaire**

**Introduction**

The questionnaire aims at understanding the contexts of the chronic disease patients in terms of their disease and how they affect their self-management and the use of medical devices. In order to protect privacy, the name of this questionnaire will be kept anonymous and will be identifiable by codes only known to the researcher. All the information will be kept strictly confidential and for analysis only.

**Objectives**

1. To understand how the contexts affect the self-management, the use of medical devices and the perception of e-health.
Questions

About Diabetes Mellitus and Self-management

4. How long have you been diagnosed with diabetes mellitus?
   - [ ] Less than 1 year
   - [ ] 1 - 3 years
   - [ ] 3 - 5 years
   - [ ] Over 5 years

5. Besides diabetes mellitus, do you have other chronic diseases? If yes, please indicate what are they?
   - [ ] None
   - [ ] Heart disease
   - [ ] Respiratory disease
   - [ ] Hypertension
   - [ ] Arthritis
   - [ ] Others, please specify:

   ___________________________________________________________

6. How much do you know about diabetes mellitus?
   - [ ] Not much
   - [ ] A little
   - [ ] Some
   - [ ] Many
   - [ ] Very much

7. Do you understand the health risks that are caused by diabetes mellitus?
   - [ ] Not much
   - [ ] A little
   - [ ] Some
   - [ ] Many
   - [ ] Very much

8. How do you manage your disease? (You can tick more than one)
   - [ ] See the doctor
   - [ ] Take medicine
   - [ ] Insulin
   - [ ] Check blood sugar
   - [ ] Diet control
   - [ ] Do exercise
   - [ ] Seek Traditional Chinese Medicine
   - [ ] Others, please specify:

   ___________________________________________________________

9. Which part of the self-management is most challenging to you? (You can tick more than one)
   - [ ] Take medication on time
   - [ ] Check blood sugar daily
☐ Diet control  ☐ Do exercise regularly
☐ Record the health data  ☐ Follow up regularly

7. Do you use the glucose meter to test your blood sugar regularly everyday?
☐ Yes  ☐ No (please go to question 8)

8. Why you do not check your blood sugar regularly ?
☐ Feel no need  ☐ Not convenient  ☐ Difficult to use
☐ Don't like the style  ☐ Too painful to use
☐ Others, please specify:

_____________________________________________

9. Does your disease affect your daily life? (If yes, please answer question 10)
☐ No  ☐ A little  ☐ Some  ☐ Many  ☐ Very much

10. Which part of your daily life is most affected by your disease?
☐ Work  ☐ Daily routine  ☐ Family relationships
☐ Leisure activity  ☐ Social life  ☐ Diet habit
☐ Other, please specify:

_____________________________________________

11. Does your disease affect your emotions?
☐ None  ☐ A little  ☐ Some  ☐ Many  ☐ Very much

12. Do you feel stressed or worried with your self-management?
☐ No  ☐ A little  ☐ Some  ☐ Many  ☐ Very much

13. How importance it is of the support of your family or friends in your self-management?
14. Did you find information about self-management? If yes, which source did you use? (You can tick more than one)

☐ No  ☐ Yes (please tick the following)

☐ Friend  ☐ Family member  ☐ Health care providers

☐ Internet  ☐ Newspapers  ☐ Magazines  ☐ Books

☐ Others, please specify ________________________________

15. Did you admit to the hospital in the last 12 months due to the disease or the complication of the disease?

☐ Yes  ☐ No

16. Do you think that if you can check your health data (e.g., blood sugar level, food nutrition, blood pressure, etc.) by tracing the historical graphs by yourself, it can help to control your disease and improve your health more effectively?

☐ Yes  ☐ May be  ☐ No

17. Do you think that if you can monitor your health by using digital technologies such as Internet or smart phone, it can help you to manage your health more effectively and efficiently?

☐ Yes  ☐ May be  ☐ No

18. Do you think if your doctors or other healthcare providers can trace your health data (e.g., blood sugar level, food nutrition) everyday and give you guidance accordingly, it can control your disease and improve your health better?

☐ Yes  ☐ May be  ☐ No

19. If you can use digital technologies to monitor your health, which kind of device do you prefer to use?

☐ Computer  ☐ Smart phone  ☐ Tablet  ☐ Smart clothes

☐ Smart jewelry or watch  ☐ Embedded in other appliance  ☐ On the wall
Personal information

- Gender
  - Male
  - Female

- Age
  - 39 or below
  - 40 - 49
  - 50 - 59
  - 60 - 69
  - 70 or above

- Marital status
  - Single
  - Married
  - Divorced
  - Widowed

- Working status
  - Full-time
  - Part-time
  - Unemployed
  - Retired

- Income per month
  - <HK$3,000
  - HK$3,001 - HK$6,000
  - HK$6,001 - HK$10,000
  - > HK$10,001

- Educational Level
  - Primary school
  - Secondary school
  - Tertiary
  - University

- Total number of family member living with you (including yourself)
  - 1
  - 2
  - 3 - 5
  - More than 5

- Do you use the following devices?
  - Computer for documentary only
  - Computer for documentary & Internet
  - Smart phone
  - Tablet
  - None of the above

Thank you for your co-operation!

Your name: ______________________________ Contact Tel: _____________________
問卷調查

有關糖尿病及自我管理

1. 請問你患此病症有多久？
   - □ 少過 12 個月  □ 1 - 3 年  □ 3 - 5 年  □ 超過 5 年

2. 除了糖尿病之外，請問你還有沒有其他的長期病症？如有，請說明。
   - □ 沒有
   - □ 心臟病  □ 呼吸道疾病  □ 高血壓  □ 關節炎
   - □ 其他，請說明：_____________________________________________

3. 你對於糖尿病有多少認識？
   - □ 不清楚  □ 少許  □ 一些  □ 很多  □ 非非常多

4. 你對於糖尿病的風險有多少認識？
   - □ 不清楚  □ 少許  □ 一些  □ 很多  □ 非非常多

5. 你怎樣處理你的疾病？(你可選擇多過一項)
   - □ 看醫生  □ 吃藥  □ 打胰島素針  □ 驗血糖
   - □ 食物控制  □ 做運動  □ 看中醫
   - □ 其他，請說明：_____________________________________________

6. 在自我管理中，那部份對你是最大的困難？
   - □ 定時食藥或打針  □ 每天測量血糖指數
   - □ 控制飲食  □ 經常做運動
   - □ 記錄健康指數  □ 定期覆診

7. 你有否每天用血糖機去測血糖指數？
   - □ 有  □ 沒有 (請答問題 8)
8. 為何你沒有定時用血糖機去測血糖指數？ (你可選擇多過一項)

☐ 覺得無需要 ☐ 不方便 ☐ 很難用
☐ 不喜歡那個款式 ☐ 用時太痛
☐ 其他，請說明：_____________________________________________

9. 你的疾病有否影響你的日常生活？ (如有，請答問題 17)

☐ 沒有 ☐ 少許 ☐ 一些 ☐ 很多 ☐ 非非常多

10. 你的疾病最影響你日常生活的那一部份？

☐ 工作 ☐ 日常秩序 ☐ 家庭關係
☐ 休閒活動 ☐ 社交生活 ☐ 飲食習慣
☐ 其他，請說明：_____________________________________________

11. 你的疾病有否影響你的情緒？

☐ 沒有 ☐ 少許 ☐ 一些 ☐ 很多 ☐ 非非常多

12. 你有否對於"自我管理"覺得有壓力或感到焦慮？

☐ 沒有 ☐ 少許 ☐ 一些 ☐ 很多 ☐ 非非常多

13. 你家人或朋友的支持對你的"自我管理"是否重要？

☐ 不重要 ☐ 少許 ☐ 一般 ☐ 重要 ☐ 非非常重要

14. 你有否找尋"自我管理"的資料？如有，用何種途徑？ (你可以選擇多過一項)

☐ 沒有 ☐ 有 (請你選擇以下)
☐ 朋友 ☐ 家人 ☐ 醫護人員
☐ 上網 ☐ 報紙 ☐ 雜誌 ☐ 書本
☐ 其他，請說明：_____________________________________________
15. 你在過去的 12 個月內，有否因此病症或併發症而需要進醫院？

□ 有    □ 沒有

16. 如果你自己能夠利用圖表去檢查及跟蹤你一直以來的健康指數 (例如糖尿水平、食物營養、血壓水平)，你覺得會否更能有效地控制你的疾病及改善你的健康？

□ 會    □ 也許    □ 不會

17. 如果你能夠利用電子科技，例如互聯網、手機等，去自己檢查你的健康指數，你覺得會否更能有效及方便地控制你的疾病及改善你的健康？

□ 會    □ 也許    □ 不會

18. 如果你的醫生或醫護人員能夠監察你的健康指數及適時給你指引，你覺得會否更能有效及方便地控制你的疾病及改善你的健康？

□ 會    □ 也許    □ 不會

19. 如果你可用“電子保健”去監察你的健康，你會選擇那一種設備？

□ 電腦    □ 智能電話    □ 平板電腦    □ 智能衣服

□ 智能首飾或手表    □ 附在家居電器或家具上    □ 附在家居牆上

□ 其他，請說明 ____________________________

個人資料

1. 性別

□ 男    □ 女

2. 年齡

□ 39 歲或以下 □ 40 - 49 歲 □ 50 - 59 歲 □ 60 - 69 歲 □ 70 歲或以上

3. 婚姻狀況

□ 單身    □ 已婚    □ 離婚    □ 喪偶
4. 工作
    □ 全職  □ 兼職  □ 失業  □ 退休

    ● 每月收入
      □ HK$3,000 以下  □ HK$3,000 - HK$6,000  □ HK$6,001 - HK$10,000
      □ HK$10,001 以上

    ● 教育程度
      □ 小學  □ 中學  □ 大專  □ 大學

    ● 家中總成員 (連你自己在內)
      □ 1  □ 2  □ 3 - 5  □ 多過 5 人

    ● 你有否用以下的電子設備?
      □ 電腦文書  □ 電腦文書及上網  □ 智能電話  □ 平板電腦  □ 以上皆無

    謝謝你的合作！

姓名: ________________________________

聯絡電話: ________________________________
Appendix C - Phase 2 Survey Results

- How long have you been diagnosed with diabetes mellitus?  (Total response n = 97)

- Besides diabetes mellitus, do you have other chronic diseases? If yes, please indicate what are they?  (Total response n = 92)
• How much do you know about diabetes mellitus? (Total response n = 95)

![Bar chart showing knowledge levels about diabetes mellitus.]

• Do you understand the health risks that are caused by diabetes mellitus? (Total response n = 96)

![Bar chart showing understanding levels of health risks associated with diabetes mellitus.]

• How do you manage your disease? (You can tick more than one) (Total response n = 97)

![Bar chart showing various management methods for diabetes mellitus.]

375
6. Which part of the self-management is most challenging to you? (Total response n = 94)

Which part of the self-management is most challenging to you?

- None
- Take medicine on time
- Check blood sugar every day
- Diet control
- Do exercise regularly
- Record the blood sugar level
- Follow up regularly

Total response n = 94

<table>
<thead>
<tr>
<th>Age</th>
<th>None</th>
<th>Take medicine on time</th>
<th>Check blood sugar every day</th>
<th>Diet control</th>
<th>Do exercise regularly</th>
<th>Record blood sugar level</th>
<th>Follow up regularly</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>39 or below</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>4</td>
</tr>
<tr>
<td>40 - 49</td>
<td>0%</td>
<td>13%</td>
<td>17%</td>
<td>38%</td>
<td>21%</td>
<td>13%</td>
<td>0%</td>
<td>24</td>
</tr>
</tbody>
</table>
7. Do you use the glucose meter to test your blood sugar regularly everyday? (Total response n = 91)

8. Why you do not check your blood sugar regularly? (Total response n = 40)
• Does your disease affect your daily life? (If yes, please answer question 10) (Total response n = 92)

• Which part of your daily life is most affected by your disease? (Total response n = 84)
6  Does your disease affect your emotions? (Total response n = 93)

![Bar chart showing the percentage of respondents for different levels of disease emotional impact.}

7  Do you feel stressed or worried with your self-management? (Total response n = 93)

![Bar chart showing the percentage of respondents for different levels of self-management stress.}

8  How important is the support of your family or friends in your self-management? (Total response n = 93)

![Bar chart showing the percentage of respondents for different levels of family support.}
14. Did you find information about self-management? If yes, which source did you use? (You can tick more than one) (Total response n = 89)

![Bar chart showing the percentage of respondents who found information about self-management from various sources. The sources are: None (27%), Friends (18%), Family (15%), Health care providers (44%), Internet (19%), Newspapers (26%), Magazines (27%), Books (23%).]

15. Did you admit to the hospital in the last 12 months due to the disease or the complication of the disease? (Total response n = 87)

![Pie chart showing the percentage of respondents who admitted to the hospital in the last 12 months due to the disease or the complication of the disease. 17% said Yes, and 83% said No.]

10. Do you think that if you can check your health data (e.g., blood sugar level, food nutrition, blood pressure, etc.) by tracing the historical graphs by yourself, it can help to control your disease and improve your health more effectively? (Total response n = 93)

17. Do you think that if you can monitor your health by using digital technologies such as Internet or smart phone, it can help you to manage your health more effectively and efficiently? (Total response n = 92)
18. Do you think if your doctors or other healthcare providers can trace your health data (e.g., blood sugar level, food nutrition) everyday and give you guidance accordingly, it can control your disease and improve your health better? (Total response n = 92)

![Bar chart showing the response distribution.](image)

19. If you can use digital technologies to monitor your health, which kind of device do you prefer to use? (Total response n = 76)

![Bar chart showing the device preference.](image)
If you can use digital technologies to monitor your health, which kind of device do you prefer to use?

<table>
<thead>
<tr>
<th>Category</th>
<th>Computer</th>
<th>Smartphone</th>
<th>Tablet</th>
<th>Smart clothes</th>
<th>Smart watch or smart jewelry</th>
<th>Embedded in other appliance</th>
<th>Hanged on the wall</th>
<th>Total Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 39</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2</td>
</tr>
<tr>
<td>40 - 49</td>
<td>40%</td>
<td>15%</td>
<td>10%</td>
<td>0%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>20</td>
</tr>
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<td>50 - 59</td>
<td>13%</td>
<td>43%</td>
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<td>0%</td>
<td>23%</td>
<td>10%</td>
<td>0%</td>
<td>30</td>
</tr>
<tr>
<td>60 - 69</td>
<td>33%</td>
<td>33%</td>
<td>10%</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>3%</td>
<td>30</td>
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<tr>
<td>Over 70</td>
<td>18%</td>
<td>18%</td>
<td>0%</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
<td>36%</td>
<td>11</td>
</tr>
<tr>
<td>Total Respondeents</td>
<td>24</td>
<td>29</td>
<td>8</td>
<td>2</td>
<td>16</td>
<td>7</td>
<td>7</td>
<td>93</td>
</tr>
</tbody>
</table>
Appendix D - Task Guidelines for the Diabetes Systems

Rehabilitation Website

- Register a new user name and password.
- Select patient user
- Find the information about diabetes management and answer the questions.
- Go back to the homepage
- Go to diet control
- Go to food converter and check fruits
- Go to drug chart
- Go to music relaxing exercise
- Go to exercise
- Go to drug therapy
- Go to blood sugar recorder and download the record list
- Go to action plan
- Go to exercise recorder
- Go to discussion forum
- Go back to homepage
- You can explore a little bit of the website
- Exit the website

Mobile Application

20. Go to "Setting"
21. Enter your personal information. E.g., name, weight, height, etc. If you need change the unit, please do so now
22. Enter your food today and calculate the calories consumption (if necessary)
23. Enter your food yesterday and calculate the calories consumption (if necessary)
24. Enter your activity/exercise today and calculate the calories consumption (if necessary)
25. Enter your activity/exercise yesterday and calculate the calories consumption (if necessary)
26. Enter your blood sugar data in the last 3 times
27. Check your food, exercise and blood sugar records in the last few days
28. You can browse the rest of the application
復康會網站

1. 請註冊及開一個新用戶戶口
2. 選擇“患者”
3. 進入到 "「自療」糖尿病 - 糖尿病與自我管理" 部份並解答問題
4. 返回主目錄
5. 進入"識飲又識食 - 飲食與血糖控制（一）"
6. 進入"食物換算"及選擇 "水果"
7. 進入"藥物表"
8. 進入"肌肉鬆弛練習"
9. 進入"運動練習"
10. 進入 "乖乖服藥 - 糖尿病藥物治療"
11. 進入 "血糖記錄表" 及下載表格
12. 進入 "行動計劃"
13. 進入 "運動記錄表"
14. 進入 "討論區"
15. 返回主目錄
16. 你可以以一分鐘瀏覽網站其他部份
17. 離開網站

智能手機應用程式 (Kiwi 血糖管理助手)

1. 請到 "設置"
2. 填上你的個人資料，例如名字、年齡、身高、體重，等，如果需要變更設置，請於此時更改
3. 新建你"今天"的早餐前的血糖度數
4. 新建你"今天"的午飯後的血糖度數
5. 新建你"昨天"的早餐前的血糖度數
6. 新建你"昨天"的午飯後的血糖度數
7. 於"數據曲線"內查看你記錄過的血糖記錄
8. 於"分析報告"內查看你記錄過的血糖記錄
9. 到 “血糖知識”內查看一些糖尿病知識
10. 到 “設置”內設定 “我的提醒” ，設定測量血糖的提醒
11. 你可用一分鐘去瀏覽這個應用程式的其他部份

智能手機應用程式 (減肥助手)

1. 請註冊及開一個新用戶戶口
2. 填上你的個人資料，例如名字、年齡、身高、體重，等，如果需要變更設置，請於此時更改
3. 請到 “信息設置”，填上你的起始體重、目標體重、身高、生日、姓別等，然後 “立即保存”
4. 返回首頁，選擇 “瘦身工具”，選擇 “一分鐘肥胖測試”，然後填上適當資料， ”進行計算”
5. 返回前一頁，選擇 “體重指數 (B MI )”，然後填上適當資料， ”進行計算”
6. 返回前一頁，選擇 “基礎代謝計算器”，然後填上適當資料，”進行計算”
7. 返回前一頁，選擇 “身高體重標準”， ”進行計算”
8. 返回首頁，選擇 “體重記錄”，然後”立即保存”
9. 到 “食物庫”，選擇 “谷類”，選擇 “米飯”，加入“收藏”，加入“晚餐”，填上 ”200” 克，然後”立即保存”
10. 返回 “食物”，選擇“蔬菜”，選擇 “紅蘿蔔”，加入“收藏”，加入“晚餐”，填上 ”100” 克，然後”立即保存”
11. 返回 “食物”，選擇 “禽肉”，選擇 “雞”，加入“收藏”，加入“晚餐”，填上 ”150” 克，然後”立即保存”
12. 返回 “食物”，選擇 “畜肉”，選擇 “豬肉 (肥瘦)”，加入“收藏”，加入“晚餐”，更改日期， 填上 ”200” 克，然後”立即保存”
13. 返回 “食物”，選擇 “菜類”，選擇 “廣東菜”，選擇 “皮蛋瘦肉粥”查看
14. 返回首頁，到 “運動”，選擇 “步行活動”，選擇 “走路上班或上學”，選擇 “添加運動”， ”收藏運動”， 填上 ”30“ 分鐘，然後”立即保存”
15. 或可選擇 “計時器”，填上適當資料，然後”立即保存”
16. 返回 “運動”， “步行活動”，選擇 “散步”，選擇 “添加運動”， ”收藏運動”，填上”60“ 分鐘，然後”立即保存”
17. 返回 “運動”， “步行活動”，選擇 “散步”，選擇 “添加運動”， ”收藏運動”，更改日期， 填上 ”40“ 分鐘，然後”立即保存”
18. 返回前一頁，選擇 “爬梯子”，選擇 ”添加運動”， ”收藏運動”，更改日期，填上 ”20“ 分鐘，然後
立即保存

19. 返回首頁，選擇 "每日步數記錄"，填上"1500" 步，然後"立即保存"

20. 返回首頁，選擇 "圖表分析"，按 "二周"，"熱量統計"，"步數統計"

21. 選擇 "日歷"，查看 "消耗大卡"，"平衡大卡"

22. 到 "論壇"，查看內面的資料

23. 關於隱私問題，請到 "信息設置" 修改

24. 返回首頁，查看今天體重及體重變化，可更改前數天體重以此測試

25. 你可用一分鐘去瀏覽這個應用程式的其他部份
## Appendix E - Phase 4 Research - Questionnaire

### Opinions of the Diabetes Systems

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>A.</td>
<td>1. This website or application make me feel pleasant</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>2. I like the look and feel of the website or application</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>3. This website or application looks attractive</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>4. When I was using it I was totally focus on it</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>B.</td>
<td>5. I feel that this website or application is easy to use</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>6. It is clear and easy to understand</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>7. I can easily find the information I was looking for</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>8. I can enter the data very easily</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>9. I should be very familiar with this website or application</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>C.</td>
<td>10. This website or application can allow me to choose the plan or functions that are suitable for me</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>D.</td>
<td>11. This website or application can enhance my knowledge about diabetes</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>12. This website or application can allow me to learn new knowledge</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>13. This website or application can provide me with necessary information and features</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>14. This website or application can give me adequate advice</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>E.</td>
<td>15. Use this website or application can allow me more effective in my self-management</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>16. Use this website can help me to improve my health</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>17. Use this website can make me more confident to manage my disease</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>F.</td>
<td>18. The design of this website or application is suitable for me</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>19. This website or application can meet my needs</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>20. This website or application have good interaction with me</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>G.</td>
<td>20. This website or application have good interaction with me</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>H.</td>
<td>21. This website or application can allow me to connect</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
with the others

I.
22. I am satisfy with this website or application 1 2 3 4 5 6 7
23. I intend to use this website or application in the future 1 2 3 4 5 6 7

<table>
<thead>
<tr>
<th>What kind of factors are most important to you with this kind of website or application?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Simple and easy to use 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>2. Beautiful and attractive 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>3. Timely and convenient 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>4. Give me adequate support when I need it 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>5. Facilitate me to connect with others 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>6. Allow me to choose suitable plan or features 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>7. Enhance my knowledge about diabetes and self-management    1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

Opinions of the Diabetes Systems (Reference)

<table>
<thead>
<tr>
<th>A. Aesthetic experience</th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. This website or application make me feel pleasant 1 2 3 4 5 6 7</td>
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<td></td>
</tr>
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<td>3. This website or application looks attractive 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When I was using it I was totally focus on it 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Perceived control (competence)

| 5. I feel that this website or application is easy to use 1 2 3 4 5 6 7 |
| 6. It is clear and easy to understand 1 2 3 4 5 6 7 |
| 7. I can easily find the information I was looking for 1 2 3 4 5 6 7 |
| 8. I can enter the data very easily 1 2 3 4 5 6 7 |
| 9. I should be very familiar with this website or application 1 2 3 4 5 6 7 |

C. Autonomy

| 10. This website or application can allow me to choose the plan or functions that are suitable for me 1 2 3 4 5 6 7 |

D. Exposit/ expound

| 11. This website or application can enhance my knowledge about diabetes 1 2 3 4 5 6 7 |
| 12. This website or application can allow me to learn new knowledge 1 2 3 4 5 6 7 |
| 13. This website or application can provide me with necessary information and features 1 2 3 4 5 6 7 |
| 14. This website or application can give me adequate advice 1 2 3 4 5 6 7 |

E. Provide meaning

| 15. Use this website or application can allow me more effective in my self-management 1 2 3 4 5 6 7 |
16. Use this website can help me to improve my health | 1 2 3 4 5 6 7
17. Use this website can make me more confident to manage my disease | 1 2 3 4 5 6 7

**F. Relevancy**
18. The design of this website or application is suitable for me | 1 2 3 4 5 6 7
19. This website or application can meet my needs | 1 2 3 4 5 6 7

**G. Interactivity**
20. This website or application have good interaction with me | 1 2 3 4 5 6 7

**H. Social connect**
21. This website or application can allow me to connect with the others | 1 2 3 4 5 6 7

**I. Overall rating**
22. I am satisfy with this website or application | 1 2 3 4 5 6 7
23. I intend to use this website or application in the future | 1 2 3 4 5 6 7

**What kind of factors are most important to you with this kind of website or application?**

| 1. Simple and easy to use | 1 2 3 4 5 6 7 |
| 2. Beautiful and attractive | 1 2 3 4 5 6 7 |
| 3. Timely and convenient | 1 2 3 4 5 6 7 |
| 4. Give me adequate support when I need it | 1 2 3 4 5 6 7 |
| 5. Facilitate me to connect with others | 1 2 3 4 5 6 7 |
| 6. Allow me to choose suitable plan or features | 1 2 3 4 5 6 7 |
| 7. Enhance my knowledge about diabetes and self-management | 1 2 3 4 5 6 7 |

**糖尿病自我管理網站的意見**

| Apps ______________ |
| 非常重要 | 非常不重要 |

**A.**
1. 這個網站看上去令人感到愉快 | 1 2 3 4 5 6 7
2. 我喜歡這個網站的外觀與感覺 | 1 2 3 4 5 6 7
3. 這個網站看上去很吸引 | 1 2 3 4 5 6 7
4. 當我用這個網站時我全神投入 | 1 2 3 4 5 6 7

**B.**
5. 我覺得這個網站很容易用 | 1 2 3 4 5 6 7
6. 這個網站清晰易明 | 1 2 3 4 5 6 7
7. 我能夠很容易的在這個網站找尋想找的資料 | 1 2 3 4 5 6 7
8. 我能夠很容易的加進資料 | 1 2 3 4 5 6 7
9. 我應該能夠很熟識的用這個網站 | 1 2 3 4 5 6 7

**C.**
10. 這個網站能讓我自主的選擇適合我的計劃及 | 1 2 3 4 5 6 7
方法

D.
11. 這個網站能加深我對糖尿病的知識 | 1 2 3 4 5 6 7
12. 這個網站能讓我學習新的知識 | 1 2 3 4 5 6 7
13. 這個網站能提供給我必須的資料及功能 | 1 2 3 4 5 6 7
14. 這個網站能給我適當的建議 | 1 2 3 4 5 6 7

E.
15. 用這個網站能令我更有效的做自我管理 | 1 2 3 4 5 6 7
16. 用這個網站能有助我改善我的健康 | 1 2 3 4 5 6 7
17. 用這個網站能令我更有信心管理我的病 | 1 2 3 4 5 6 7

F.
18. 這個網站的設計很適合我 | 1 2 3 4 5 6 7
19. 這個網站能配合我的需要 | 1 2 3 4 5 6 7

G.
20. 這個網站與我有良好的互動 | 1 2 3 4 5 6 7

H.
21. 這個網站能讓我跟其他人連繫 | 1 2 3 4 5 6 7

I.
22. 我對這個網站很滿意 | 1 2 3 4 5 6 7
23. 我打算未來會用這個網站 | 1 2 3 4 5 6 7

你覺得這類網站有那種因素對你很重要？

1. 簡單易用 | 1 2 3 4 5 6 7
2. 美觀悅目 | 1 2 3 4 5 6 7
3. 方便及即時 | 1 2 3 4 5 6 7
4. 在我有問題時能得到適當的支援 | 1 2 3 4 5 6 7
5. 能讓我跟其他人連繫 | 1 2 3 4 5 6 7
6. 讓我自主的選擇適合我的計劃及方法 | 1 2 3 4 5 6 7
7. 能加深我對糖尿病及自我管理的知識 | 1 2 3 4 5 6 7

我管理網站的意見（分析參考）

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<tr>
<th></th>
<th>非常不重要</th>
<th>非常重要</th>
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<tr>
<td><strong>A. Aesthetic experience 美感經驗</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 這個網站看上去令人感到愉快</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>2. 我喜歡這個網站的外觀與感覺</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>3. 這個網站看上去很吸引</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>4. 當我用這個網站時我全神投入</td>
<td>1 2 3 4 5 6 7</td>
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<table>
<thead>
<tr>
<th><strong>B. Perceived control (competence) 自我能力</strong></th>
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<tr>
<td></td>
<td>1 2 3 4 5 6 7</td>
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<td>5</td>
<td>我觉得这个网站很容易用</td>
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<tr>
<td>6</td>
<td>这个网站清晰易明</td>
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<td>7</td>
<td>我能够很容易的在这个网站找想找的资料</td>
</tr>
<tr>
<td>8</td>
<td>我能够很容易的加进资料</td>
</tr>
<tr>
<td>9</td>
<td>我应该能够很熟悉的用这个网站</td>
</tr>
<tr>
<td>10</td>
<td>C. Autonomy 自主性</td>
</tr>
<tr>
<td>11</td>
<td>这个网站能让我自主的選擇適合我的計劃及方法</td>
</tr>
<tr>
<td>12</td>
<td>D. Exposit/ expound 资料性</td>
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<tr>
<td>13</td>
<td>这个网站能加深我对糖尿病的知識</td>
</tr>
<tr>
<td>14</td>
<td>这个网站能讓我學習新的知識</td>
</tr>
<tr>
<td>15</td>
<td>E. Provide meaning 提供意義</td>
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<tr>
<td>16</td>
<td>这个网站能让我有問題時能得到適當的支援</td>
</tr>
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<td>17</td>
<td>这个網站能提供給我必須的資料及功能</td>
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<td>18</td>
<td>F. Relevancy 相關性</td>
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<tr>
<td>19</td>
<td>这个網站的設計很適合我</td>
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<tr>
<td>20</td>
<td>G. Interactivity 互動性</td>
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<tr>
<td>21</td>
<td>这个網站與我有良好的互動</td>
</tr>
<tr>
<td>22</td>
<td>Social connect 社交聯系</td>
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<tr>
<td>23</td>
<td>这个網站能讓我跟其他人連繫</td>
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<tr>
<td>24</td>
<td>Overall rating 整體滿意度</td>
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</table>

你覺得這類網站有那種因素對你很重要？

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<th>陈述内容</th>
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<td>3</td>
<td>方便及即時</td>
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<td>在我有問題時能得到適當的支援</td>
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<td>6</td>
<td>讓我自主的選擇適合我的計劃及方法</td>
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<td>能加深我對糖尿病及自我管理的知識</td>
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Appendix F - Compare Means of the Systems

Table 1: Means of the systems

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<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
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<td><strong>Q1 - pleasurable to use</strong></td>
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<td>.50990</td>
<td>4.1843</td>
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<tr>
<td>Glucose</td>
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<td>5.4286</td>
<td>.53452</td>
<td>.20203</td>
<td>4.9342</td>
<td>5.9229</td>
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<td><strong>Q2 - look and feel</strong></td>
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<tr>
<td>Website</td>
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<td>5.9229</td>
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Table 2: Compare means of three systems

ANOVA

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### Q23. Future_use

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### Remark: Table 3 - 6 : Post Hoc Tests

Table 3 - Q 11. This website or application can enhance my knowledge about diabetes

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#### ANOVA

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**Post Hoc Tests**

**Multiple Comparisons**

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- *The mean difference is significant at the 0.05 level.

**Table 4 - Q 13.**
This website or application can provide me with necessary information and features

**Descriptives**

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Post Hoc Tests

Multiple Comparisons

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* The mean difference is significant at the 0.05 level.

Table 5 - Q 15. Use this website or application can allow me more effective in my self-management

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**Post Hoc Tests**

### Multiple Comparisons

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* The mean difference is significant at the 0.05 level.

**Table 6 - Q 22. I am satisfy with this website or application**

**Descriptives**

| Satisfaction22 | 400 |
### ANOVA

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### Post Hoc Tests

#### Multiple Comparisons

**Dependent Variable: Satisfaction22**

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* The mean difference is significant at the 0.05 level.
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<td>Mean</td>
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<td>6.00</td>
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### Independent Samples Test

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<tr>
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<th>Levene's Test for Equality of Variances</th>
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## Appendix G - Follow Up Results

<table>
<thead>
<tr>
<th>Name</th>
<th>Continue or not</th>
<th>Reasons</th>
<th>Others remarks</th>
<th>Blood sugar conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Website</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| LI | No | Laziness  
No time  
He thought he has finished the tasks and learnt the knowledge  
He will not check it again unless there's new information  
He thought that he's already established own lifestyle pattern and it works so he thought there is no need to change it.  
Check blood sugar 4 - 5 times/ week as normal  
He started doing exercises since he was diagnosed with diabetes more than 10 years ago. He kept doing it since he thought that doing exercise is good for his health. | Ask he if someone help is useful?  
Social help - remind is helpful | Stable |
| LN | Yes. Use about once per week. | She thought that it can updated her about the news of diabetes. | She had suffered badly about her backpain and was admitted to hospital for a few months. Then she was living with her daughter for several months in the USA. Her daughter was worried about her since she was living alone. | Stable |
| NG | No | Too troublesome. Will easily lost himself when browsing the site. | | Stable |
| CU | No | She thought that she had done more exercises so she didn't need it.  
She did more exercise because her feet pain and the doctor told her to do more exercise.  
She mainly did some | Lower since the doctor gave her higher dosage of medicines. |
<table>
<thead>
<tr>
<th>Name</th>
<th>Activity</th>
<th>Frequency</th>
<th>Reason</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG</td>
<td>Stretching exercise at home.</td>
<td>More exercises, about 2 - 3 times per week with colleagues, family about once per week during weekend</td>
<td>He asked if there's anything new in the website. Colleagues do exercise in the afternoon since it's easier to book the venue.</td>
<td>A bit higher 7.6 of blood sugar but BP is stable</td>
</tr>
<tr>
<td>TG</td>
<td>No</td>
<td>Lost his smartphone</td>
<td>He stressed that he was taking a new medicine to control better his diabetes. He also mentioned about his brother's diabetes and thought that diet control and exercise were no use for him.</td>
<td>Stable</td>
</tr>
<tr>
<td>NA</td>
<td>No</td>
<td>He forgot to use them after a while since he thought that his diabetes was stable and not changed much.</td>
<td></td>
<td>Stable</td>
</tr>
<tr>
<td>EM</td>
<td>No, forgot about it.</td>
<td>No use. Too time-consuming. She thought that she just need to be careful about her diet.</td>
<td>She emphasized on taking natural complementary food.</td>
<td>Stable</td>
</tr>
<tr>
<td>CH</td>
<td>Yes, sometimes</td>
<td>Since &quot;It is already there&quot; in his smartphone. He will check it when he has time, e.g., in Sunday. But he only read the information of diabetes not using the apps to enter the data since it is inconvenient for him. He doesn't check blood sugar regularly and thought that he just needs to careful about his diet. He said the information can help him to know what to eat.</td>
<td></td>
<td>Stable</td>
</tr>
<tr>
<td>LA</td>
<td>No</td>
<td>He changed his mobile phones after the interview and he didn't download it again</td>
<td>He thought the app is useful for diabetes</td>
<td>A bit higher 6.9 than the average.</td>
</tr>
</tbody>
</table>
He thought that since he's not very fat and he didn't need to use it. But he thought that diet information was important. He also thought that he needed to do exercise but he said he was too busy to do it but will plan to do it. He thought that the unit was not in HK (but in fact it was not true). He seldom download the apps and game apps since he didn't like to do anything he thought was wasting his time. He didn't like to make friends with people in the virtual group as he preferred to have friends he already known.

<table>
<thead>
<tr>
<th>PW</th>
<th>No</th>
<th>No use since it was not convenient for him. Did less exercise, he just controlled his diet. Since he thought that his blood sugar level is lower since he was taking higher dosage of medicine. He checked blood sugar everyday and mainly stored the data in his glucose meter and checked it sometimes. His doctor didn't check it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>YM</td>
<td>No, No time, No mood</td>
<td>Lost his smart phone so he forgot the name of the apps and could not found them again. He only ate less and he got the diabetes diet information from the diabetes organization sometimes. He didn't mark the data on the phone since he usually checked it earlier in the morning when waking up. It's easier to mark on the booklet then waiting for the phone to turn on.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walk 45 min. after 8pm. Since 2 - 3 years then stopped. Now picked up again 3 months earlier due to weight gained &amp; high blood pressure increase. He felt that he should do it and felt better.</td>
</tr>
</tbody>
</table>

He's more aware of his disease since his mother also has diabetes. He had 7 - 8 years of diabetes. He had more social supports from his family and friends and he thought that the patient self-help group was not important for him.

Lower since he took higher dosage of medicine
<table>
<thead>
<tr>
<th>MP</th>
<th>No</th>
<th>Unknown due to not wanting to expose.</th>
<th>She has got married.</th>
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**Pictures**


