TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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Mobile Applications to Support Physical Exercise – Motivational Factors and Design Strategies

Julkaisu 1318 • Publication 1318

Tampere 2015

Tampereen teknillinen yliopisto. Julkaisu 1318
Tampere University of Technology. Publication 1318

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Thesis for the degree of Doctor of Philosophy to be presented with due permission for public examination and criticism in Tietotalo Building, Auditorium TB 219, at Tampere University of Technology, on the 2nd of October 2015, at 12 noon.

Tampereen teknillinen yliopisto - Tampere University of Technology
Tampere 2015

ISBN 978-952-15-3562-8 (printed)
ISBN 978-952-15-3593-2 (PDF)
ISSN 1459-2045

Abstract

The growing incidence of health problems attributed to contemporary lifestyles, and the limited resources of healthcare, has led several stakeholders to look for alternative preventive healthcare methods. Physical exercise has many good effects for health, but people often lack motivation towards it. Smartphone applications can act as motivational tools, as they are accessible, mobile, and have suitable technological abilities. During past 10 years, a large number of mobile exercise applications have been launched and, increasingly, wellness technologies have been researched in the field of human-computer interaction (HCI). However, the field lacks a comprehensive overview of the design strategies related to motivational exercise applications. Additionally, research in the field has mostly been conducted in western cultures, and perspectives from the developing world are missing.

This thesis explores the design space of mobile applications that aim to motivate the users to engage in physical exercise. The main foci of the research were *to identify the motivational factors towards the use of mobile exercise applications* and *to formulate a comprehensive overview of design strategies for motivational, mobile exercise applications*. The results were gained from a constructive design research process that included user studies, concepting and evaluation of motivational exercise applications, a cross study analysis of motivational factors, and formulating design strategies. The user studies were conducted in Finland and India with working-age participants.

Based on a rich set of empirical studies, this research produces insights for *a wide set of motivational factors towards the use of mobile exercise applications*. It points out differences in motivational factors between Finnish and Indian participants. For example, the use of surprising elements and certain playful elements as sources of motivation appealed to Indian participants more than Finns, who, in general, had a more pragmatic perspective towards the exercise applications. Finns were motivated by viewing their goals and progress by numbers and graphs, while Indians did not adopt the numerical approaches. The second outcome of the research is a comprehensive, structured and focused *model of design strategies for motivational, mobile exercise applications*. The model includes 34 design strategies divided into six dimensions. Nine of the strategies are India specific. The design strategies can be utilised in the design work of future exercise applications.

Preface

I love taking steps, especially by hiking and trekking. Being in nature gives me peace of mind and relaxation. My favorite places are natural places, where my mind and heart wander whenever I need to return my peace of mind. I can still remember the places in Iceland and Finland were I was hiking with my fourlegged, dearest friend, Fálki. Fálki, you carried me over even the rockiest paths, and your brave heart gave me strength. Those times are like yesterday. At those times, I also started the long path of this thesis. I cannot tell how many kilometers its' length has been, how many steps I have taken, or how many stones I have crossed – not any exercise application in the earth can tell me. However, now I am finished, believe or not! What an adventure! Why did it take so much time, you may wonder. My response to you is: "Life is." And according to the Indian participants of our studies: "Being on the way is more important than reaching the goal." I kind of like that mindset.

During this long hike, I have been privileged to share the path with many individuals, and I have received so much support whenever my packback has been turned out to be too heavy. My official supervisor, Professor Kaisa Väänänen (Tampere University of Technology) has provided regular and professional support in every phase of the hike. Company-specific supervisors Professor Jonna Häkkilä (former: Nokia Research Center, current: University of Lapland), Professor Minna Isomursu (former: VTT Technical Research Centre/Nokia Research Center, current: University of Oulu) and Principal Scientist Eija Kaasinen (VTT Technical Research Centre) have offered enthusiastic and insightful support in different phases of the process. I want to thank you all enormously, and I hope I will still have a chance to walk with you again at some point.

I also want to thank the pre-examiners of this thesis. Associate professor Mathilde Bekker (Eindhoven University of Technology) and Associate professor Konrad Tollmar (KTH Royal Institute of Technology), thank you for your valuable comments and suggestions for improvement during the last kilometers of the hike. In addition, thank you, professor Turkka Keinonen, for acting as the opponent, thus making the reaching of the goal an exciting and unforgettable event.

With the warm thoughts I think of the times of Nokia Research Center. That was a place where I grew up (in the occupational sense, ofcourse). That was time of the true group work. That was time when I conducted the studies of this thesis with my

wise and professional colleaques. Some of you acted as co-authors in the articles included here: Shruti Ramiah, Jan Blom, Elina Mattila, Pertti Huuskonen, Muzayun Mukhtar, Jani Mäntyjärvi, Ykä Huhtala, Jussi Kaasinen, Jukka Salminen, Lotta Hynninen, Antti Väätänen, Esa Koskinen, and Klaus Laine. Thousand thanks, it has been a great pleasure to work and write with you. We have collected many steps together. The list of individuals whom I want to express the warmest thanks continues with colleaques and friends: Kirsikka Kaipainen, Susanna Paasovaara, Päivi Heikkilä, Heli Väätäjä, Marketta Niemelä, Siddharth Nair, Jussi Huhtala, Arto Puikkonen, Jarmo Kauko, Ari-Heikki Sarjanoja, Kaisa Järviö, Leena Ventä-Olkkonen, Paul Holleis, Karthikeya Acharya, Marja Harjumaa, Toni Vanhala, Miikka Ermes, Pasi Välkkynen, Raimo Lappalainen, Päivi Lappalainen, Laura Hokkanen, Kati Kuusinen, Thomas Olsson, Maiju Vuolle, Henna Salonius, Jenni Poutanen, and Sanna Peltoniemi. Plus all other colleagues I have worked with during these years, and with whom I am now working. Some of you have really carried the backback for me for some time, and we have managed to climb steep walls of mountains together. I cannot express how grateful I am for you. Special thanks to the “mother” of our unit in the Department of Pervasive Computing, Hilkka Losoi, for your caring support and reminding about taking care of my well-being. Managers in different phases: Kari Hjelt, Jyri Huopaniemi and Tommi Mikkonen, thank you for letting me do this work.

I want to express my gratefulness, once more, to (then existing) Nokia Research Center Tampere and Bangalore for providing me possibilities to conduct the projects that this thesis is about. Also, big thanks go to the Finnish Nuadu consortium for making the health promotion study possible. Nokia Foundation supported my work by granting a stipend when I was in the middle of the hike. Tampere University of Technology funded the finalisation phase of the thesis in the end of 2014. VTT Technical Research Centre also supported the work when I was working there in 2012. The city of Tampere (Tampereen kaupungin tiederahaston toimikunta) granted a stipend for the printing of this book.

All voluntary study participants in India and Finland: you are the heart of this thesis. So, many, many thanks for your participation, valuable feedback and insight. I hope that the participation also gave something for you – maybe a small seed to increase physical activity in your daily lives?

My family deserves the largest share of the gratefulness. Our fabulous, sweet, beautiful and lovely daughters **Lumi and Pilvi**: you have brought back my creativity, innovation and imagination, and you fulfill my days with love, sunshine and joy. I am so, so lucky because I have got you. I want to thank my husband Ville for giving me hope and building a beautiful home for us when I was writing my thesis. This phase of the path has been tough, but it has made us stronger. I love you so much, all three of you! <3 May our hike together, from now on and forever, be long and cheerful! My parents Raija and Esko deserve the biggest applause for giving me support in all phases of my journey called life. You have taken care of me and loved me despite of all the "rocky mountains" I have climbed, and I have become a responsible and caring adult because of that. Warm thanks to my grandmother, too. Your passion for books and your wisdom inspired me since I was a little girl. I miss you much, and the fleeting moments with you.

Without naming especially anyone but warmly thinking of you all, I also want to thank all dear friends and relatives who faithfully walk with me year after year. Together, we have gone "over the hills and far away", as it is said in the Nightwish's song. At the early times of the research, I had two four-legged friends: Fálki frá Stóradal and Amelie, now in memoriam. You taught me many things during the years you walked beside me. Thanks so much for everything! Run free wherever you are, and be happy!

This book is devoted to the strong girls and women in my life, most of all to my daughters Lumi and Pilvi, my mother Raija, my grandmother Helvi, my aunt Maija-Liisa, and my soul sister Hanna. A rolling stone gathers no moss ☺

Tampere/Lahti, June 2015

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List of Publications

This thesis is based on the following original publications that are referred in the text as P1-P7. The publications are reprinted with permissions from the publishers.

P1. Ahtinen, A., Mäntyjärvi, J., & Häkkilä, J. (2008). Using heart rate monitors for personal wellness – The user experience perspective. *Proceedings of the 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 1591-1597.

P2. Ahtinen, A., Isomursu, M., Huhtala, Y., Kaasinen, J., Salminen, J. & Häkkilä, J. (2008). Tracking Outdoor Sports – User Experience Perspective. *Proceedings of Ambient Intelligence - European Conference, Lecture Notes in Computer Science, 5355*, 192-209.

P3. Ahtinen, A., Mattila, E., Väätänen, A., Hynninen, L., Koskinen, E., Salminen, J., & Laine, K. (2009). User experiences of mobile wellness applications in health promotion: User study of Wellness Diary, Mobile Coach and SelfRelax. *Proceedings of the 3rd International ICST Conference on Pervasive Computing Technologies for Healthcare*.

P4. Ahtinen, A., Ramiah, S., Blom, J., & Isomursu, M. (2008). Design of mobile wellness applications: Identifying cross-cultural factors. *Proceedings of the 20th Australasian Conference on Computer-Human Interaction*, 164-171.

P5. Ahtinen, A., Isomursu, M., Mukhtar, M., Mäntyjärvi, J., Häkkilä, J., & Blom, J. (2009). Designing social features for mobile and ubiquitous wellness applications. *Proceedings of the 8th International Conference on Mobile and Ubiquitous Multimedia*, article 12.

P6. Ahtinen, A., Isomursu, M., Ramiah, S. & Blom, J. (2013). Advise, Acknowledge, Grow and Engage: Design Principles for a Mobile Wellness Application to Support Physical Activity. *International Journal of Mobile Human Computer Interaction, 5*(4), 20-55.

P7. Ahtinen, A., Huuskonen, P., & Häkkilä, J. (2010). Let's all get up and walk to the North Pole: Design and evaluation of a mobile wellness application. *Proceedings of the 6th Nordic Conference on Human-Computer Interaction*, 3-12.

Author's Contributions to Publications

This page summarises the author's contributions to the individual publications of the thesis. The author was the primary author in every publication, and thus was responsible for writing each publication.

P1. The author had the main responsibility in designing the study and conducting the data collection, as well as performing the data analysis.

P2. The author had the same responsibilities in this paper as in P1.

P3. The study was conducted as a part of the EU-funded ITEA2 project Nuadu. The author participated in designing the user study and conducting the data collection. The author had the main responsibility of conducting the qualitative data analysis.

P4. The author had the main responsibility of planning the study and participated actively in the data collection and analysis.

P5. The author had the main responsibility in designing the study, and participated actively in the data collection and analysis, as well as the concept design and evaluation.

P6. The author had a key role in planning the studies, and participated actively in the data collection and analysis. She also participated actively in the iterative concept design work and the evaluation of the concept. She had the main responsibility of formulating the design implications presented.

P7. The author had the main responsibility of designing the studies, conducting the studies, and performing the data analysis. The author led the iterative application design work.

1. Introduction

This chapter introduces the background and motivation for the research of the thesis, as well as the research scope and questions. It also explains the contribution of the thesis and the author's contributions to each research paper included in the thesis.

1.1 Background and Motivation

"*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1946). According to this definition by the World Health Organization, health means overall well-being. Everybody wants to be healthy and well, as those are among the very basic needs of human beings (Len and Gough, 1991). Unfortunately, there is plenty of un-wellness among the people living in modern society. In the middle of all the good things brought by the improved living standards, many people suffer from overweight and obesity, stress, mental illnesses, and sedentary lifestyles, among other issues. The high costs of treatments and therapies and the lack of resources in public health care services have led to a demand for self-care systems to support well-being and prevent illnesses. Mobile technologies and applications, which have the ability to be always present and are capable of doing many things, have been harnessed to beat the problem by *promoting well-being*. Such technologies are usually called *mobile wellness technologies* or *applications*.

Among the variety of available wellness applications, which includes all kinds of applications for improving eating habits, managing weight, reducing stress-levels, improving sleep, integrating relaxation, etc., there are also applications targeted especially to promote physical activity. Those applications are usually called *exercise applications, physical activity applications,* or *fitness applications*. Many studies show that mobile exercise applications and gadgets can increase motivation towards physical activity (e.g. Zuckerman and Gal-Oz, 2014; Tudor-Locke, 2002) and thus improve individuals' well-being. Being physically active has many positive direct and indirect effects on health (US Department of Health and Human Services, 2000), while a too sedentary lifestyle negatively affects health (Dantzig et al., 2013).

Physical activity has the positive effects of maintaining optimal weight, promoting positive feelings, and keeping many physiological measurements (blood pressure, cholesterol, blood sugar) at healthy levels (Miles, 2007). One of the most evident examples of the effects of a lack of physical activity is being overweight. In 2008, 35% of adults (20 years and older) worldwide were overweight (as defined by having a body-mass index greater than or equal to 25) and 11% were obese (as defined by having a body-mass index more than or equal to 30) (WHO, 2014). Global obesity has almost doubled since 1980 (ibid.).

People need motivation towards conducting physical exercise, because physical exercise itself does not necessarily feel good, particularly not in the beginning. Mobile exercise applications can potentially increase motivation towards physical activity and initiate a change, such as being physically more active. Ideally, *the changes in daily habits*, such as adding a little bit more activity to the daily life, will later on lead to *permanent changes*, i.e. adopting a more active and healthier lifestyle that is visible in one's everyday lifestyle and attitude. *Supporting behaviour and lifestyle changes* and *the maintenance* of such changes (e.g. Prochaska and Norcross, 2001), can be seen as the ultimate goals of exercise applications.

This thesis explores the design space of motivational, mobile exercise applications through a constructive, user-centred design research process. This research belongs to the field of human-computer interaction (HCI). Based on the extensive user research process, our research produces insights for *a comprehensive set of motivational factors towards the use of mobile exercise applications*. This thesis also presents *a model of design strategies for motivational exercise applications*. We compare the model to the design strategies presented by others and the related theoretical work. When our research process started in 2008, the domain of mobile wellness applications was relatively new. At the time, several applications and devices for supporting or motivating physical activity already existed (e.g. Sports Tracker application, heart rate monitors, and pedometers). Some articles had been published about exercise applications (e.g. Consolvo et al., 2006; Gasser et al., 2006). However, no one knew if the domain of wellness applications would be a success or failure.

Some years have passed since the implementation of the studies presented in this thesis, and in the meanwhile, the domain has earned its place both in the field of

research and commercial applications. For example, the most significant conferences of HCI have separate tracks for health and wellness technology research. There are even dedicated conferences for the topic, such as Pervasive Computing Technologies for Healthcare. In addition, the conference on Persuasive Technology targets to the persuasive technologies with the broader scope, where health and wellness technologies form one branch. Thousands of commercial applications related to health and wellness are available in the markets, for all different purposes. Applications such as Endomondo, Nike+, RunKeeper, and Jawbone UP are just a few examples of the existing spectrum of mobile exercise applications. The most popular exercise applications have millions of users (Ram, 2012). A movement called Quantified Self has been established for sharing the interest of self-tracking (Choe et al., 2014). Moreover, the research domain of exercise and wellness technologies is multidisciplinary; the technologies have been investigated from the perspectives of various research fields, including design, HCI, psychology, health sciences, and sport sciences.

The technical possibilities have evolved much since our research began. We have seen the shift from basic mobile phones to smartphones with faster communication, information search possibilities, high-quality touchscreens, fast processors, automatic updates, and platforms through which one may purchase and download a multitude of applications to personalise one's phone. There is also a large amount of sensors available that can track different things about the users and their contexts, e.g. activity/inactivity, heart rate, stress, location and temperature. Thus, it is a very good thing that we had a future-oriented approach in our research and did not limit our thinking to the limitations of the (then) existing technological possibilities. Some scenarios and concepts that we designed and constructed during our research process seemed to be somewhat challenging to implement due to the then existing technical possibilities, but currently, our scenarios are possible and actual.

Understanding the user is one of the key points to success in the expanding spectrum of wellness applications (Klasnja et al., 2011). The approach of this thesis is *user-centred*, and thus the thesis draws from people's real *experiences, expectations, needs, perceptions, motivations* and *usage habits*. We have studied people without and with wellness applications to find out what motivate individuals to exercise; what are their user needs, barriers, motivations, perceptions, and

expectations towards the exercise applications; and how we should design the applications to be motivational. The user studies have been extensive. We have collected data, gained knowledge, and drawn inspiration with different user-centred methods in *two extremely different cultures*: India and Finland. We have created concrete design solutions in the format of concepts and a prototype, and then validated the outputs with potential users. Based on the cross study analysis about *the motivational factors* towards the use of mobile exercise applications, we present *a model of 34 design strategies for motivational, mobile exercise applications.*

1.2 Research Scope and Questions

The purpose of this thesis was to explore what aspects in mobile exercise applications motivate people to use the applications, how the motivational factors appear in two different cultural areas (Finland and India), and what are the design strategies for motivational, mobile exercise applications.

The research questions of the thesis are the following:

RQ1: What motivates people to use mobile exercise applications?

RQ2: How do these motivational factors appear in two cultural areas: Finland and India?

RQ3: What are the design strategies for motivational, mobile exercise applications?

The first and the second questions address *the user's perspective.* By *motivational factors,* we mean the aspects and features of the exercise applications (or those that could be implemented in future exercise applications) that our study participants considered motivational. Motivational factors include the users' needs, experiences, perceptions, and expectations towards the motivational exercise applications, as revealed in our user studies. Also, they include the explicit motivations and de-motivations towards the use of exercise applications, as stated by the participants in our studies. The third question adopts *the designer's perspective* by presenting the findings in the format of a model of *design strategies* that can be utilised in further design work. The term "design strategies" is meant to describe methods that can be utilised when designing motivational exercise

applications. As whole, RQ1 and RQ2 focus on understanding motivational factors towards the exercise applications, and RQ3 transforms these factors into design knowledge in the form of design strategies for motivational exercise applications.

The purpose of this thesis is not to show evidence of the effectiveness of the suggested design strategies or solutions as such. This thesis presents the results gained during the constructive design research process, not from the studies of effectiveness. Showing evidence of these strategies' actual effect on participant engagement in physical exercise would be a natural next step and an important topic for future research.

Even though the second research question addresses the diverse cultures of Finland and India, the research does not cover all of the cultural areas of Finland and India. That would be too broad a scope, as India is especially rich in its amount of cultures. As the amount of research cases in the qualitative research (and thesis) is limited, we focused on a sample of cases collected in urban India and Finland, where we tried to balance the living standards and conditions of the participants by selecting the participants based on a defined profile.

1.3 Results and Contribution

The amount of research and commercial products on the domain of mobile exercise applications is extensive. Still, the domain is partly lacking a comprehensive overview on the motivational factors behind the usage of exercise applications and the design strategies for motivational exercise applications. Several researchers have published lists of design strategies for wellness and persuasive applications (although sometimes calling these strategies implications, considerations, guidelines, or patterns) based on theory (e.g. Consolvo et al., 2009; Klasnja and Pratt 2011) or empirical user studies (e.g. Consolvo et al., 2006; Fritz et al., 2014). However, there is no comprehensive listing or model of the design strategies for designing motivational exercise applications. Much knowledge does exist, but it is quite scattered. *The main contribution of the thesis is to form a comprehensive model of design strategies for motivational mobile exercise applications* and *provide new knowledge about the motivational factors and design ideas inside each design strategy.* The model can be used by designers of exercise

applications as a starting point (McKnight and Cassidy, 2010), inspirational material or a checklist for their design work.

One of the most common contributions of publications related to HCI research in general are the suggestions of design strategies. A common approach is to present design guidelines and apply them to the design of a certain application (e.g. Consolvo et al., 2009; Munson and Consolvo, 2012). Oinas-Kukkonen and Harjumaa (2009) explicitly state that their model of persuasive systems design, which includes 28 design implications, can be used in design and evaluation. This thesis complements that approach by presenting a model of 34 design strategies for motivational, mobile exercise applications. From the viewpoint of constructing design relevant knowledge, design strategies can be placed in the middle territory between practice and theory. Höök and Löwgren (2012) call this territory intermediate-level knowledge, while Dalsgaard and Dindler (2014) talk about intermediary knowledge. Design strategies, similar to design guidelines, is knowledge that is more abstracted than the presentation of design concepts, but on the other hand, design strategies do not aim at producing as generalisable knowledge as theories (Höök and Löwgren, 2012).

Another contribution of this research is its cross-cultural perspective. So far, most work on the domains of wellness and exercise applications has been conducted in western cultures and developed societies. This study considers these domains in two locations with very different cultures: Finland and India. Thus, we are adding the perspectives of eastern cultures and developing societies to the research of exercise applications.

1.4 Outline of the Thesis

This thesis includes seven chapters that are structured as follows. The first chapter, Introduction, explains the background and motivation for the research, as well as the scope, questions and the contribution of the research. The second chapter provides an overview to theoretical approaches relevant to the present work: psychological, technological, design, and cultural. It also addresses the present research in light of related work. Chapter 3, Research Approach, Process and Methods summarises the methodology utilised in the research process. Chapter 4 presents the findings related to RQ1: What motivates people to use mobile exercise

applications? Chapter 5 summarises the findings on RQ2: How do these motivational factors appear in two cultural areas: Finland and India? It emphasises the Indian perspective. Chapter 6 introduces the model of design strategies by addressing RQ3: What are the design strategies for motivational mobile exercise applications? It also discusses these design strategies in light of the prior design strategies. Chapter 7, Discussion and Conclusions, discusses the present model of design strategies for motivational, mobile exercise applications in light of the theoretical approaches. It discusses the means for utilising the model in design, the contribution and novelty value of the model, and its limitations. The validity and generalisability of results, as well as topics for future research, are also discussed.

2. Related Work

Designing motivational, mobile exercise applications demands a multi-disciplinary approach, which combines *psychological approaches of human behaviour and motivation* with *knowledge of the technological, cultural and design approaches* (Figure 1). In this chapter, the relevant psychological theories are presented. Also, the understanding of the role and possibilities of mobile technology in the context of exercise support is outlined. Importantly, an overview of the existing design strategies for mobile wellness applications is provided, as well as the role of user experience in design. As our research was conducted in two areas, we provide a glimpse to the relevant cultural studies and the differences between the studied contexts, Finland and India.

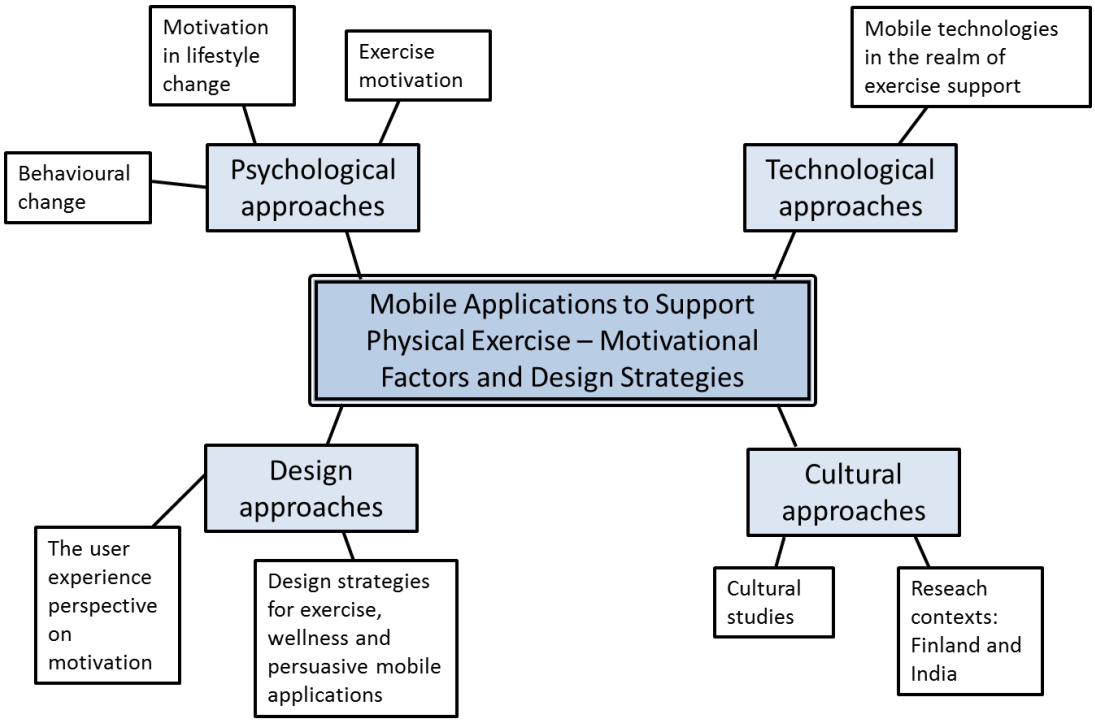


Figure 1: The structure of the related work of the thesis.

2.1 Psychological Approaches

2.1.1 Behavioural Change

The ultimate goal of the exercise applications is, at least from the perspective of health sciences, to increase the amount of physical activity of individuals, and to support the increased activity to become a part of their daily life. To become physically more active is a change, which demands efforts from the individual. Conducting physical activity does not happen automatically and usually the person needs to go beyond her/his comfort zone to conduct exercise. People can affect their health and well-being with small daily decisions and choices. Many people aim at making decisions that contribute towards wellness; for example, they would like to exercise more, to follow a healthy diet or to sleep more regularly. However, individuals repeatedly make unfavourable choices because they are occupied with other tasks, do not have sufficient information, are constrained by their cognitive capabilities, or they cannot resist the temptation of instant gratification (Thaler and Sunstein, 2008). Many people find it difficult to follow and be consistent with wellness activities and would welcome support that would "nudge" (ibid.) them towards choices that would be in accordance with one's wellness targets. Mobile applications can support individuals in making better decisions at the right moments, as they are usually always along with the users (e.g. Morris, 2012).

In many cases motivation towards physical activity diminishes after the initial enthusiasm. However, the positive effects of physical activity are short-term, and thus, the physical activity should be rooted as a part of lifestyle and it should be executed regularly and in a continuous manner (Miles, 2007). Theories of behaviour change describe the stages through which the individuals progress towards a more permanent change in lifestyle, and towards better well-being. When designing technologies that aim at supporting individuals in the long-term behaviour change process, it is very important to be aware of the characteristics and phases of the process.

The most well known theory on behaviour change, often utilised and summarised among the research on wellness technologies, is **Transtheoretical Model** (Prochaska and Norcross, 2001). According to the theory, the individual starts from *the pre-contemplation stage*. In that phase, the person is not considering any behavioural change and is not aware of the problems. However, her/his close-ones

are often well aware of the problems. In the next stage, *contemplation*, the person is aware of the problem and thinks about a change. In this phase, however, she/he has not made a commitment to take action. This phase is usually long, as people frequently stuck there. They intend to take action in the near future, when they are in *the preparation* stage, and they already make small behavioural changes, "baby steps" (p. 444). In *the action* stage, the individual actively modifies her/his behavior, experiences and environment in order to overcome the problem, demanding commitment, time and energy. This phase results in the most prominent behavioural changes that receive the greatest external recognition. The next stage, *maintenance*, is a continuous process where people try to prevent relapses. In that phase, the intention is to strengthen the state attained in the action phase. When the change is complete, the individual is in *the termination stage*. In that stage, the individual does not have to work to prevent relapse and she/he has a total confidence of high-risk situations. As discussed by e.g. Klasnja et al. (2011), behaviour changes related to wellness are usually long-term and ongoing processes where the activities promoting health are interspersed with lapses and setbacks. People tend to relapse especially when their daily routine is altered or interrupted, for example, they tend to gain weight during holidays (Yanovski et al., 2000).

A more recent theoretical model, **Health action Process Approach** (HAPA) by Schwarzer (2008), consists of similar stages of change as transtheoretical model, but it divides the process into three phases: intention, planning and action. In *the intention* phase, people have not yet formed motivation towards the health related task. In *the planning* phase, they want to change but have not taken action yet. In *the action* stage, they have initiated the desired behaviour and they need to prevent and overcome relapses and barriers as well as to recover from setbacks.

Abraham and Michie (2008) have created **taxonomy of behaviour change techniques** that are common in many health behaviour theories. Originally, their taxonomy included 26 techniques, for example *provide general information, provide general encouragement, set graded tasks* and *use follow-up prompts*. Out of the 26 items, they suggest that at least five are evident in effective physical activity interventions (Michie et al., 2009). Those are *self-monitoring, intention formation, specific goal setting, review of behavioral goals* and *feedback on performance* (ibid.). Later on, Michie et al. (2011) refined their taxonomy and added 14

techniques. Direito et al. (2014) studied the presence or absence of the behaviour change techniques in physical activity and dietary smartphone applications. They included top-40 applications from Apple App Store Health & Fitness category, in November 2012. They found that there was variation in the amount of behaviour change techniques present in the applications. On average, there were eight techniques present per application. They conclude that behaviour change techniques are not widely used in the current physical activity and dietary applications, although from the perspective of technology, many of the techniques could be utilised.

2.1.2 Motivation in Lifestyle Change

The words "motivation" and "emotion" stems from the Latin verb "movere", which means "to move" (Bradley, 2000). Both motivation and emotion are fundamentally related to action. Motivation has two parameters: direction and intensity. Direction (towards or away) maps well with the hedonic value (pleasant or unpleasant), which is a central parameter of emotion. Also, the intensity maps well with the other parameter of emotion, i.e. arousal. (ibid)

Primarily, this thesis explores people's *motivations to use the exercise applications*. Interest towards the usage of the application must be first achieved and then maintained over time. If the user loses interest in the application, the application loses its ability to effectively support the exercise activities. However, which is also important, is *the motivation towards conducting physical activity itself*, and ultimately, *the long-term motivation towards the maintenance of change*. Those three parts of motivations are connected, and it can be assumed, based on the previous research, that a well-designed exercise application can increase the motivation towards physical activity (Zuckerman and Gal-Oz, 2014; Tudor-Locke, 2002), and ideally, the application could also be able to motivate and support the long-term behaviour change process. Towards the end of the process, the role of the exercise promoting application may become smaller, if the individual adopts an active lifestyle. However, ideally, the application can persuade and support the change along the process.

In an attempt to changing lifestyle habits, both *intrinsic* and *extrinsic motivations* play a role. According to **Self-Determination Theory**, people are inherently motivated to perform activities that hold intrinsic interest for them (Ryan and Deci,

2000). Intrinsically motivated people engage in exercise activities for pure satisfaction caused by the activity itself. According to Self-Determination theory, behaviour that is caused by intrinsic motivation is highly autonomous and shows strong self-determination. Intrinsic motivation relates also to the perceptions of competence and relatedness. Intrinsic motivation is considered as a main source of energy to drive human behaviour and when present, it facilitates behavioural maintenance and adherence. Extrinsically motivated behaviours are performed to satisfy external demands or to attain an outcome that is not directly related to the physical activity itself. *Internalisation of extrinsically motivated behaviors* leads to better engagement, learning and performance, as well as less dropping out or relapses. Thus, it leads to greater well-being. (ibid)

According to Malone and Lepper's (1987) **theory on motivation of learning**, several factors can be used to promote intrinsic motivation. *Challenge* refers to working towards personally meaningful goals and getting feedback about the performance. *Recognition* relates to the satisfaction gained when others recognise and appreciate individual's performance. *Curiosity* helps maintaining motivation in an ongoing task by attracting the individual's attention. For instance, surprises can be used to evoke curiosity. The knowledge that something interesting will occur in the future helps foster motivation. *Control* means that a person should have the feeling of being in command of the process. A clear cause-effect relationship should be shown to people in order them to believe that their performance will have a powerful impact. *Fantasy* emphasises the role of imagination and creative thinking in motivation. Social contexts also play a role in motivation and persuasion. *Competition* and *cooperation* are powerful social sources of motivation with the means of comparison, peer pressure and social support. (ibid) All the motivational factors described above have been utilised, explicitly or implicitly, more or less, in the existing spectrum of exercise applications.

Goal-setting theory decribes the characteristics of the good, motivational goals (Locke and Latham, 2002). A motivational goal needs to be personally important and meaningful for an individual. A good goal should be set either by the individual or with the help of a professional rather than being a general goal. In addition, the invidual should be able to view the progress towards the goal and get to know when she/he has achieved it. A motivational goal is also challenging enough, but

realistically achievable at the same time. Feedback about the progress should be provided when working towards the goal. (ibid.)

2.1.3 Exercise Motivation

People in general are physically too inactive due to, e.g. the modern lifestyle that supports sedentary activities, such as sitting in a car, sitting on the desktop or sitting on the couch. On average, individuals' adherence to physical exercise activities decreases within age (Calfas et al., 1994). What, then, are the sources of motivation towards the physical activity that can be utilised when promoting physical activity? The issues of basic theories of motivation are applicable, for example Self-Determination Theory (Ryan and Deci, 2000), briefly discussed in the previous section. However, there are also more specific models, which cover the motivational factors on physical activity.

For example, Markland and Ingledew (1997) have generated a model called **Exercise Motivation Inventory-2** that represents a wide range of motivations for engaging in physical activity. The inventory includes 51 items divided to 14 factors. The factors are the following: *affiliation, appearance, challenge, competition, enjoyment, health pressures, ill-health avoidance, nimbleness, positive health, revitalisation, social recognition, strength and endurance, stress management* and *weight management.* Kilpatrick et al. (2005) studied college students' motivations for physical activity, utilising the above-mentioned motivation measurement tool. More specifically, they divided physical activity to sports (physical activity governed by rules and involving competition; e.g. tennis, football) and exercise (physical activity that targets achieving fitness or other athletic objectives, e.g. aerobics, cycling). They found that the motivations to participate sport activities were more likely to be intrinsic, such as enjoyment and challenge, than the motivations for participating exercise activity. Motivations for exercise were more likely to be extrinsic, focusing to appearance and weight management.

2.2 Technological Approaches

The use of technological possibilities for supporting people performing physical exercise has expanded remarkably during the past years, as well as the spectrum of wellness related applications in general. It has become a recognised domain and gained much interest in research, industry and business. There is currently thousands

of wellness, fitness, sport and health related downloadable applications or "apps" for all mobile platforms. The RunKeeper app (runkeeper.com), one of the most popular ones, had 9 million users already in 2012 (Ram, 2012). Among the other popular exercise applications are, for example, Nike+ (nikeplus.nike.com), Sports Tracker (sports-tracker.com), Endomondo (endomondo.com) and Jawbone Up (jawbone.com/up). Many companies have produced their own wearable gadgets and wristbands for collecting the activity data, among them Fitbit (fitbit.com), Nike+ Fuelband, Microsoft Band (microsoft.com/Microsoft-Band) and the variety of heart rate monitor wristwatches. Building a whole ecosystem around the health technologies has emerged during the past years, for example Microsoft Health (microsoft.com/microsoft-health). Systems that combine smart sensor devices, wearables and applications to the cloud services are established to provide a comprehensive user experience. They aim at combining data from several sources for providing more insights and value, as well as storing all data in one location.

Mobile devices provide an important platform for applications that support people in their wellness and health related activities, as noted by Anderson et al. (2007), Consolvo et al. (2008b; 2009), Fritz et al. (2014) and many others. The role of mobile health is discussed by Atienza and Patrick (2011). They argue that it may be "the killer application" (p. 151) in the current century. They refer to the speed with which mobile technology is adopted; the role of mobile technologies as personal devices; possibilities for real-time data collection, monitoring and analysis of health-related information; and the possibilities for personalisation. The increasing number of sensors available on smartphones supports collection of data from different sources. The data can be analysed locally on the device or on servers (ibid.). Campbell and Choudhury (2012) list the sensors and technologies in current smartphones that can be utilised in wellness applications. Those include accelerometers, digital compasses, gyroscopes, GPS, quad microphones, dual cameras, near-field communication, barometers, and sensors for light, proximity and temperature. In addition to the sensing technologies, smartphones have high-quality touchscreens, multiple radios for body, local and wide area communication, and plenty of space for data storage (ibid.).

Quantified self, also called personal informatics (Li et al., 2010) refer to the practice of self-tracking and reflecting on the collected personal information.

Quantified-Selfers are the forerunners of tracking data about themselves with the technologies available. Choe et al. (2014) call them "extreme users" (p. 1143). They studied the motivations of Quantified-Selfers and found three main motivations: to improve health, to improve other aspects of life, and to find new life experiences. Rooksby et al. (2014), for their part, found five styles in which self-tracking happens: directive (or goal driven) tracking to e.g. lose weight; documentary tracking; diagnostic tracking that looks for links between things; tracking for collecting rewards or points; and fetished tracking due to pure interest towards the gadgets.

2.3 Design Approaches

2.3.1 The User Experience Perspective on Motivation

The ISO standard (2010) defines the user experience (UX) as follows: "A person's perceptions and responses that result from the use or anticipated use of a product, system or service." Studying user experiences and trying to optimise the user experience is a key part in the user-centred design of motivational exercise applications. Without a good user experience, the application is usually quickly abandoned and when it is abandoned, it cannot support motivation towards physical activity.

According to Hassenzahl (2006), **product user experience** consists of *pragmatic* and *hedonic* attributes. By pragmatic attributes, he refers to the functional usability and usefulness of the product, while the hedonic attributes relate to the non-instrumental and emotional needs of the people using the product. Hassenzahl (2003) lists, e.g. *stimulation, identification* and *evocation,* as hedonic user experience attributes. Hedonic attributes are strong potentials for pleasure (ibid.) When creating applications that aim to motivate, the hedonic attributes play an important role, because the usage motivation is usually founded on the emotional aspects of the application's usage experience. If the application is able to raise positive emotions or experiences, the motivation to use it is potentially high. Gaver and Martin (2000) list e.g. *novelty, surprise, diversion* and *mystery* as necessary parts of product user experiences. According to Logan et al. (1994), people have non-instrumental needs for *novelty, change* and for *expressing themselves through objects and belongings*. In the face of routine and repetitiveness, people tend to

grow weary (Hekkert, 2006). Designing applications that aim to keep users' interest levels high may involve the inclusion of something *unexpected,* for example a surprising element (Brandtzaeg et al., 2004). From the perspective of design, this means acknowledging that after a certain timeframe, users will lose interest. Elements that are novel and surprising need to be introduced to maintain users' level of engagement.

2.3.2 Design Strategies for Exercise, Wellness and Persuasive Mobile Applications

Although there is plenty of supporting evidence for the potentials of harnessing mobile technology to improve well-being, designing wellness applications that users would really benefit from, and which they would like to use for a long time, is not a straightforward issue. For example, a study conducted by Dennison et al. (2013) explored young adults' experiences and views about health related smartphone applications. Although the participants' were positive about the mobile phone's potentials to help people in adopting healthier lifestyles, they revealed several concerns and challenges around the health and wellness applications. One concern was that they were lacking commitment to using applications and they abandoned those very quickly. According to the study participants, most applications required too much effort from the user. In addition, the prompts, messages and reminders given by the applications were concerned as irritating. Those issues usually led to abandoning the application.

To design good wellness applications, a range of design strategies (also called implications, requirements, principles or guidelines) for exercise and wellness applications have been proposed as a result of studying existing applications with users, or based on the theoretical knowledge. Furthermore, more generic listings of design patterns targetting to design for behaviour change has been published, for example the Design with Intent toolkit (Lockton, 2013). It is an extensive toolkit of 101 patterns for influencing people's behaviour through design. The patterns in the tookit are divided into eight lenses: Architectural, Errorproofing, Interaction, Ludic, Perceptual, Cognitive, Machiavellian and Security. The design patterns have been drawn from different theoretical disciplines, and the focus of the work is on influencing more sustainable behaviour through design.

Next, 11 relevant lists and models focusing specifically on design strategies for exercise and wellness applications are presented in their chronological order (Table 1). Among the strategies for exercise and wellness applications we present one model of persuasive design strategies, namely PSD model, which concerns the design of persuasive technologies in general (Oinas-Kukkonen and Harjumaa, 2009).

Authors and year of publication	**Focus of the model/list**	**Design strategies**	**Number of design strategies**	**Origination**
Consolvo et al. (2006)	Design requirements for technologies that encourage physical activity	Proper credit, awareness, social influence, practical constraints	4	User study of mobile application Houston for sharing step counts with friends
Campbell et al. (2008)	Game design principles for everyday fitness applications	Core mechanic, representation, micro goals, marginal challenges, free play, social play, fair play	7	Prior work on fitness video games and applications
Consolvo et al. (2009)	Design strategies for technologies to support behaviour change	Abstract & reflective, unobtrusive, public, aesthetic, positive, controllable, trending & historical, comprehensive	8	Behavioural and social psychological theories and prior work on persuasive technology
Oinas-Kukkonen & Harjumaa (2009)	PSD model – design principles for persuasive system content and functionality	Categories: primary task support, dialogue support, system credibility support, social support	28	Theories of persuasion and persuasive technologies
Munson & Consolvo (2012)	Design strategies to encourage physical activity	Goal setting, rewards, self-monitoring & reminders, sharing	4	Prior work on technologies to support physical activity, and a user study with GoalPost mobile exercise application
Morris (2012)	Guidelines for motivating health-related lifestyle change with the mobile device	Remind people who they want to be, foster an alliance, apply social influence, show people what they	7	Prior work in health psychology, psychotheraphy, behavioural economics and

		could lose, put the message where the action is, raising emotional awareness, reframe challenges		influence
Klasnja & Pratt (2012)	Design space of mobile phone based health interventions	Tracking health information, involving the health care team, leveraging social influence, increasing the accessibility of health information, utilising entertainment	5	Prior work on mobile-phone health applications
Fan et al. (2012)	Design guidelines for systems that track and visualise physical activity	Charts & abstract art, choices of different visualisations, integrate visualisations into daily routines, the goal adapted to the user's abilities	4	User study with Spark, an art display for visualising physical activity
Fritz et al. (2014)	Implications for the design of persuasive technologies to provide long-term support in physical activity	Maintenance as well as change, identification and evolution of appropriate social networks, changes in activity and metrics, evolution of rewards	4	User study of wearable activity monitoring technologies, mainly Fitbit and FuelBand
Consolvo et al. (2014)	Design considerations for mobile technologies to encourage consumer health and wellness	Collecting behavioural data, providing self-monitoring feedback, supporting goal-setting	3	Prior work on the design of mobile health and wellness technologies
Den Akker et al. (2014)	Framework of tailoring concepts in real-time physical activity coaching systems	Feedback, goal setting, inter-human interaction, adaptation, user targeting, context awareness, self-learning	7	Prior work on activity coaching systems

Table 1: Prior lists and models focusing on design strategies for exercise and wellness applications.

Design requirements for technologies that encourage physical activity. Consolvo et al. (2006) present design requirements for technologies that encourage physical activity. Their list of four requirements is based on their user study with a mobile application Houston for sharing step counts with friends. The first design requirement is *give users proper credit for activities* and it is explained as follows: "To address the issue of proper credit for activities, it is important for designers to understand the common physical activities of their target population, the limitations of the measurement device, and provide users with the ability to supplement/edit measurements with additional information." (p. 462) The second requirement, *provide personal awareness of activity level*, relates to providing awareness of three types: a history of past behaviour, current status, and the progress towards the goal. The third principle, *support social influence*, relates to the perceived impacts of social pressure, social support and communication. Finally, they suggest *consider the practical constraints of users' lifestyles*, meaning that: "Technologies that encourage physical activity should either not require the user to wear any new devices or if devices must be carried or worn, form factor is critical." (p. 463)

Game design principles for everyday fitness applications. Campbell et al. (2008) analysed prior work on fitness video games and everyday fitness applications (Salen and Zimmerman, 2003; Koster, 2004; Juul, 2005), and formed design principles for everyday fitness games. *Core mechanic* refers to the set of interactions that the player repeats during the play. *Representation* means aesthetics and narrative of the game, which bring enjoyment to the play. *Micro goals* are short-term goals that provide frequent gratification, and entice sustained play. They provide means for reaching long-term, macro goals that might otherwise feel overwhelming. *Marginal challenges* are challenges that are at the margin of a player's abilities and they provide the player an attempt to face the next challenge. *Free play* refers to the design that leaves a maximal number of choices open to the player, and thus does not demand for overly restrictive rules to be obeyed. *Social play* is about the internal and external social relations in games. *Fair play* means that all players have an equal change of winning. Fairness in the rules and the core mechanic, and matching players of approximate skill level are among the means of realising fair play.

Design strategies for technologies to support behaviour change. In their more recent work, Consolvo et al. (2009) continued listing design strategies for wellness applications. Theory-driven design strategies for technologies to support behaviour change include eight strategies. They were drawn from behavioural and social psychological theories (e.g. Prochaska and Norcross, 2001; Locke and Latham, 2002) as well as prior work on persuasive technology. *Abstract and reflective* is a strategy related to the use of data abstraction, rather than raw and explicit data collected from the user, to display the information related to user's goals and progress. *Unobtrusive* relates to presenting and collecting data unobtrusively. The data should be available in every occasion for the user and it should not interrupt her/his everyday life. The strategy called *Public* is about collecting and presenting personal data, in a way that does not make the user feel uncomfortable in situations, where others might become aware of it. The strategy of *Aesthetic* states that the technology that may be used over time, needs to sustain interest of the user, and thus the physical and virtual aspects must be comfortable and attractive, supporting the user's personal style. *Positive* is about using positive reinforcement to encourage change, by rewarding the user for performing the desired behaviour and attaining her/his goal. When the user does not perform the desired activity, she/he should not be punished but supported in a way that sustains the interest. The strategy called *Controllable* refers to the user's control of who has access to her/his data, as well as her/his permissions to add, edit and delete own data. *Trending and historical* is about providing reasonable and accessible information on user's past behaviour. Finally, *Comprehensive* states that the technology should comprehensively account for the range of activities that contribute to the user's lifestyle.

Persuasive Systems Design (PSD) model. Persuasion is considered a key element in promoting sustained use of self-management applications, such as wellness and health applications. Fogg (1998) defines the concept of persuasion as "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action" (p. 225). In the other words, persuasive technologies aim at changing people's thinking and behaviour. Models for designing and evaluating persuasive technologies include, for example, the Persuasive Systems Design (PSD) model (Oinas-Kukkonen & Harjumaa, 2009), which was inspired by, e.g., the persuasive design strategies proposed by Fogg (2003). PSD model has been utilised

in supporting the development of personal health and well-being systems (Harjumaa and Muuraiskangas, 2014). In the PSD model, there are 28 design principles divided into four categories. The first category is called *Primary task support*. It includes the principles of reduction, tunnelling, tailoring, personalisation, self-monitoring, simulation, and rehearsal. The second category is *Dialogue support* and in that category the design principles are praise, rewards, reminders, suggestion, similarity, liking, and social role. The third category, *System credibility support*, includes the principles of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. The fourth and final category is called *Social support*. That category includes the principles of social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition.

Design strategies to encourage physical activity. Munson and Consolvo (2012) list four design strategies to encourage physical activity, suggested by prior work, and their user study findings related those strategies. The studied strategies were: *goal setting*, *rewards*, *self-monitoring and reminders*, and *sharing*. In their user study with two versions of the mobile exercise application called GoalPost, they found that most participants responded well to the use of both secondary and primary goals that were attempted simultaneously to them. Surprisingly, only a few participants described rewards as motivating, despite the prevalence of badges and other rewards in commercially available systems. The participants found journaling the exercise data helpful, but many doupted if they had kept it up without the reminders. The participants had concerns about oversharing exercise related data to others, and they lacked receiving support that they wanted or expected to get from others.

Guidelines for motivating health-related lifestyle change with the mobile device. Morris (2012) proposes guidelines for motivating change with the mobile device. Her list is based on research in, e.g., health psychology, and focuses more broadly on promoting health related lifestyle changes rather than changes in physical activity. However, it is at least partly applicable in the context of physical activity. The first guideline, *Remind people of who they want to be* is about driving the lifestyle change by reminding people of their self-ideals. Individual's values should be utilised when motivating towards the change. *Foster an alliance* relates to

developing a trusted alliance between the user and the application. Morris notices that: "Just as the therapeutic alliance evolves over the duration of treatment, health technologies must develop greater understanding of users over time and adapt to their changing needs." (p. 27) *Apply social influence* strategy means identifying and forming relevant peer groups who engage healthful habits. Self-efficacy of an individual can be fostered by showing successful strategies of others, and it can also be beneficial to learn from the struggles of other persons. *Show people what they could lose* strategy anticipates potential losses caused by unhealthy behaviour. *Put the message where the action is* refers to the effectiveness of the time and place based prompting. By *raising emotional awareness* with the help of the application, the individuals can be made more aware of how their moods associate with the behaviour and choices. Negative moods can be associated with lapses from health goals. Becoming more aware of the emotional state, the individuals may develop alternative coping strategies to prevent the lapses. The last guideline, *Reframe challenges,* means that "examining one's immediate interpretations of daily events and considering alternatives helps people respond to challenging situations in more constructive ways." (p. 31)

Design space of mobile phone based health interventions. Klasnja and Pratt (2012) outline the design space of mobile phone based health interventions. Their list is based on the strategies and types of interventions that have been implemented on mobile health applications. Similar to the list of Morris (2012), also the list of Klasnja and Pratt deals with the design of health related applications and does not focus primarily on exercise applications. *Tracking health information,* often referred to as *self-monitoring*, can provide many benefits. Those include increased frequency of desired behaviours and decreased frequency of undesired behaviours; better understanding and awareness of one's behaviours and health patterns; and opportunistic engagement in desired behaviours. The strategy called *Involving the healthcare team* relates to informing the healthcare team about the patient's symptoms, activities and physiological parameters. *Leveraging social influence* strategy include three ways that have been pursued by mobile health interventions: 1) facilitating social support or competition among individuals who share the same goal; 2) facilitating social support from family and friends; 3) leveraging peers who have succeeding in accomplishing similar health goals. *Increasing the accessibility*

of health information refers to mobile devices' abilities to deliver reminders, health information, motivational messages, and other kinds of content that can help in managing the health, to individuals without any effort on their own part. Finally, *utilising entertainment*, includes two aspects: 1) making reminders and informational messages more engaging by interspersing them with other interesting or amusing non-health related content; 2) using games to support health management.

Design guidelines for systems that track and visualise physical activity. Fan et al. (2012) present four design guidelines for systems, which track and visualise physical activity. The guidelines are based on their user deployments with Spark, an informative art display that visualises physical activity by using abstract art. The first guideline addresses the use of both *charts and abstract art*. They suggest that graphs should be used to establish initial awareness and allow users to search for specific information. Abstract art should be used as an ambient display. *Choices of different visualisations* should be offered to enable users to customise their experience, as well as to select the level of detail of the information they want to see. That guideline is also important because in that way the application can increase variety and tailor to users' individual tastes. The third guideline, *integrate visualisations into daily routines*, addresses the integration of visualisations to different devices, such as cell phones, tablets and standalone displays located in the users' surroundings. The last guideline states that *the goal should be adapted to the users's physical abilities*, and not provide one goal for everyone.

Implications for the design of persuasive technologies intended to provide long-term support in physical activity. The work by Fritz et al. (2014) lists four implications for the design of persuasive technologies intended to provide long-term support. The implications are drawn from their interviews with the long-term users of wearable activity monitoring technologies, such as Fitbit and Fuelband. The first implication is stated as *motivating maintenance as well as change*. They suggest that the tools should offer explicit motivation for the maintenance of practices or achievements in addition to prompts to introduce changes in behaviour. The next strategy called *supporting the identification and evolution of appropriate social networks* states that the designs should consider adding support for finding relevant and motivating communities for the individuals. The application should also support

for chancing communities or evolving communities as people's needs and practices change. Third, they suggest the strategy called *supporting changes in activity and metrics*: "Designers of systems should consider ways in which measurements and tracked activities can be augmented or evolved over time, or ways in which different sensing technologies can be integrated into the overall ecosystem of support tools." (p. 495) Their final strategy is *supporting the evolution of rewards*, and it refers to providing a variety of rewards and changing rewards over time, as well as considering the integration of other types of rewards, for example "real world" or tangible rewards.

Design considerations for mobile technologies to encourage consumer health and wellness. Consolvo et al. (2014) provide a comprehensive overview of three common functions on wellness applications, based on prior work: *collecting behavioural data*, *providing self-monitoring feedback* and *supporting goal-setting*. They discuss e.g., the advantages and disadvantages of manual vs. automatic tracking of exercise; reminders; different forms of feedback (graphs, stylised representations, textual feedback); goal sources; and small rewards for goal achievement.

Framework of tailoring concepts in real-time physical activity coaching systems. Den Akker et al. (2014) present a conceptual framework that identifies seven tailoring concepts in real-time physical activity coaching systems. Their model is based on a literature review, and focuses on the perspective of tailoring the exercise applications. They define tailoring as follows: "the process of adjusting the system's behaviour to individual's specific context" (p. 351). The tailoring concepts presented by them are the following: feedback, goal setting, inter-human interaction, adaptation, user targeting, context awareness and self-learning. By tailoring *feedback* they refer to the possibilities to provide differing feedback to the user based on timing, content and ways of representation. According to them, the *goal setting* concept can be seen as an extension of feedback. Tailoring concept called *inter-human interaction* refers to the applications that utilise user's peers to coach her/him by utilising shared exercise plans, virtual competition and other aspects of social influence. By *adaptation* they mean the process of tailoring message content to individual's status. *User targeting* is a technique that aims to fit the representation, suggestions and recommendations to the individual, and it can be

made based on the personal information given by the user, e.g. weight, height, gender and age. For example, the application could suggest certain activities to reach the goal based on the user's earlier set of preferred activities. *Context awareness* refers to utilising user's context (situation) to provide relevant content to the user. Last, *self-learning* technique is used in applications that record the various interactions that the user has with the application, and learns from them. For example, the application could move the user forward through the stages of behaviour change. The application changes with the user throughout his/her use of it.

2.3.3 Analysis of the Existing Design Strategies

Out of the 11 lists and models presented in the previous section, six focuses specifically on the design of physical activity promoting applications, four addresses wellness and health applications in general, and one focuses on persuasive applications. The design strategies on the three out of the 11 lists and models have been derived based on the empirical research, while most of the lists and models have been formulated based on the theoretical knowledge and/or the existence of the desin strategies in applications. Five lists focus on specific kind design strategies: fitness games (Campbell et al., 2008); visualisations of physical activity (Fan et al., 2012); long-term use of fitness devices (Fritz et al., 2014); tailoring of physical activity coaching systems (Den Akker, 2014); and basic support aspects on wellness technologies (Consolvo et al., 2014). The others, six out of 11, include many different kinds of design strategies.

The existing models and lists, except the PSD model (Oinas-Kukkonen and Harjumaa, 2009), include less than 10 design strategies, many of them only four or five strategies. PSD model (Oinas-Kukkonen and Harjumaa, 2009) includes 28 strategies and thus, it is the most comprehensive prior model. However, despite of its comprehensiveness, even the PSD model does not include all the design strategies listed in the other lists. The strategies related to, e.g. playfulness or gamified approach, are missing in the PSD model, while they are present in some other models (Campbell et al., 2008; Klasnja and Pratt, 2012).

When analysing the content of all strategies presented in the existing lists and models, 24 strategies deal with the basic mechanisms of support – tracking and self-monitoring, goal setting, progress, feedback, and rewarding. 13 strategies address

the social factors, e.g. social influence, sharing, cooperation, and competition. There are eight strategies concerning coaching and guidance, and seven strategies around the aesthetics and visual representations of the wellness data. Then, there are strategies for tailoring, gamified approach, and long-term use but most of them come from the models of Campbell et al. (2008), Den Akker (2014) and Fritz et al. (2014) that focus explicitly on those aspects. Even a quick analysis of the existing design strategies indicates that there are plenty of strategies, but they exist scattered in several lists and models. Thus, a comprehensive overview of the strategies is not easy to perceive.

2.4 Cultural Approaches

2.4.1 Cultural Studies

According to a widely cited definition, culture is "the collective programming of the mind which distinguishes the members of one group or category of people from another." (Hofstede, 1991, p. 5) Culture has an important role in shaping individuals' attitudes, behaviours, values, norms, and practices (Khaled et al., 2006). Theories for characterising cultural dimensions reveal differences between India and Finland. For example, in **Hofstede's model** (1991), India scores higher than Finland in the *collectivism* factor, which means the level of how integrated people are into groups. According to the model, individuals act predominantly as members of a lifelong and cohesive group in societies that are collectivist. In individualistic societies, the effort is made on personal achievements and rights. People tend to stand up for themselves and their immediate family, and choose their own affiliations. Finland gets higher scores than India in the *uncertainty avoidance* factor, which means how tolerant the society is for uncertainty and ambiguity. This factor reflects the extent to which members of a society try to cope with anxiety by minimising uncertainty. People in societies of high uncertainty avoidance try to minimise the unknown and unusual circumstances. They try to proceed with careful step-by-step planning. In contrast, low uncertainty avoidance cultures accept and feel comfortable in unstructured situations or changeable environments. In general, they are more tolerant of change.

To recent date, research and design of persuasive technologies has mostly taken place in the developed world in the individualistic cultures (Khaled, 2006). The

influence of cultural factors has been largely ignored on the design of persuasive technologies (Orji and Mandryk, 2014). However, one should not take granted that the user needs and motivational factors would be similar in all cultures. According to Khaled et al. (2006), it is necessary to draw upon cultural themes of the target audience, in order for persuasion to have the greatest impact. Thomas et al. (2008) illuminate the challenge of the designers doing their work from the perspective of the developed world: *"Much of the developed world implicitly subscribes to a largely common world-view and set of values. If not done carefully, those attempting projects in the developing world may easily fall into the trap of presuming that every culture has the same set of values and goals that they themselves adhere to. As a result, one may do an efficient job of doing exactly the wrong thing with respect to the actual values of aims of those in the developing communities."* (p. 3911).

Khaled et al. (2006) present their work around **cultural tailoring of persuasive technologies**. They claim that the persuasive design strategies proposed by Fogg (1998), namely *reduction, tunneling, customisation, suggestion, self-monitoring, surveillance* and *conditioning,* are tailored to the individualist audience. Khaled et al. (2006) propose a set of strategies targeted for persuasive tools designed for collectivist users, based on the findings from cross-cultural psychology and sociology about the behavioural tendencies of people belonging to collectivist cultures. *Group opinion* refers to the strategy of allowing an individual to make decisions by providing her/him with opinions of other group-members. *Group surveillance* uses normative influence as a motivator. In that strategy, the entire group is either rewarded or punished for the actions of the individuals. *Disapproval conditioning* uses negative reinforcement as a motivator to change attitudes and behaviours. *Deviation monitoring* is a strategy of monitoring user's actions and make a notification if the behaviour is deviated from the "correct", collectively accepted behaviours of the group. *Group customisation* refers to the one or more members of the group to customise the application settings on behalf of the group's collective needs, preferences and goals. These design strategies emphasise the important role of the integration in the group and the perspective of collectivism to the persuasive technologies. It is a fresh and relevant viewpoint for the design of

mobile applications, as “the traditional perspective” for the mobile devices is that the mobile phone is a personal device (Häkkilä and Chatfield, 2005).

2.4.2 Research Contexts: Finland and India

In this section, we discuss the characteristics of the two contexts selected for our explorative studies. We chose Finland and India because of the variation in environmental and cultural conditions. We wanted to gather inspiration for design from the different viewpoints - western vs. eastern, developed vs. developing and northern vs. southern countries, as well as the different levels of users’ exposure to wellness technologies.

India is a large, developing country with the second largest population in the world. With 23 official languages, as well as numbers of religions practiced (Library of Congress, 2011), India is associated with enormous cultural diversity. There is broad variation in quality of life and living standards in the country (Census of India, 2011). With a population density of 325 inhabitants per sq. km, urban India is a hectic and dense environment. Nobel Prize winner and a well-known Indian author Amartya Sen (2005) describes India as an extremely heterogeneous culture and a nation of contrasts with a pluralist, interactive and dynamic heritage. Traffic is one of the major challenges with high noise and pollution levels. On the other hand, India is home to a variety of traditional wellness practices, such as meditation and yoga. Those emphasise emotional and mental aspects of wellness along with the physical, and some people consider them spiritual practices. In tradition, guidelines for healthy living, for example suitable diet for different times of the year and occasions, can also be found. However, these are increasingly less adhered to as people’s lifestyles change.

In comparison, Finland is a relatively small and economically well-developed country with a western lifestyle and quite uniform standard of living. There is one main religion. 92% of Finns speak Finnish as their mother tongue. The population density (16 inhabitants per sq. km) is one of the lowest in Europe (This is Finland, 2014). Even from urban areas, clean natural spaces are easily accessible in Finland. Finns have a strong tradition of outdoor activities and each season offers a different selection of activities. Physical leisure activities such as walking, trekking, skiing, fishing, and berry picking are popular and comparatively easy to integrate into everyday life. According to Kafatos et al. (1999) Finns spend a greater amount of

their leisure time on physical activity than, for instance, southern Europeans. In addition, Finland is a leader in occupational health programs promoting physical activity. (ibid.)

2.5 Our Research in Light of Related Work

Based on a rich set of studies, our research produces insights for *a comprehensive set of motivational factors towards the use of mobile exercise applications*. Thus, our research complements and supports the existing literature around the mobile applications that aim at supporting and motivating for physical exercise.

As already explained in Section 2.3.2, researchers on the domain of wellness applications and persuasive technologies have published many listings and models of the design strategies for wellness applications (Table 1). The analysis of the existing design strategies in Section 2.3.3 indicated that the design strategies are scattered in several lists and models, and the entity of them is quite difficult to perceive and utilise. In addition, most of the existing lists and models are limited in the amount of design strategies. From the designer's perspective, there is a lack of a comprehensive, easy-to-perceive overview, which can be used as a starting point or checklist for designing motivational exercise applications. As a result of this thesis, *a model of the design strategies for motivational exercise applications* that is based on our extensive design research process, is presented. The model is mirrored with the prior findings and strategies presented by others, as well as with theoretical knowledge.

In addition, the present model provides *insight for designing exercise applications for people outside the western culture – in specific, India*. In that area, the research on exercise applications, and wellness applications in general, has been very limited so far (Section 2.4.1).

Although the main focus of the thesis was not to produce new knowledge to psychological theories, a set of theories on behaviour change and motivation have been utilised as background material throughout the research process. For example, the factors of intrinsic motivation (Malone and Lepper, 1987) have inspired the design work in the phases of Explorative studies and Concepting and evaluation (P4, P5, P6). Also, the Transtheoretical Model (Prochaska and Norcross, 2001), has been utilised in the design of the Living Application concept (P6). In the same research

phases, the UX framework (Hassenzahl, 2006), especially the knowledge on hedonic factors, has inspired the concept design. The potentials of the mobile technology has also inspired the whole research, but we did not limit our concepting work based on the technological possibilities at the time of research.

3. Research Approach, Process, and Methods

By utilising the constructive design research process (Koskinen et al., 2011) and user-centred design approach, we studied the design space of motivational exercise applications. We designed concepts and one application prototype, and evaluated them with users and participants. As a result of the cross study analysis of all of the conducted empirical studies we gained knowledge on the motivational factors towards the use of mobile exercise applications (RQ1 and RQ2), as well as formulated a model of 34 design strategies for motivational, mobile exercise applications (RQ3). Those are the main contributions of this thesis. The overview of the research process can be seen in Figure 2.

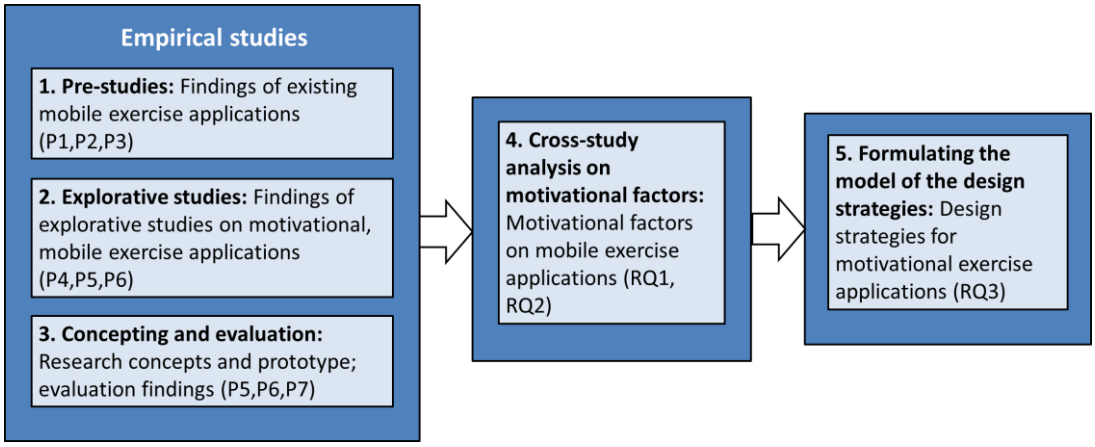


Figure 2: Overview of the phases of the research process, and how the publications and research questions relate to the phases of the research process.

3.1 Overall Approach

The main approach of the research process was *constructive design research* (Koskinen et al., 2011). The constructive design research process was selected as the main approach because the scope of the research was to build concepts and prototypes of motivational exercise applications, as well as to construct a model of design strategies for motivational exercise applications. The constructive design research methodology "refers to design research in which contruction – be it product, system, space, or media – takes center place and becomes the key means in

constructing knowledge" (Koskinen et al., 2011, p. 5). According to Koskinen et al. (2011), the construction can be, for example, a prototype, scenario, mock-up, or a detailed concept that could be built in the future. The intention of the constructive design research is to identify problems and discover factors that might otherwise remain unnoticed. It is usually future-oriented and plays with imaginary things rather than existing ones. (ibid.) In our research process, we constructed four application concepts and one working prototype. In addition, the main construction of this thesis is the model of design strategies for motivational exercise applications, as stated by the research question 3 (RQ3).

All studies of our research process focused on the motivations, needs, perceptions, user experiences and expectations towards motivational exercise applications. The focus was on participants' subjective experiences that are dynamic (Forlizzi and Ford, 2000) and context dependent (Battarbee, 2004). *The user-centred design* (UCD) is a natural approach for the research that aims at designing motivational applications for people to use. The user-centred design approach was utilised in our research process because the aim of the research was to understand what are the motivational factors towards the use of exercise applications (RQ1 and RQ2), and to derive design strategies based on that knowledge (RQ3). The standardised user-centred design approach suggests that the products and services should be based on true or latent needs, concerns and expectations of the potential end user group (ISO, 1999). Olsson (2012) provides an extensive discussion on the important role of studying user expectations and experiences in each phase of the user-centred design process.

In our research process, we utilised *mixed-methods research* (Cresswell and Plano Clark, 2007). By utilising mixed-methods research, i.e. mixing of data, the research results in better understanding of the problem than using either dataset alone (ibid.). More than half of the studies were *field studies*, where we provided the participants with a mobile application to be used for a certain period, varying from 1 week to 3 months. Klasnja et al. (2011) discuss the important role of field studies, i.e. studies that are conducted in situ, in the early stages of the application development. The field studies can reveal experiences and viewpoints that cannot be explored in the controlled or laboratory settings (ibid.).

All studies included *qualitative research methods.* Qualitative methods play an essential role in user-centred design, as the aim of UCD is typically to deliver novel designs, evaluate existing designs and understand user needs for the designs to be (Blandford, 2013). In our research, understanding the user needs, experiences, motivations and expectations towards the exercise application was the main purpose – and with qualitative methods we could best address those. Klasnja et al. (2011) note that qualitative studies focusing on people's experiences with the technology help researchers understand why and how their system is working. They consider this outcome – understanding – a central contribution of HCI work in the domain of health- and wellness applications. Even though most of our studies were qualitative, *quantitative methods* were utilised when approapriate, e.g. when we wanted to ask structured questions from a larger sample of individuals (P1, P3, P7).

3.2 Devices, Applications, Concepts, and Prototypes Involved

Totally, there were 9 different devices, applications, concepts and prototypes focusing on supporting physical activity and/or wellness involved in the whole research process. *The devices* and *applications refer to commercial off-the-shelf applications* that were studied in the first phase of the research process (heart rate monitors, Sports Tracker, Wellness Diary and Mobile Coach). Four concepts and one application prototype were the outcomes of the third phase of the research process (Living Application, Gift of Good Health, Photo Frame of Health, Web of Avatars, Into). *The difference between the concept and prototype was the level of their maturity*. *The application prototype was a working application that could be installed into a mobile phone and used in the real world settings*. However, it was not as mature as the off-the-shelf applications. *By concepts we mean concept designs that could not be yet installed or used, but they were presented to the participants with illustrative material,* i.e. visualisations with textual explanations. Here, a short overview about the devices, applications, concepts and a prototype is provided, and they are presented in more detail in Appendix B.

Heart Rate Monitors. In P1, various types of heart rate monitors (HRM) wristwatches were involved, depending on the models the respondents had. At the time of study, in their simplest form, HRMs provided information on user's current

heart rate, and the heart rate variation during the conducted exercises, and there was a possibility to set heart rate limits. The advanced models, however, were more like computers on the wrist, and they provided intelligent functionalities for, e.g. viewing the training effect, getting personal advice, as well as viewing various data on the exercise.

The Sports Tracker. The Sports Tracker Application (mobile and web interfaces) was studied in P2. At the time of the study, the Sports Tracker was an application for tracking, browsing, viewing, storing and comparing user's exercises, especially in outdoor settings (Figure 3). The application collected information such as the route, speed, pace, distance, time and altitude. In the web portal, the users could share their workout data with other users.

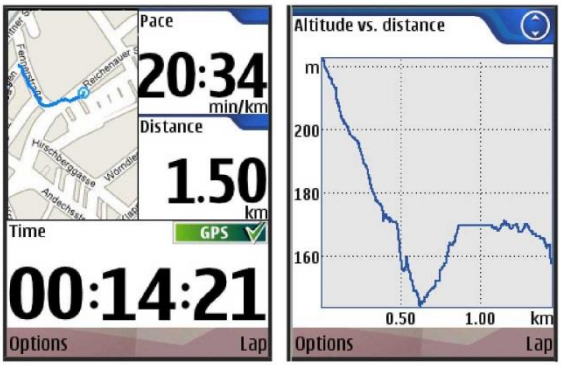
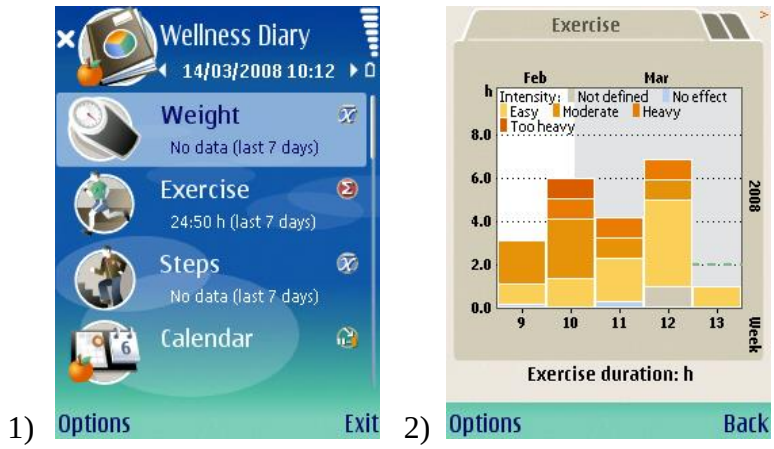


Figure 3: Examples of views of the Sports Tracker mobile application. 1) A map and numeric data of the current workout. 2) A graph of the changes during the workout (altitude vs. distance).

The Wellness Diary. The Wellness Diary (Figure 4) was involved in two studies, presented in P3-P6. Wellness Diary was a mobile application for daily journaling of various wellness parameters, e.g., weight, exercise, stress, and sleeping time. The user could select the most suitable parameters to be tracked. The entries were made manually. The feedback was offered in two ways – graphs and a list view of entries.



1) 2)

Figure 4: Examples of the views of the Wellness Diary. 1) The main view. 2) The feedback graph of exercise.

The Mobile Coach. The Mobile Coach (Figure 5) was a mobile application for supporting physical activities, involved in P3. It automatically generated training plans based on user's goals. It provided recommendations of the duration and intensity of each training session and adapted the training program based on the exercises that were actually performed.

1) 2)

Figure 5: Examples of the Mobile Coach screens. 1) The view for entering the performed exercise. 2) The exercise summary of the week.

The Living Application. The Living Application (P6) was a mobile application concept with a phased approach, and it focused on physical activity support (Figure 6). It was developing based on the user's progress. It provided new functionalities as rewards as the user reached new levels. The advices and feedback also developed to be more detailed as the user was progressing. It also surprised users every now and

then with additional content, e.g. cooking recipes. The concept was presented in the form of a scenario consisting of five use cases that were loosely drawn from Transtheoretical Model (Prochaska and Norcross, 2001).

Figure 6: In the initial phase of use, the Living Application collects background information from the user in order to set suitable goals. The avatar called Into acts as a personal advisor. A screenshot of the conceptual design (Graphic design: Jussi Huhtala).

The Gift of Good Health. The Gift of Good Health (Figure 7) was a concept to promote the use of wellness applications. The wellness application was sent to other person's mobile phone as a gift. The sender of the gift could personalise the application to the receiver, for example by setting some suggestions for goals, or even passing on own training program. The receiver of a gift could select whether to keep the suggested targets of define own ones. This concept was presented and studied in P5.

Figure 7: A screenshot of the conceptual design of the Gift of Good Health (Graphic design: Muzayun Mukhtar).

The Photo Frame of Health. The Photo Frame of Health concept (P5) supported cooperation between family members, couples and close-ones that were living apart from each other, and utilised role models as motivators for wellness (Figure 8). It allowed the users to share their health-related information (e.g. goals, status messages, greeting, health tips) with others. The information was shown in the digital photo frame, which worked together with the mobile application. The pictures of celebrities could be used in the frame as an inspirational factor. Surprising factors, for example animated Bollywood dancers to celebrate success, were provided every now and then.

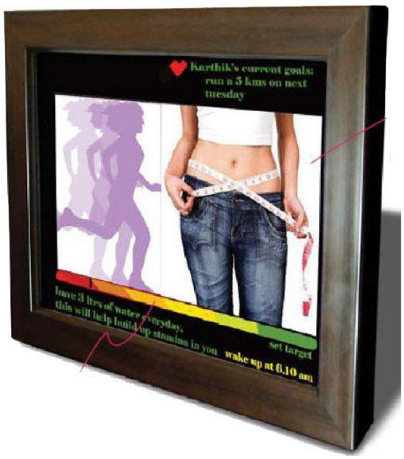


Figure 8: A screenshot of the conceptual design of the Photo Frame of Health (Graphic design: Muzayun Mukhtar). A view with the user's own and another person's goals, the progress towards the goals, as well as a picture of a celebrity as an inspirational factor.

The Web of Avatars concept. The Web of Avatars concept (P5) combined the motivational opportunities that ad-hoc communities and shared goals provide – it was designed to connect wellness enthusiastics with similar profiles, targets and interests (Figure 9). The application used close proximity connections to connect people. The connections were represented as neuron networks.

Figure 9: A screenshot of the conceptual design of the Web of Avatars (Graphic design: Muzayun Mukhtar). The avatars of the users with similar profiles are connected by the means of close proximity connections, and represented as neuron networks. The thickness of the axon between neurons represents the activity of the connection between the users.

Into. Into (P7) was a working prototype of a social and playful mobile application to support exercise motivation (Figure 10). It combined social team play with other playful elements. In the application, the users could record their steps and proceed on a map of a home country based on their step count. They could create challenges and form a team to proceed together towards the challenge. Small playful elements were included, i.e. an animal figure the represented the speed of the team, and postcards from the reached destinations.

Figure 10: Screenshots of Into (Graphic design: Jussi Huhtala). A) The combined progress of the team shown in numeric information as a line on the map. B) A figure of an animal showing the speed of the team.

The Magical Gadget. The Magical Gadget, utilised in P5 and P6, was a mockup that could have any imaginable functionalities or appearances, and it was "used" in the participatory study sessions (Figure 11). It is explained in more detail in Section 3.5.

Figure 11: A selection of mock-ups that represented Magical Gadgets.

3.3 Phases of the Research Process

The research process consisted of five phases: *1) Pre-studies, 2) Explorative studies, 3) Concepting and evaluation, 4) Cross study analysis on motivational factors* and *5) Formulating the model of the design strategies*. The knowledge and findings gained during the first three phases, i.e. the empirical studies (Table 2), was analysed with the means of cross study analysis to find out the motivational factors on mobile exercise applications (phase 4). The model of the design strategies was formulated from the identified motivational factors (phase 5).

Phase of the research process	**Studies, locations & papers**	**Focus of the study**	**Methods, lengths of studies & number of participants**	**Applications, gadgets, prototypes & concepts involved**
1) Pre-studies	Heart rate monitor study (Finland) **P1**	-study the HRM users' usage habits, motivations and barriers to use the commonly used wellness technology -provide insight to design of the future mobile exercise applications	-semi-structured interviews, n=8 -online questionnaire, n=860	Heart rate monitors

	Sports Tracker study (Europe) **P2**	-collect and analyse user experiences and usage habits evoked by the mobile sports tracking system -to derive guidelines for further design	-2-weeks trial with Sports Tracker -semi-structured interviews -SMS-based questionnaires -n=28	Sports Tracker mobile & web applications
	Health promotion study (Finland) **P3**	-study usefulness, usability, usage habits and motivational factors during the longer-term usage period of three mobile wellness applications	-3-months trial with 3 mobile applications -n=119 in total -semi-structured interviews, n=20 -3 online questionnaires, n=60-87 -usage logs, n=66	Mobile applications: -Wellness Diary -Mobile Coach -Self Relax (out of the scope of the thesis)
2) Explorative studies	Study with Wellness Diary (Finland & India) **P4, P5, P6**	-identify design factors to be considered when designing culturally sensitive mobile wellness applications -gain understanding and inspiration for design	-2-weeks trial with a technology probe -3 rounds of semi-structured interviews -n=16	Wellness Diary mobile application
	Study with Magical Gadget (Finland & India) **P5, P6**	-gain deeper understanding and insight into the user needs related to designing motivational wellness applications	-participatory design task, 2 hours/person -semi-structured interviews -observation -n=12	Magical Gadget
3) Concepting & evaluation	Study of the Living Application & social wellness concepts (Finland & India) **P5, P6**	-evaluate the Living Application concept and 3 minor concepts that we designed in our constructive design research process	-focus groups, 2 hours/group -n=19	Concepts: -Living Application -Gift of Good Health -Photo-frame of Health -Web of Avatars
	Study of Into (Finland) **P7**	-evaluate Into, a social and playful mobile exercise application, which was designed in our constructive design research process	-paper prototype evaluation, n=12 -1-week trial with a working prototype, n=37 -semi-structured interviews -online questionnaires	-Into paper prototype -working prototype of Into mobile application

Table 2: Overview of the empirical studies of the research process.

In our research process, the first studies were initiated in June 2007 and the final evaluations took place in the end of 2009. The cross study analysis of the findings of all studies was conducted afterwards, in 2014. The studies were done in an R&D group of a multinational company developing mobile devices and applications. Most studies were conducted in a team of at least two researchers. In the cultural studies, there were researchers from both cultures present in planning, conducting and analysis. In the studies where usage of certain wellness application was included, the participants were handed out a mobile phone with the application pre-installed, to be used throughout the study. An exception was P2, where the participants used their own phones.

3.3.1 Pre-Studies

By utilising several user-centred research methods (interviews, questionnaires, user trials) we first studied the usage habits, user experiences, motivations, barriers of use and expectations towards the (then) existing mobile exercise applications. We arranged three studies to investigate the existing solutions to gain insight to the user-centred design of the future applications. The studies were the *heart rate monitor study* (P1), *Sports Tracker study* (P2) *and health promotion study* (P3). Based on those findings, we formulated an overview of the factors that could be motivating towards using the exercise applications and thus, increasing physical activity.

3.3.2 Explorative Studies

After the pre-studies, we designed and conducted explorative studies of motivational exercise applications in two contexts: Finland and India. The purpose was to gain in-depth understanding on the user needs and perceptions in relation to mobile exercise applications that support and motivate people to engage in physical activity, as well as to get inspiration and ideas relevant in the design of motivational wellness applications. Two studies were conducted: *study with Wellness Diary* (P4, P5, P6) and *study with Magical Gadget* (P5, P6). We conducted the studies in two differing contexts to get another point of view for design. The methods on this phase were interviews, user trials, participatory design methods, and observations.

3.3.3 Concepting and Evaluation

The focus of the third phase was to generate concrete solutions (concept designs and prototypes) to respond to the identified user needs, expectations and

motivational factors, and to evaluate them. The iterative design process started by arranging several concept design workshops in Finland and India, scenario creation, and quick concept evaluations. The findings from the pre-studies and explorative studies led and inspired the concept creation all along the way. We created more than 10 novel concept designs on wellness and exercise, and out of them, we finally selected five concepts to be studied further, based on the quick concept evaluations. Five concepts were selected based on their potentiality, perceived acceptance, relevancy, and novelty value. First, four of them (the Living Application; the Gift of Good Health; the Photo Frame of Health; and the Web of Avatars) were evaluated in focus groups in Finland and India. The Living Application concept was evaluated both in Finland and India, while the latter three were evaluated in India. This study is called *the study of the Living application and social wellness concepts* (P5, P6). The fifth concept, Into, was further developed as a working prototype and evaluated in a user trial, *study of Into* (P7). Into was evaluated in Finland.

3.3.4 Cross Study Analysis on Motivational Factors

To answer the research question **1: What motivates people to use mobile exercise applications?** and **2: How do these motivational factors appear in two cultural areas: Finland and India?**, a cross study analysis (phase 4) was conducted to analyse the findings of the empirical studies (phases 1, 2 and 3). The motivational factors on mobile exercise applications were analysed by using content analysis (Zhang and Wildemuth, 2009). In practice, the analysis process was the following. The author of this thesis started with a walk-through of the findings of each published article (P1-P7). The findings that related to motivational factors towards the use of exercise applications were selected for futher inspection, while findings related to other themes, such as usability, were left out. The motivational factors consisted of participants' experiences (what aspects had motivated them), perceptions (what aspects they perceive motivational) and expectations (what aspects would motivate them). All findings related to motivational factors were written on separate notes. The notes were then categorised based on how they related to each other, so that notes including similar types of motivational factors were grouped together to form one category. Six categories of motivational factors appeared, each of which included several factors. The motivational factors concerning especially the Indian perspective were sorted out. The outcomes, i.e., the

categorised set of motivational factors, is presented in Chapter 4, and the motivational factors concerning especially the Indian perspective in Chapter 5.

3.3.5 Formulating the Model of the Design Strategies

The main objective of the constructive design research process was *to formulate and present a model of understandable and arguable design strategies for motivational exercise applications.* The final phase (phase 5) of the research process was the construction of the model. This phase of research contributes to research question **3*:* What are the design strategies for motivational mobile exercise applications?** The design strategies were derived from the motivational factors identified in phase 4 by adopting the designer's perspective: how could the application design respond to the factors that users consider motivational. Totally, a number of 34 strategies were identified. The design strategies were named descriptively (e.g. Automatic tracking; Adapting to surroundings). The six higher level categories of the design strategies formed the six dimensions of the model (e.g. Be My Advisor; Utilise My Sociability). The dimensions and design strategies were numbered. The model was formulated from the practical viewpoint, as its purpose was to serve and guide future design activities on the domain. It was also visualised in the form of a flower so that it would be memorable and easy to glance. The model was finally mirrored against the design strategies identified by other wellness technology researchers, as well as grounded with appropriate theoretical knowledge. The purpose was to explain the strategies with the theoretical knowledge and find links and relations to basic theories, as well as the design strategies proposed by other researchers.

3.4 Participants

All our studies directly involved end users or potential end users. For each study, we recruited a new group of participants. In total, there were 152 participants involved in the interviews, participatory task, and focus groups. In addition, the online questionnaire of the heart rate monitor study involved 860 respondents. The health promotion study included 119 subjects, but only a subset of them were interviewed or responded to the online questionnaires. Out of the participants who were involved in the interviews, participatory task and focus groups, 57% were

females. Out of the online questionnaire respondents of the heart rate monitor study, 25% were females. In health promotion study, 70% of all participants were females.

The target profile of the participants was defined as follows: 25-55 years old; living in urban area; engaged in sedentary work; and interested in wellness management, e.g. trying to increase physical activity or lose weight. In some studies there were some exceptions from the target profile. For example, in the study of the Living Application and social concepts, the oldest participant was more than 55 years old. All study participants were experienced users of mobile phones, but the amount of features used on mobile phone varied between the participants. The level of physical activity varied among the participants, but all participants conducted at least some level of physical activity in a regular basis, i.e. there were no completely inactive ones. The Finnish participants were clearly more aware of or experienced with wellness technologies, e.g. heart rate monitor or pedometer, than Indians.

The recruiting of the voluntary participants took place mostly through the extended networks of the local researchers involved, and through advertisements or hobby clubs. The exceptions were the heart rate monitor study, where the questionnaire was basically open for everybody on the Internet (although it was promoted on certain web sites focusing on wellness issues), and the health promotion study, where the recruiting took place based on strict criteria and screening (as the study was part of a broader randomised controlled trial). Appendix A summarises the participants' profiles in each study.

3.5 Data Collecting Methods

The data collection methods in the empirical user studies (phases 1-3) were *semi-structured interviews (individual and group); observations; participatory design; technology probe; questionnaires* and *usage logs*. We did not use all of the methods in all studies, but selected the most appropriate ones. By utilising *mixed-methods research* (Cresswell and Plano Clark, 2007) we aimed to gather both explorative, in-depth knowledge with *qualitative methods*, as well as more generic knowledge with *quantitative methods*. The emphasis was on qualitative methods because of the explorative nature of the research.

Interviews. Interviewing was the main data collecting method, as it was used in all of the studies. When appropriate, interviews were arranged in different phases of

the study, e.g. before the trial, during the trial and after the trial (e.g. the study with Wellness Diary). Some studies utilised short phone interviews (e.g. the Sports Tracker study), but in most studies we conducted face-to-face in-depth interviews (e.g. the heart rate monitor study and the study with Wellness Diary). The study of the Living Application and social concepts utilised group interviews (focus groups) while the interviews in all other studies were conducted for one person at the time. When conducting the interview, the interviewer had a semi-structured discussion guide to follow, but the discussion was not limited to the topics of the discussion guide. The semi-structured approach is used when the interviewer needs to have a freedom to ask for clarifications and additional questions based on the discussion (Lazar et al., 2010). The semi-structured approach was a natural choice for our purpose, as we wanted to gain in-depth understanding on our research topic. The discussion guide was generated separately for each study, but the main themes were consistent across the studies, e.g. the usage habits, the motivational factors and the barriers of use.

Participatory Design and Observations. Participatory design task called Magical Gadget was used in the study with Magical Gadget. The Magical Gadget task was adapted from the SPES method (Iacucci and Kuutti, 2002). We first asked the participants to name their "wellness space", i.e. a place that they associated with their wellness activities. In those places, we arranged the participatory study sessions with each participant. The wellness spaces included e.g. "yoga at home", "gym activities in the sports club" and "cycling or walking outdoors". The participants were privided a selection of different mock-ups, such as a bracelet and blank cardboard boxes of different sizes and shapes (Figure 11). They represented Magical Gadgets. The participant selected one Magical Gadget to be "used" during the wellness session, which was observed by the researchers. For the observer, we had a checklist for the things to be observed, but we did not limit the observations to the topics on the list. The Magical Gadget did not have any limitations but the imagination of the participant. They could attach the gadget where they wanted, and they were asked to use the gadget as they did their wellness activity. They were asked to think aloud what they would do with the gadget, what the gadget would do, and how it would react. The purpose of this task was to get the participants involved

in the design process and to obtain further insights through generative rather than reflective approach. The participatory sessions included also in-depth interviews.

Technology Probe. Wellness Diary application was used as a technology probe (Hutchinson et al., 2003) in the study with Wellness Diary. Wellness Diary was selected as a technology probe because previous studies had revealed it as an easy-to-use and easy-to-understand application (Mattila et al., 2008), and it included a wide set of different wellness parameters to be selectively used based on the user's needs. With the technology probe, we aimed to provide the participants a sample of what a wellness application could be, as well as to gather their opinions, attitudes and ideas towards motivational wellness applications. Especially in India, where wellness applications were not familiar at the time of the study, it was important to give some kind of concrete example of what it is meant by wellness applications.

Questionnaires. In the Sports Tracker study we utilised text-message based questionnaires inspired by Experience Sampling Method (Larson et al., 1983). The text-message based questions were used to collect user experience data over the period of two weeks. The number of text-message questions sent was 8-10 depending on what the participants replied to two questions. Among the questions, there were both multi-choice as well as open-ended questions.

In the heart rate monitor study, health promotion study and the study of Into we launched online questionnaires with multiple choice as well as open ended questions. There were also Likert-scale questions where the respondents selected their level of agreement or disagreement for a set of statements. In the heart rate monitor study we used questionnaires to validate the qualitative findings of the interviews with a larger sample of people. On that study, we launched one questionnaire. In the health promotion study we had three rounds of questionnaires in the different phases of the study period. In the study of Into we launched one questionnaire in the end of the usage period.

Usage Logs. The health promotion study was the only study were we used usage logs of the applications. They were used to get and objective view of the usage frequency of the applications. Log files were downloaded from the phones that the participants used throughout the study. 58% of the mobile phones were reached for downloading the data.

3.6 Data Analysis Methods

Qualitative Data Analysis. Most of the data of the empirical studies (phases 1-3) was qualitative, resulting from semi-structured interviews. The study sessions were video/audiotaped and transcribed. The analysis was carried out by at least two researchers, and the results were discussed with a wider group of researchers. In the data analysis concerning the India studies, there was always a local researcher who participated the data analysis.

A content analysis (Zhang and Wildemuth, 2009) was the most common analysis method that we used for interpreting the qualitative data. This analysis method was applied for the semi-structured interviews and the open-ended questions of the questionnaires. The content analysis adapts an inductive approach, where the raw data are compressed into categories or themes through the researcher's examination (Zhang and Wildemuth, 2009). We conducted the content analysis digitally. Briefly, the process for the content analysis was the following: the interview transcription notes were organised on a spreadsheet based on the research questions/topics discussed on a certain study. In addition, new topics that emerged in the interview were included. There could be, for example, 40 different topics initially, as in the study with Wellness Diary (P4, P5, P6), but the final data analysis was conducted from the perspective of motivational issues.

We also used the affinity wall technique (Beyer and Holzblatt, 1997) for the qualitative data analysis. The method is designed for collaborative analysis of qualitative data. This technique was used in the study with Magical Gadget (P5, P6) for interpreting the data from the participatory task, the observational data and the interviews included. For the analysis made manually on the wall, the process was the following. The raw data was first transcribed verbatim. Next, the transcriptions of the interviews and observations were converted into affinity wall notes, with one observation or note on one piece of paper. The notes were then manually and collaboratively organised on the wall by the research team members. Practically, the notes were clustered thematically to create sub-categories and main categories based on their connections. The categories were also given descriptive names. The ideas and insigths raised during the affinity wall process were marked on separate post-it notes and attached to the wall. After the analysis, the main findings and ideas were

visible on the wall in the structured format and with labels, ready for the discussion and summing up.

Quantitative Data Analysis. The quantitative data derived from the questionnaires (P1, P2, P3, P7) and data logs (P3) were analysed by the means of basic statistical methods on SPSS and Excel. The methods included descriptive statistical analysis methods, e.g. mean, standard deviation, range and mean opinion score, as well as methods for comparing means, i.e. one-way ANOVA and post-hoc tests.

4. Motivational Factors towards the Use of Mobile Exercise Applications

The following three chapters present the results of the thesis, and the positioning is done in Chapter 7. The results are presented to answer the research questions:

RQ1: What motivates people to use mobile exercise applications? (Chapter 4)
RQ2: How do these motivational factors appear in two cultural areas: Finland and India? (Chapter 5)
RQ3: What are the design strategies for motivational mobile exercise applications? (Chapter 6)

This chapter addresses the RQ1. Chapter 5 addresses the RQ2. Chapters 4 and 5 adopt the user's perspective by presenting the motivational factors towards the usage of mobile exercise applications, gained through the cross study analysis of the findings of our empirical studies (Figure 2). Chapter 5 focuses especially to the Indian perspective on the motivational factors. Chapter 6 addresses the RQ3, and adopts the designer's perspective. In that chapter, the proposed design strategies have been derived from the motivational factors presented in Chapters 4 and 5 (Figure 2). In Chapters 4 and 5, the origination of the presented findings is presented as P1-P7. These refer to the original articles included in this thesis (see page x).

4.1 General Findings

The wellness applications aim to improve people's health and well-being. As already explained in Introduction, the exercise applications would ideally support users in permanent behaviour changes, such as adopting a physically more active lifestyle. As behaviour change processes are typically long lasting (Prochaska and Norcross, 2001; Klasnja et al., 2011), the application should be able to motivate users for a long time. Unfortunately, rare applications are successful in maintaining motivation, and in most cases, the usage of the application diminishes after the initial excitement, or the application is discarded totally (Dennison et al., 2013).

In our pre-studies, we saw signs of the decreasing usage motivation of the studied applications. According to our first study, **the usage of the heart rate monitor diminished because of the learning effect**. In other words, the users learned the training effect of the exercises they were doing frequently. They also learned how much they spent calories during certain exercise. Thus, the gadget could not offer the additional value and interest to the exercise anymore after some time. In general, the participants complained that **they got bored to the use of the heart rate monitor over time, because there was not any new data or information appearing during the usage**. (P1)

Similarly, in our explorative studies, the Wellness Diary application (Figure 4) that acted as a technology probe was not considered very motivating in a long-term use. Especially the **Indian participants lost their interest towards the Wellness Diary very quickly**. Also Finns stated similar opinions, though with a milder tone. Wellness Diary was considered as a "one-way" approach, requiring significant effort from the user to input data manually, but providing insufficient benefit and value for the user. Users in Finland and India expected that **the application should be more versatile and interactive than Wellness Diary in order to keep the usage motivation high**. (P4, P6) Based on the findings about the diminishing motivation towards the use of exercise applications, we decided to explore the factors that could be utilised when designing motivational exercise applications.

4.2 Factors of Basic Support

4.2.1 Tracking and Viewing

To be able to track and view the physical activity data seemed to be one of the main motivational factors of the use of exercise applications. The users of Sports Tracker application (Figure 3) **appreciated the automatic tracking of several exercise related parameters** (length, route, speed etc.), as well as the data being stored in the training diary, which they could view afterwards (P2).

In addition, the Wellness Diary application provided a tool for tracking different wellness parameters, although it demanded for manual entries of the data. The important motivational factor of the Wellness Diary was perceived to be in the long-term use – **following the long-term progress on different aspects** (physical activity, weight, eating, stress etc.) of wellness (P3, P4). However, many

participants commented that **the manual tracking of data was too laborious and cumbersome**, and they wished for the automatic input of wellness data (P4). Especially the Indian users of our study probably had gotten bored and stopped using the application before even realising the value of the long-term tracking, as their motivation dropped dramatically already during the study period of two weeks (P4). The similar trend in the usage of the Wellness Diary could be found also in the long-term health promotion study, conducted in Finland. On that study, the usage activity declined towards the end of the usage period. (P3)

4.2.2 Goals Setting and Progress

The goal setting feature of the Wellness Diary, which allowed users to set goals for physical activity, weight, stress etc., was adopted by the Finnish participants in our study with the Wellness Diary. **The goal setting approach was familiar for the Finns** prior to the study, and they set goals for the exercise, weight, sleeping time and/or working time. (P4)

On the other hand, **quantifiable goal setting for wellness was considered strange by the Indian participants**. Setting wellness related goals was not an approach that the Indian participants used and understood. They did not adopt the goal-setting feature of the Wellness Diary during the study period, and in addition, some of them commented that creating wellness related goals would even cause another stress-factor in their lives. They wanted **to see the impact the wellness activities have on their health and quality of life** rather than viewing their progress towards a quantified, specific target. This mindset was summarised aptly by one of the Indian participants: *"Being on the way is more important than reaching something."* (Female, 27 years, India). We learned from the Indians, that for them, consistency and regularity in following a particular routine or a set of practises was more important for wellness than achieving a specific target. (P4)

However, the subsequent study focused more on the exercise aspect of wellness, and not for the whole range of wellness activities. The participants, both Indians and Finns, regarded **setting training program and achievable goals, and being able to view one's progress and the impact of the workout, as important motivational factors**. Most participants wished that the application would provide **support on setting appropriate goals and advice on what activities they should perform** to achieve their goals. (P6)

4.2.3 Acknowledgements and Rewards

Our studies showed that the users of different applications included in our research process considered **seeing the effects of their efforts very motivating**. While pursuing exercise activities they usually wanted to achieve something "bigger", for example reduce weight, and viewing the progress towards that intention was motivating them. They also **expected to receive positive encouragement, praise and rewards when appropriate**, to keep their motivational level high. (P1, P2, P3, P4, P6, P7)

We designed many ways to acknowledge the users in the Living Application concept (Figure 6). The application was designed to give feedback on the progress in audio, textual and visual formats. Explicit positive encouragement was given during and after the exercise. After each exercise session the user was given a summary of the progress. The amount of exercise was also visualised in a playful manner – distance walked on the globe. In addition, the users were rewarded with a new feature on the application when they reached their target and a new level. The new feature could be, e.g. more versatile data and feedback about the exercise, the possibility to compare exercises with others, music that matches their exercise tempo, or maps with new exercise routes. (P6)

The participants of the Living Application evaluation study **valued the application's ability to show their progress towards their goals and to provide encouraging feedback**. The opinions were divided about rewarding users with new features. Half of the participants regarded the idea as a positive thing, as the application would then become smarter and more versatile along with their progress, and they would learn to use the features gradually. Thus, in addition to keeping up the interest towards the application, it would also increase the usability. However, the other half of the participants felt that receiving new features step-by-step would limit their freedom of choice, and they wished to get all possible features at once. (P6)

In the Into application, we designed and evaluated a small element of rewarding the user, in addition to acknowledging that the target has been reached. The rewarding element was the postcard that was received from the target destination, as it was reached. The postcards were saved to the application's postcard gallery and could be viewed also afterwards. This way of rewarding was perceived to have a

small motivational effect by a minority of the users, but majority of the users stated that it did not have effect on the usage motivation. However, it did neither irritate the users. (P7)

4.3 Factors of Advising

4.3.1 Advisory Role

When studying the existing applications in the pre-studies, the participants considered the training programs and coaching as motivational factors in the Mobile Coach application (Figure 5). The participants perceived the application as a personal trainer and they liked the feature that planned the exercises for them. (P3) On the other hand, the feedback the heart rate monitor (HRM) was giving was not considered personal enough, but to be in a too general level. The HRM users wished to get more personalised feedback. (P1)

In the study with the Wellness Diary, most Indian participants and some Finns **wanted interpretation and guidance from the application instead of just raw numbers**. They wished that the application would **play an advisory role**, as they were concerned about whether they were exercising enough or doing their exercises in the right manner. In addition, the "personal trainer" on the application would **motivate them by reminding** about doing the exercises and **spurring**. This expectation was repeated in the forthcoming study with the Magical Gadget. For most of the participants, the imaginary Magical Gadget played the role of a personal trainer with the following aspects: **instructor, motivator and "someone who would know the user"**. The participants expected **the application to take an active role in their lives** and remind them of the importance of the exercising. They wanted the application **to give them a push when they needed it**. In addition, they wished to get **instructions and advice** of, e.g. how often to exercise, how to conduct specific exercise, **warnings** if they were doing something wrong, **reminders** to warm up and stretch. They wanted to get advice before the exercise, during it, as well as afterwards. They also wanted to get summaries related to their progress. (P6) It was clearly visible that the participants expected the exercise application to be almost like **a human companion** with personality and personal touch for advicing.

We designed the Living Application concept to "act as a personal trainer in the pocket". In brief, the Living Application acted as a personal trainer and motivator by setting goals, exercise programs, providing guidance and feedback. In the evaluation of the Living Application concept, all **the participants in Finland and India appreciated and approved the fundamental idea of the concept, i.e. a personal trainer that supports and motivates exercise activities**. Moreover, **the Indians emphasised that there should be a sense of "human touch"** in the application, which means that they would like to feel that **the application understands them**. The participants also wished that **the role of the advisor would change during the process – initially its role would be more like an instructor and evolve to act like a friend later on.** That way it would be able to give appropriate support in every phase of the process. (P6)

4.3.2 Seeing the Future

A nuanced finding from the health promotion study was that, for one participant, the Wellness Diary **showed that something was happening before concrete results were visible in the body**. She commented that the application revealed invisible things for her. For example, when looking at the mirror, seeing concrete results for the weight decrease takes time, but viewing the weight entries on the application **showed that the trend remained towards the right direction**, even though the weight changed up and down during weeks. (P3)

In the explorative studies, some users of the Wellness Diary commented that **the application should explicitly take a look at the future**. They wished that the application would be able to inform the users of their progress and visualise the benefits that they are going to experience in the future, if they continue with a certain regime. They wanted to see the concrete impact of their wellness related efforts in the application, even though they could not see them yet with a naked eye. (P4)

4.4 Factors of Adaptability

4.4.1 Adapting to Activities and Surroundings

The studies of the existing exercise applications revealed that the users of Sports Tracker wanted to have better **possibilities for personalising the application to better suit their own exercise activities**. For example, tracking regular running

activity differs from tracking an once-in-a-lifetime hiking trip, and those would need different ways of support. (P2) At the same time, the Mobile Coach application provided **updated exercise programs**, which aspect, according to the interviewees, kept the usage activity high. In addition, the simple adaptability of the Mobile Coach - the application **raised the requirements for the exercise and re-planned the schedule** if the user did not do the planned exercises on a certain day – was considered as the main benefits of the applications. (P3)

From the explorative studies in India we learned that the long distances, hectic traffic and pollution levels contributed to the process of choosing and scheduling exercise activities. Leisure walking was a popular but differing activity in Finland and India. In Finland, people could walk in the nature and unfamiliar paths. In India they usually walked in familiar and sometimes restricted and gated areas of their residential neighbourhood, sometimes even on the roof terrace, without proper natural settings. It became clear that the map-based exercise features were not considered useful in urban Indian context since the heavy traffic and dense built environment rule out many outdoor exercise activities, such as cross-country running and cycling. We observed that **diverse environments should be supported by applications to assist finding wellness potentials in the surroundings**. The application could also be able to **compensate to the lack the natural beauty in the heavily built and polluted environments**. (P4)

4.4.2 Evolving with the Users and Situations

During the whole research process, we often heard the participants complaining about the static nature of the (then) existing exercise applications, and their inability to keep up the usage motivation for a long time. **The more dynamic approach** was wished and expected by the participants, and those applications that already provided some sort of new things among the use were appreciated. (P1, P2, P3, P4)

Our explorative studies in Finland and India revealed that the application should be able **to adapt to the constantly changing conditions of everyday life**, **as well as the progress made by the users**. The users fell ill, needed to travel, experienced mood changes, etc. In those situations, the application would ideally **notice the exceptional situations** and adapt the exercise program accordingly. Sometimes it would recommend an easier exercise or an alternative for a specific workout. In addition, the application should take into account the level and progress of the user,

and adapt itself based on that. The users would **need different kinds of advice, instructions and exercise recommendations in the different phases of progress**, for example when being a beginner or already having established the routine. (P6)

The Living Application concept was designed to evolve with the user as she/he made the progress. The application took **a phased approach and the user progressed through different levels**. The application **adapted** the exercise targets, programs, advice and feedback based on the phase of the user. The targets became more challenging as the user progressed to higher levels. The exercise programs were adapted to the progress by suggesting variation in the activities, and by increasing the suggested amount of exercise. There was also a special use case for situations when the user could not follow the normal exercise regime, for example during illness. **During the inactive periods the application concept was designed to help to maintain motivation** by providing encouraging messages and information on the user's progress so far. After the inactive period, the application adapted the exercise program and target to support easing back into the normal workout routine. (P6)

The evaluation of the Living Application revealed that **the participants both in Finland and India appreciated the application's ability to evolve and adapt** – the changing programs, suggested activities and challenges. The division into different difficulty or challenge levels was received positively. **The living approach was preferred to static one**. They also **responded positively to the application's ability to change the mode during exceptional situations**, such as illness and travelling, and to provide a soft re-start after a break. (P6)

4.5 Social Factors

4.5.1 Sharing, Cooperation and Competition

In the Sports Tracker study, **sharing exercise data with familiar persons** was considered as an additional new way to keep in touch and maintain social networks. Among the study participants, **there were individuals who mentioned that competition with others was a motivating factor**. The users of the Sports Tracker were interested in seeing if others had been exercising in the same area or even taken same routes. The users were mostly **interested in viewing the sporting activities of those who they knew already**. An important factor for the social use

to be motivating was a large enough community of familiar persons. An exception, when they wanted to view data from strangers, was the case when travelling to unfamiliar places. In those situations it was seen useful **to be able to look at where people have been exercising and plan their own routes accordingly**. (P2)

Many Indian participants of our explorative studies wished to do physical workouts as a group, and to share their goals, positive experiences and success in pursuing wellness. They usually **preferred cooperation to competition**. Competing with others was not considered as a motivational factor towards wellness in our explorative studies. **Most participants preferred competition with themselves rather than with others.** (P5) Comparing one's own previous and current workouts was seen as a motivational factor also in the Sports Tracker study. The users challenged themselves with their previous workouts on the same route by trying to break records when going the same route again. (P2) The social features of the Into application (Figure 10) were exercise team formation, collecting steps together with the team members, and viewing the individual and collective progresses towards the target. In the evaluation, more than half of the users rated that the social aspects of Into, **competition and cooperation, had positive impact on the usage motivation**. We found out that the users were satisfied with the Into's ability to **enable competition and cooperation at the same time**, and the users perceived them as motivating factors. **The users could make their selection between mentally competing** against the other team members by comparing the results in the Team view, **or cooperating** with them by contributing towards reaching the team challenge together. (P7)

4.5.2 Re-Uniting and Group Formation

Sharing goals with others was observed to be a good motivator in our explorative studies. Especially the Indian participants spoke about sharing their goals with other people, and about how they wanted to work together towards their goal. However, doing wellness activities together was often difficult due to practical issues, such as arrangements and schedules. Small slots of free time due to long working days and time spent on commuting made it **complicated to find shared time slots for wellness activities**. For Indian participants, it was also common to move from one place to another to search for the job, and there was a lack of social networks in the new place, which was considered as a problem. (P5)

The concept of the extended family has strongly lived in India. In the past, family members were living as physically close units and wellness related issues were also discussed in the family, and it was natural part of life. Wellness information and habits were passed from the elders to the younger generations, and **the family members could motivate each other.** Nowadays, people in urban India live more and more in nuclear families instead of extended families, and **a lot of mobility** can be observed because of the education, career, etc. Family members, who used to live together, **are now living apart from each other and meeting only rarely** – sometimes as infrequently as once or twice a year. Despite of these structural changes in the physical proximity of the family members in India, **the role of family in spreading wellness related knowledge was highly valued** by our participants and especially our younger participants (30 years and younger) were **concerned about the absence of wellness related trusted information sources.**

Inspired by these findings we designed a concept called "Photo Frame of Health" (Figure 8). The application concept supported **cooperation between family members, couples and close friends who were living apart from each other**. It allowed the users to share their health related information, like goals, status messages, greetings, recommendations, and health tips, with others. The information could be seen on a digital photo frame. On the concept evaluation study, the Indian participants stated that the application concept felt like a message from the persons they care. Most of all, they liked the visual and colorful material provided by the concept, and they considered the visualisations of wellness as inspirational and motivational stuff. (P5)

In addition, we designed the concept "Web of Avatars" (Figure 9) to be able **to communicate with people with similar wellness profiles, aspirations, and interests**. The concept utilised the add-hoc communities created with people within the close proximity. In the concept, the application kept looking for matches between profile information by using close proximity connections, and connected people with similar profiles, so that they could start communicating. The connections between people were visualised as a neuron network. The thickness of axons between the neurons represented the activity of the connection. In the concept evaluation, the Indian participants were consistent in that they would not like to use the application with strangers but with the existing social network or at least semi-

familiar persons, as also supported by our other findings already reported. **A potential use case in India would be to search for persons with similar aspirations**, **for example inside a big residential area.** Typically, those are gaited and closed communities, but the habitants do not necessarily know each other. Tasks like **searching for a potential partner for the exercise activity** could be done with the help of the application. (P5)

4.5.3 Utilising Role Models

The importance of **the motivational role of the role models appeared especially among the Indian participants** of our explorative studies. The participants reported that they were motivated when they saw other people succeed, e.g. to decrease weight or increase happiness. The effective role model could be a friend who had achieved a challenging results or just someone who was good-looking. There was also **a strong tendency of idol worship, for example celebrities, politicians and gods.** It was commented that nowadays celebrities were more and more connected with the fitness domain, and they could be used as wellness messengers. (P5, P6)

In the Living Application evaluation study, **all the Indian participants liked having the avatar as an exercise advisor. Most Indian participants wanted to have their role model as their advisor on the application**. The instructor should be someone they aspired to be like, whose advice they would be willing to take and company they would enjoy. Movie stars and sportspersons were mentioned as popular role models. The Finnish participants were not so much keen on having the role model or avatar as an instructor. They preferred more practical way of getting instructions, and some participants even considered the avatar as an annoyance. (P6)

Our concept "Photo Frame of Health" (Figure 8) utilised role models as motivators. On the main screen of the application concept, there was a possibility to view a picture of a celebrity, for example a Bollywood actor in a good shape, for motivational purposes. In addition, the celebrities were used as a rewarding factor: when the user would achieve the target, animated Bollywood figures would start dancing on the screen. (P5)

4.5.4 Passing Forward

In India, it was observed that the concept of wellness application was not widely known. In our study, we used Wellness Diary as a technology probe, to give

participants an idea of what a wellness application could be, to evoke their opinions, attitudes and ideas towards wellness applications. We observed that people should be made aware of the application, and they would need to get information on the application in order to become interested in that. At the same time, it was found out that, **especially in India, the transfer of wellness information relied strongly on social relationships.** Traditionally, the information has been passed from elders to the children. It can be assumed that **social relationships could play an important role in spreading wellness information as well as wellness applications**. The trust towards and the value of the application was perceived to come from the recommendations of other people who you know and trust (trusted sources of information). (P5)

Based on these results we designed and evaluated a concept called "Gift of Good Health" (Figure 7). The idea on that concept in brief was that the wellness application was sent to the other person's mobile phone as a gift. Thus, **the awareness to the wellness application came from people one knows**. The sender of the application could personalise the application for the receiver, for example by suggesting goals and targets, or even by passing on own training program. The concept evaluation in India generated contradictory feedback towards the idea of sending a wellness application as a gift. Some participants stated that receiving the application as a gift from a person that you know would probably have positive impact in taking new things into use, while others thought that it would not have an effect. (P5)

4.6 Factors of Engagement

4.6.1 Variety and New Things

"The data just stays there and does nothing" was a commonly heard comment about the Wellness Diary, especially from the Indian participants in the explorative studies. The Wellness Diary was perceived as a static application. They envisioned what kind of wellness application would be motivating for them. They wanted to have **more interactive, exciting, joyful and lively approach with new features appearing to help keep their motivation to use the application high**. It became clear that the users in both contexts **wanted to have a lot more variety** to the features and functionality of the application. (P4, P6)

The same expectation was found very clearly in the participatory study with the Magical Gadget, where **getting variety was considered important in maintaining motivation**. The participants felt that as the time went by, new features and information in the application would keep them interested. (P6). In addition, the users of the Sports Tracker liked **getting regular updates to the features and content**, and it was considered to be a factor to keep the usage motivation high (P2).

Based on the findings about how boring it was to use" static applications", we designed some engaging features to the Living Application. First of all, the adaptation of the application to the user's progress and situations were designed to bring novelty to the user experience. This was perceived as a motivational factor, as already presented. In addition, continued use and achieving goals unlocked more features and functionalities on the Living Application, provided for the user as rewards. Rewarding the users with new features when they achieved the target divided opinions between Finns and Indians in the evaluation; there were both likers and dislikers in both locations (P6)

4.6.2 Surprise

To maintain the users' curiosity, the Living Application concept occasionally introduced **surprising elements**, for example a healthy cooking recipe or instructions for stretching exercise. **The elements of surprise particularly appealed to the Indian participants** of the Living Application evaluation study, and they suggested **additional types of surprises**, such as "a permission to treat oneself to new clothes or a body massage", "a permission to eat an ice cream" or something that would make them laugh. (P6)

4.6.3 Playful Features

The Living Application included **a playful avatar, who acted as a personal trainer**. Additionally, there was **a playful visualisation of the progress made on the globe**, as already explained. All Indians liked the avatar as the exercise advisor and they wanted to have their own role model there. Finns did not appreaciate the avatar as much. The playful visualisation of the progress was well received in both locations (P6).

We refined the idea of progressing on the globe further and realised it in the Into application. Into used the analogy of "travelling on the map" to visualise physical activity data. In the user study, visualising physical activity achievements as a

virtual trip between cities and villages was regarded as a concrete and understandable analogy, as well as interesting and fun. They liked to view the map often to see if they were already on the halfway or if they soon reached the destination. Between the departure place and the destination they could think which places they had already passed along the way and in which place they were at the moment. In addition to being concrete and understandable, **the participants also experienced fun and enjoyment when looking at the progress on the map**. (P7)

There were two additional, minor playful features in the Into application. First, it rewarded the users with a digital postcard from the reached destination when the team progressed to the destination. The postcards were saved to the postcard gallery. Second, based on the speed that the team progressed, the application showed an animal figure, e.g. a snail, a galloping horse, or a flying eagle. According to the user study, those design elements had some positive effect on the usage motivation, but they were perceived as more minor motivators than the general idea of proceeding on a familiar map. (P7)

4.7 Factors of Representation

4.7.1 Representation beyond Numbers

The Wellness Diary Application provided feedback of the progress by showing numbers and graphs. The study with the Wellness Diary indicated that some participants **would prefer a more versatile visualisation of the progress than just raw numbers and graphs. Especially Indian participants commented on how boring it was to view numbers and graphs**. When comparing the Indians and Finns, the Finns found the graphs more motivational than Indians. (P4)

In the Living Application concept to motivate physical exercise we designed **a visualisation of the globe**, where the distance travelled towards the user-set destination indicated the amount of her/his physical exercises, as already discussed. The most **participants' reactions towards the visualisation were positive**, both in India and Finland. However, it was emphasised that the visualisation should include both short- and long-term goals. (P6)

The similar type of visualisation was refined in the design of Into. In the Into application we used the analogy of "travelling on the map of the home country" for visualising the amount of physical activity. The progress on the map was based on

user's step count. According to the user study of Into, the **users liked the challenges reflecting trips between places and viewing the progress between the places on a map**. According to the participants, **proceeding on a map of the home country provided understandable and concrete feedback about the progress**. The users explained that the target felt more concrete because there was a clear goal of travelling virtually from one place to another, and realistic departure and destination places. The participants liked the idea of travelling between real-life cities, towns and villages. As the participants of the study were Finnish, the map of Finland was familiar for them and they were quite aware of the distances between the places they selected. For most of the participants, **travelling virtually between cities or villages made viewing the physical activity achievements more concrete than viewing the achievements as kilometres or steps,** which was an alternative way to view the achievements in Into. They emphasised that **the familiarity of the game world was a very good aspect**. They had former experience in travelling between places in the real world and thus they had a mental picture of the distances and how much time and effort those would require. (P7)

4.7.2 Descriptive Data

Recording descriptive notes and subjective feelings in addition to raw facts and numbers was raised among the participants in two studies. In the health promotion study, the **users wanted to save descriptive data** to the free form diary of the Wellness Diary application. They wrote notes about how they exercised; reasons for poor sleep; social context or location of activities; and explanations for the lack of physical activity or poor activity results. (P3). In addition, some participants of the explorative studies made descriptive notes on the Wellness Diary application. They made notes on gym training, e.g. training legs, details of a hiking route, and reasons why they failed out to carry particular activity. (P4). Being able to take notes was important **for recording nuanced information** and revealed a need for being able **to track more comprehensive, subjective wellness experiences**, rather than just numerical data and measurements.

5. Motivational Factors in Two Cultural Areas: Finland and India

This chapter points out the differences in the findings between the two cultural areas studied, emphasising the perspective of the Indian users. As far as we are aware, the perspective of the Indian users has not yet been explored in the domain of mobile exercise applications, and thus, this chapter provides a novel perspective to the research, which has mostly had a western point of view. The positioning of the findings is done in Chapter 7.

5.1 Non-Quantified Approaches

We observed **a difference in how the Indian and Finnish participants perceived the quantified approach for wellness**, common in the wellness applications. While **the Finns were used to the numeric approach (i.e. goals and progress presented with numbers and graphs) and accepted it, the Indian users found it very strange.** They did not adopt the goal-setting feature of the Wellness Diary during the study period, and some of them stated that setting wellness related goals would cause them additional stress. They wanted to see the big picture rather than details. **Viewing the impact that the wellness activities have on their health and quality of life was perceived much more appropriate than viewing their progress towards a quantified, specific target**. The Indian participants also **commented on how dull it was to view numbers and graphs** of the Wellness Diary application. When comparing the Indians and Finns, **the Finns found the graphs more motivational than Indians**. These findings set interesting challenges for the designers of future wellness applications: new, non-quantified ways to approach wellness goals, progress and the impact should be considered. (P4, P6)

5.2 Sense of Human Touch

Especially **the Indian participants emphasised that there should be a sense of "human touch" in the exercise applications**. By that statement they meant that they would like to feel that the application understands their particular needs, changing moods and situations, and adapts its ways of support accordingly. The

participants wished that **the role of the application would change during the process**. That way it would be able to provide appropriate support in every phase of the process. Initially, the advice given would be more fundamental and extensive, and later on it would function more on the background, and pop up when the support would be needed, for example in the times of relapse. **The Finnish participants seemed to be much more satisfied with the straightforward approach of (then) existing exercise applications** without the sense of the application "knowing the user". (P6)

5.3 Adapting to Surroundings

We learned that the long distances, hectic traffic and pollution levels contributed fundamentally to several aspects of the lives of Indians, also to the process of choosing and scheduling exercise activities. Doing physical exercise had different characteristics in India and Finland. While walking was a popular activity in both locations, it was done in different ways. In Finland, people could take a walk in the forested paths, usually available anywhere. In India, people who wanted to take a walk, usually walked in gated and limited areas of their residential neighbourhood, sometimes even on the roof terrace. The heavy traffic and dense built environment ruled out many outdoor exercise activities common in western societies, such as cross-country running and cycling. **To be able to better support the users in locations such as urban India, the exercise applications should assist finding wellness potentials in surroundings of diverse locations.** The application could also be able **to compensate to the lack of the natural beauty** in densely-built environments. (P4)

5.4 Re-Uniting Scattered Social Networks

The tendency found in our explorative studies was that **the Indians wanted to share their goals, exercise activities, positive experiences and success in pursuing wellness with others**. They usually **preferred cooperation to competition**. Practical issues, such as hectic schedules, long working hours, time spent in commuting, and moving from one place to another to search for the job, made sharing difficult in live. **The changes in the proximity of the family members were clearly visible in India**. The concept of the extended family was

disappearing. Especially the younger participants (30 years and younger) were **concerned on the disappearing role of the elderly as wellness motivators and information sources**. Nowadays, people in urban India live increasingly in nuclear families instead of extended families, and a lot of mobility can be observed because of the education, career etc. Family members are now living apart from each other and meeting only rarely – sometimes as infrequently as once or twice a year – because of the long distances. **The wellness applications could utilise the important role of family members as wellness support by re-uniting the scattered social networks**, be it either the members of the extended family or other close-ones living apart. (P5)

5.5 Idol Worship

The importance of the motivational role of the role models appeared especially among the Indian participants. They reported that they were motivated when they saw other people succeed, e.g. to decrease weight or increase happiness. The effective role model mentioned by them could be, for example, a friend who had achieved challenging results, or someone who was good-looking. In addition, **there was a strong tendency of idol worship, for example celebrities, politicians and even gods**. It was stated that **celebrities were now more and more connected with the fitness domain, and they could be well used as "wellness messengers".**

All of the Indian participants were fond of having the avatar as an exercise advisor in the Living Application. Most of them wanted to have their own role model as their advisor. According to them, the instructor should be someone they aspired to be like. Movie stars and sportspersons were mentioned as popular role models. **The Finnish users were not so much keen on having the role model or avatar as an instructor. They preferred more simplified way of getting instructions, and some participants even considered the avatar as an annoying thing.** (P6)

5.6 Increasing Awareness

We observed that the concept of wellness application was not widely known in India. We used the Wellness Diary application as a technology probe, to give participants an idea of what a wellness application can be and to evoke their ideas

towards wellness applications in general. It was observed in India that people should be first made aware of the application, and they would need to get information on the application in order to become interested in that. **It was found out that the transfer of wellness information relied strongly on social relationships in India**. Traditionally, the information has been passed from the elders to the children. Thus, one can assume that **the social relationships would probably play an important role in spreading wellness information as well as applications in India.** Among the Indian participants, the trust towards and the value of the application was perceived at least partly to result from the recommendations of other people whom one knows and trusts. (P5)

5.7 Surprising Elements

The surprising elements particularly appealed to the Indian participants of the Living Application evaluation study. They suggested **additional types of surprises or rewards**, such as "a permission to treat oneself to new clothes" or "a tip to have a body massage", "a permission to eat an ice cream", or something that would make them laugh. **The Indian participants were clearly more accepting towards the idea of unexpected elements provided by the application than the Finnish ones.** Thus, surprising elements and features could be utilised in the exercise applications, but more knowledge is needed about them in order to prevent them to become an annoyance. More information would also be needed in what kinds of surprises could be utilised in the exercise applications, and if there were totally new approaches for keeping user's motivational level high by providing unexpected elements in the exercise or wellness applications. (P6)

6. Design Strategies for Motivational, Mobile Exercise Applications

This chapter presents *34 design strategies for motivational, mobile exercise applications*. The design strategies were formulated based on the findings on motivational factors, summarised in Chapters 4 and 5. The design strategies are presented as a flower shaped model including six dimensions: *Support My Exercise*, *Be My Advisor*, *Grow with Me*, *Utilise My Sociability*, *Keep Me Engaged*, and *Visualise My Exercise* (Figure 12).

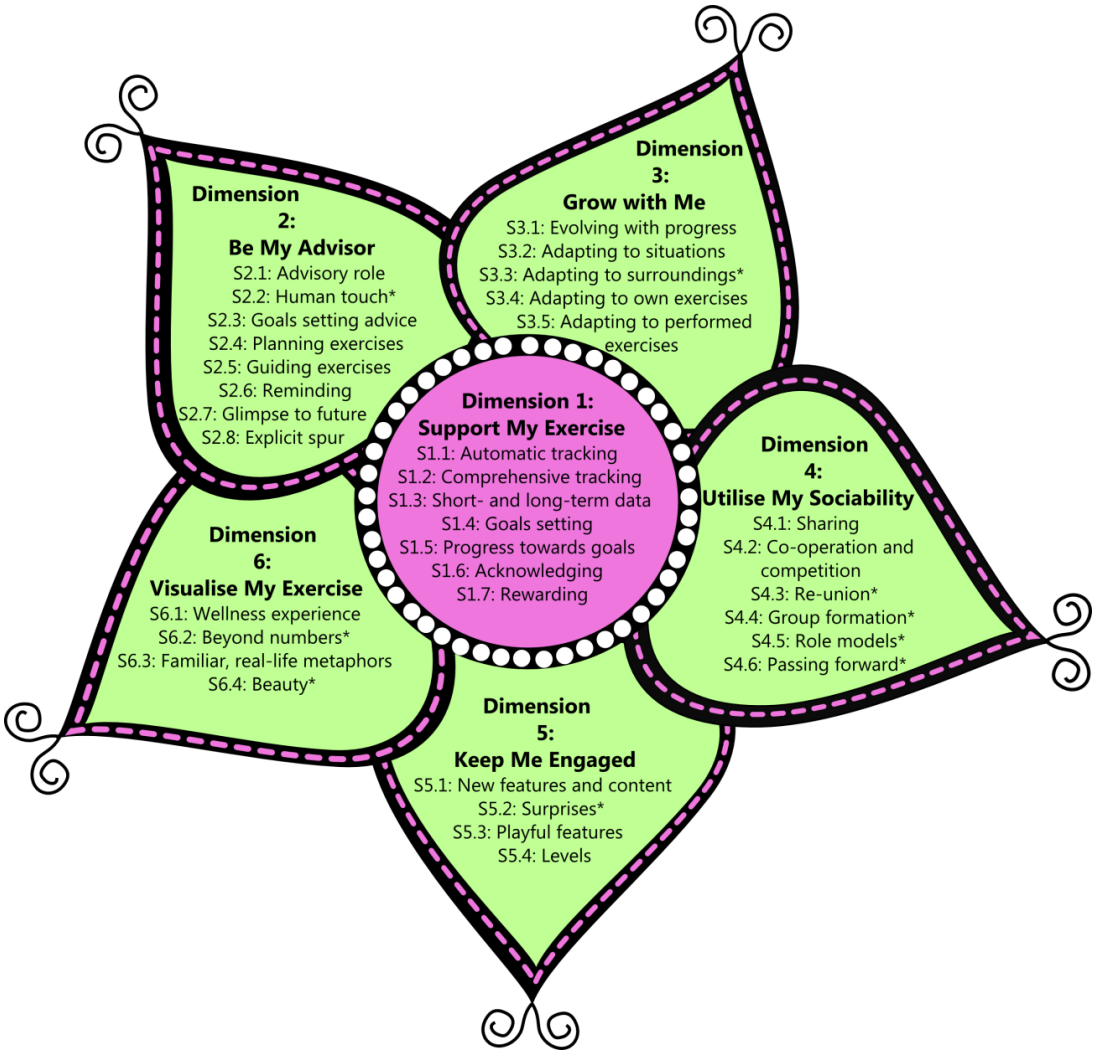


Figure 12: The model of 34 design strategies for motivational, mobile physical exercise applications, grouped in six dimensions. The design strategies that were formulated from the India specific findings, are marked with *. (Graphic design: Susanna Paasovaara & Aino Ahtinen).

The dimensions are categories of design strategies. The shape of a flower was selected to visualise the model, because it provided an opportunity to present one dimension as a fundamental dimension, and the others as equivalent to each other. The center of the flower represents the fundamental dimension of the design strategies (Support My Exercise), and the other dimensions are on the petals. In addition, the visual representation of the model is easy to glance and perceive, as all design strategies are visible at once.

All dimensions include several design strategies. The design strategies are referred as S1.1 (strategy 1 on dimension 1), S1.2 (strategy 2 on dimension 1) etc. The cultural strategies, i.e. the design strategies that were formulated from the India specific findings, are marked with *. In the following sections, the dimensions and design strategies of the present model are discoursed. In addition, the design strategies are compared to and discussed in light of the prior design strategies presented in Related Work (Table 1). The comparison between the present and the relevant prior design strategies is provided in the end of each dimension (Relation to Prior Design Strategies-sections).

6.1 Dimension One: Support My Exercise

The first dimension called *Support My Exercise* forms the core of the design strategies for motivational exercise applications. They can be found in the center of the model, because they are the very basic supporting strategies, which relate to tracking physical activity data, setting goals, as well as providing feedback and rewarding. Table 3 presents and explains the design strategies on this dimension. The table also summarises how the design strategies appeared in our studies and designs during the research process.

Dimension 1: Support My Exercise		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S1.1: Automatic tracking	Support unobtrusive and effortless tracking of exercise data. Most of the tracking should be automatic.	Automatic tracking of exercise related parameters in HRMs and Sports Tracker. Living Application concept to utilise several mobile sensing technologies for automatic tracking.
S1.2: Comprehensive tracking	Track several parameters of exercises to provide a comprehensive picture of the activity.	Sports Tracker collecting e.g. route, speed, pace, distance, time and altitude. Living Application to collect step count, activity type, energy consumption, location, speed, distance etc.
S1.3: Short- and long-term data	Save the exercise data to the application, for example to the training diary. Provide easy way for glancing recent data as well as explore the long-term data.	Sports Tracker training diary. Wellness Diary main screen and graphs.
S1.4: Goals setting	Provide means for the short- and long-term goals setting for the exercise.	Goal setting feature on the Wellness Diary, Living Application and Into.
S1.5: Progress towards goals	Show user's progress towards the goals. Give feedback about the performance.	Graphs on Wellness Diary. Feedback of the progress in Living Application (audio, text, visualisation). Visualisation of the progress in Into.
S1.6: Acknowledging	Acknowledge the user for her/his efforts related to exercising by providing explicit positive encouragement and praise.	Living Application to provide positive encouragement (audio and textual).
S1.7: Rewarding	Reward the user for her/his physical exercise when the goal or sub-goal has been achieved.	Rewards of Into (postcards) and Living Application (new features).

Table 3: The design strategies of the dimension one: Support My Exercise.

In our studies, users appreciated the automatic tracking of exercise related data, and the manual tracking was considered cumbersome and laborious. Our first design strategy is **Automatic tracking (S1.1).** It means supporting unobtrusive and effortless tracking of exercise data. Most of the tracking should be automatic to minimise user's effort. We found in our studies that users wanted to track several parameters about the exercise activity to get a big picture of the performance. Thus, our second design strategy is **Comprehensive tracking (S1.2)**. We propose that the exercise application shoud track a diverse set of parameters of exercises to provide a comprehensive picture of the activity. We also suggest that the exercise application should provide an easy way for glancing recent data as well as explore the long-term

data, because the participants of our studies considered them as motivational factors. Thus, the third design principle is called **Short- and long-term data (S1.3).** Futhermore, the participants appreciated the possibilities for the short-term and long-term goal setting on the exercise application. We suggest that the application should include both the short-term and the long-term goals setting possibilities for the exercise, and that is why the fourth design strategy is **Goals setting (S1.4)**. Based on our findings, we also propose that the exercise application should show the user's progress towards the goals, as well as give feedback about the performance: **Progress towards goals (S1.5)**. Our next design strategy, **Acknowledging (S1.6)**, is based on the study findings about how participants appreciated the application to acknowledge the user for the efforts related to exercising. The application should acknowledge the user for her/his exercise by providing explicit positive encouragement and praise. The last design strategy in the dimension one is called **Rewarding (S1.7)**. Based on our findings about at least a small motivational role of rewards, we suggest that the application should reward the user for her/his physical exercise when the goal or sub-goal has been achieved**.**

Relation to Prior Design Strategies

This section discusses the design strategies of the *Support My Exercise* dimension in light of the prior design strategies. In the literature, there is plenty of support for the existence of the *Support My Exercise* dimension and its design strategies. Consolvo et al. (2014) explain that most mobile wellness applications are built on top of three functions: collecting data, providing feedback and helping to track progress towards goals. They call these three as a "common base" (p. 182). They also state that the more advanced strategies, for example social influence and gamification, are often built on top of the common base, and thus the common base needs to be well designed.

S1.1: Automatic tracking. The PSD model mentions *Self-monitoring* as one of the design strategies for persuasive systems (Oinas-Kukkonen and Harjumaa, 2009). In addition, Klasnja and Pratt (2012) list *Tracking health information* (self-monitoring) as one of strategies for mobile health interventions. However, they do not speak out if it should happen automatically or manually. Dennison et al. (2013) found that many of their study participants were concerned about the usage of health

related applications to become overly burdensome for the user if constant manual entering of data was needed. Consolvo et al. (2014) discuss tracking of physical activity from many perspectives. They make a note that automatic detection of physical activity has become a mainstream on mobile exercise applications. However, they also note that manual tracking provides flexibility in determining the appropriate level of detail for physical activity data. They suggest that the wellness application should consider supplementing automatic detection with manual tracking (see our design strategy 6.1. for comparison).

S1.2: Comprehensive tracking. In line with the present design strategy, Consolvo et al. (2014) suggest that the application should support recording all data that the user would reasonably want to record, i.e. a full range of physical activities.

. **S1.3: Short- and long-term data.** In their early work with Houston, Consolvo et al. (2006) propose a supporting design strategy *Provide personal awareness of activity level*. They found three important types of personal awareness to provide: a history of past behaviour, current status, and activity level performance. Later on, they proposed *Trending and historical* as a design strategy for technologies that support behaviour change (Consolvo et al. 2009). By that they meant that the application should provide reasonable and accessible information about the user's past wellness activity as it relates to user's goals.

S1.4: Goals setting. In the PSD model, there is a related design strategy called *Suggestions* (Oinas-Kukkonen and Harjumaa, 2009). In their study, Consolvo et al. (2006) found an important challenge related to how the system should determine reasonable goals that encourage a sustainable increase in step count. According to them, there are two approaches: one size fits all vs. individual goals.

S1.5: Progress towards goals. Consolvo et al. (2014) discuss different ways of mobile wellness applications to give feedback. They define the types of feedback that vary from the simplest numerical values (counts) of steps taken, to the graphs, stylised representations and textual feedback, which all have their own advantages and disadvantages. First of all, the counts are straightforward to interpret as they capture the amount. However, without a context, for example a reference value, they are quite useless. Graphs provide information on how activities change over time, how users are progressing towards the goals, and how the tracked activities relate to each other. In addition, graphs are compact making them easily and quickly

glanceable. However, graphs alone do not provide interpretation and they can be difficult to understand. They refer to the low levels of graphical literacy among the general population. It means that many people have difficulties in understanding the meaning of graphically presented information. Stylised presentations, then, mean the ways of presenting wellness data in abstract representations: images or animations. They increase the privacy of the user's data; they can be attractive; and they provide means for personalising the way how the user gets the feedback. However, the meanings and mappings of them need to be learned before they can be understood. In addition, they are not as precise as numerical data. Textual messages are the fourth mean of giving feedback. There, the feedback is given in an everyday language. They can provide users feedback that they might not discover by themselves. They can be particularly useful when designing applications for populations where the level of graphical literacy is low. (ibid.)

S1.6: Acknowledging. Textual messages (Consolvo et al., 2014) relate to our suggestion of acknowledging the user for her/his exercise efforts by providing explicit positive encouragement and praise. This strategy is also supported by the design strategies called *Praise* and *Recognition*, presented in the PSD model (Oinas-Kukkonen and Harjumaa, 2009). In the study conducted by Dennison et al. (2013), the participants were concerned about the application to "tell you off" (p. 5) and the negative emotional and motivational impact of feedback that revealed large discrepancies between the goals and the actual achievement. To beat that concern, the feedback should be designed to adopt a positive tone.

S1.7: Rewarding. The supporting strategy can be found in the PSD model (Oinas-Kukkonen and Harjumaa, 2009), namely *Rewards*. Consolvo et al. address the important role of the feedback and rewarding on wellness applications. In their early publication (Consolvo et al., 2006) they suggest a design requirement *Give users proper credit for activities*. Later on (Consolvo et al., 2009), they suggest a design strategy called *Positive*, which refers to using positive reinforcement to encourage change. It states that the user should be rewarded for performing the desired behaviour and attaining her/his goal. It also states that the user should not receive a reward or a punishment when the desired acitivity is not performed, but her/his interest should be sustained.

6.2 Dimension Two: Be My Advisor

The second dimension is called *Be My Advisor* (Table 4). It adds the "human perspective" and the advisory approach to the basic support strategies described in the previous section (*Support My Exercise*). It relates to the users' expectations and wishes for the exercise application to act as a personal trainer, and to provide real-time support, guidance and interpretation to the activities, instead of just numerical facts. It also relates to the application's perceived role as a "person who knows you". Some design strategies included in the dimensions *Support My Exercise* and *Be My Advisor* are partly overlapping and dealing with same issues, for example related to goals setting (**S1.4: Goals setting** and **S2.3: Goals setting advice**). However, they differ in sense that the first dimension deals with goal setting as a basic feature, and the second dimension adds the advisory perspective on it.

Dimension 2: Be My Advisor		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S2.1: Advisory role	Play an advisory and motivational role, and take an active role in users' lives.	The exercise advisor in Living Application.
S2.2: Human touch*	Make the exercise advisor of the application to act like a human being with personality and personal touch for advicing, and know the user.	The avatar as an exercise advisor in Living Application. The Living Application to learn from user's behaviour and adapting the exercise goals and programs accordingly.
S2.3: Goals setting advice	Instruct on setting realistic, achievable, but challenging enough goals for the exercise, editable by the user.	The Living Application advisor to help in setting appropriate goals.
S2.4: Planning exercises	Offer a complete suggestion of exercise plan and program, editable by the user. Provide advice on what activities to perform to achieve goals.	The Living Application advisor to provide an editable exercise program.
S2.5: Guiding exercises	Guide the exercise activities and provide feedback before the activity, during it and afterwards.	The Living Application advisor to give feedback in all phases of the exercise.
S2.6: Reminding	Remind about the importance of doing the exercise activities.	The Living Application advisor to remind about the exercises.
S2.7: Glimpse to future	Visualise the benefits of the performed exercise activities, if the user continues with a certain regime. Tell that something is happening even though one cannot see it yet with a naked eye.	The graphs showing trends in Wellness Diary. The Living Application to tell what impact exercises have.
S2.8: Explicit spur	Give a push when the user needs it.	The Living Application giving motivational messages in everyday language.

Table 4: The design strategies of the dimension two: Be My Advisor. India specific design strategies are marked with *.

It is not surprising that the users wanted and expected the exercise application to take an advisory role. The dimension *Be My Advisor* is very easy to understand with a common sense. People are used to the existence of the real world personal trainers and coaches, so why not to utilise the same approach virtually in the exercise application. In fact, many existing exercise applications have adopted the approach of coaching.

Our participants expected the exercise application to play an advisory role. The design strategy **Advisory role (S2.1)** means that the application should play an advisory and motivational role, and take an active role in users' lives. Especially the Indian participants emphasised that the application should be almost like a human being by getting to know the user, and thus, we propose a design strategy **Human touch*** (**S2.2)**. We suggest designing the exercise advisor of the application to act like a human being with personality and personal touch for advicing, and to get to know the user. Designers of future exercise applications could consider how the exercise advisor of the application could be designed to act like a human being "with personality and personal touch" for advicing, and "know the user". Our studies showed that the participants wanted to have support for setting goals. Thus, we suggest the design strategy **Goals setting advice (S2.3)**, which means instructing on setting realistic, achievable, but challenging enough goals for the exercise, editable by the user. The participants also wanted to get a suggestion for the exercise plan in order to achieve the goals. For that, we propose the design strategy **Planning exercises (S2.4)** - Offer a complete suggestion of exercise plan and program, editable by the user, and provide advice on what activities to perform to achieve goals. Our participants expected the application to guide the exercise activities, and provide feedback about how it is going in every phase of the activity: before the activity, during it and afterwards, so our next design strategy is called **Guiding exercises (S2.5)**. Next, our studies indicated that the participants considered the reminders as a motivational factor, which is formulated as a design strategy **Reminding (S2.6)**. They wanted the application to remind them about doing specific exercise as well as more generally, remind them about the importance of exercising. Our participants wanted the application to visualise the benefits-to-become of the performed exercise activities, expecting that they would continue

with a current regime. They also wanted the application to tell that positive improvement is happening even though it cannot be observed with a naked eye yet. Thus, we propose the design strategy **Glimpse to future (S2.7)**. We suggest visualising the positive benefits of the performed exercise activities, if the user continues with a certain exercise routine. It means telling that something is happening even though it might not yet be visible. Finally, we found out that the participants expected the application to motivate them by giving a push when they needed it, for example during the inactive periods. For that, we propose the last design strategy of the second dimension: **Explicit spur (S2.8)**.

Relation to Prior Design Strategies

This section discusses the design strategies of the *Be My Advisor* dimension in light of the prior design strategies.

S2.1: Advisory role. A related design strategy is reported by Klasnja and Pratt (2012), namely *Increasing the accessibility of health information*. They summarise that one main advantage of mobile health interventions is that content such as health information and motivational messages can be delivered to the users without any effort from their part. In the PSD model (Oinas-Kukkonen and Harjumaa, 2009) there is a supporting design principle called *Social role*. According to that principle, users will be more likely to use the system for persuasive purposes, if it adopts a social role.

S2.2: Human touch*. Morris (2012) suggests a design guideline called *Foster an alliance* for motivating change. She states that the close relationships that people already have with their mobile devices could allow forming a trusting alliance between the user and the application. She compares the alliance to the close bond between a therapist and a patient, which is fostered through empathy. The PSD model (Oinas-Kukkonen and Harjumaa, 2009) also talks about the *Trustworthiness* but it is explained from the perspective of providing truthful and unbiased information, not from the viewpoint of trust between the user and advisor on the application.

S2.3: Goals setting advice & S2.4: Planning exercises. Consolvo et al. (2009) studied goal setting on mobile wellness applications. They found that the self-set and group-set goals and the goals defined by "a fitness expert" were the most

motivating goal source options. Their third option, goals defined by the fitness expert, is quite close to our finding that the participants expected to get advice for the goal setting and planning the exercises from the application. In our case though, the participants perceived the application to act as an expert, and they did not expect the support from a real-world expert.

S2.5: Guiding exercises. There are possibilities to provide feedback in different ways in each phase of the exercise. For example, the application could offer textual instructions (Consolvo et al., 2014) on the display of the device or verbal messages by audio before the exercise. It could provide verbal instuctions by audio during the exercise when the user probably would not want to take a look at the display (and many people tend to wear headphones anyway for listening to the music). Finally, it might give graphical presentations and some textual explanations (Consolvo et al., 2014) or remarks concerning the graphs about the performance after the exercise.

S2.6: Reminding. The work of Munson and Consolvo (2012) points out that journaling the exercise activities is helpful, but can be even more helpful with reminders. In their user study with the GoalPost application they found that the pop-up reminders were a well-liked feature, and the participants considered those reminders as gentle, and not overly nagging (Munson and Consolvo, 2012). The reminders increased the participants' awareness of their activity levels, and sometimes even resulted in them to be more active immediately. Dantzig et al. (2013) studied the effectiveness of the mobile application SitCoach that prompted sedentary workers from their seats after a prolonged sitting. The participants were satisfied with the reminder that was given with tactile feedback, i.e. vibration, but they did not want to be disturbed with an audio signal. Dennison et al. (2013) found that their study participants were concerned about the tone, message and situation of the reminder, and expressed annoyance caused by nagging or harassing reminders from the applications. Consolvo et al., (2014) summarise the characteristics of a good reminder as follows: it is positive and quiet, it does not nag, and it provides a shortcut to data tracking. Morris (2012) provides a more psychological approach for reminding. According to her guideline *Remind people of who they want to be*, the health application should remind people of their values and previously expressed self-ideals to support people making difficult lifestyle changes. A more straightforward design principle can be found in the PSD model (Oinas-Kukkonen

and Harjumaa, 2009), namely *Reminders*, which states that the users will be more likely to achieve their goals if the application reminds them of their target behaviour.

S2.7: Glimpse to future. One possibility to realise the S2.7. is to utilise the *Simulation* principle of the PSD model (Oinas-Kukkonen and Harjumaa, 2009). The principle states that the simulations can be used for persuasion because they show immediately the link between cause and effect. Another possibility, already commonly utilised by the exercise applications, is the usage of graphs. Consolvo et al. (2014) explain that graphs help people understand how their activities change over time, how they progress towards their goals and how their different activities might relate to each other. However, they also state that for many people, graphs are difficult to interpret (Consolvo et al., 2014). Thus, the impact of the exercise regime could be stated more explicitly to the user on the application, for example by utilising textual feedback. A textual prophecy could be made based on the user's activity so far. Morris (2012) expresses a similar design principle as ours, but from the opposite perspective. Her design guideline *Show people what they could lose* relates to anticipating potential losses of the things that people already have. For example, the application could present the potential consequences of neglecting physical activity for a longer time period by showing photos of people with low mood.

S2.8: Explicit spur. Morris (2012) suggests a related design guideline called *Put the message where the action is*, which means that the prompt is more effective, the closer to the time and place of the target activity it is. For the exercise application, it is quite easy to recognise, e.g. the inactive periods based on the activity data, and gently prompt the user to be more active.

6.3 Dimension Three: Grow with Me

The dimension of *Grow with Me* (Table 5) includes design strategies that relate to the evolvement and adaptability of the exercise application. The users expected that the application, instead of being static and stationary, should be dynamic and evolve with the user's progress, as well as with the constantly changing circumstances. Thus, it would be able to provide for relevant support in each phase and situation.

Dimension 3: Grow with Me		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S3.1: Evolving with progress	Evolve along with the user's progress by providing appropriate advice, instructions, recommendations and feedback in different phases of progress.	Living Application to give appropriate support in different phases of the process.
S3.2: Adapting to situations	Adapt to the constantly changing conditions and exceptions from the routine, such as travel and illnesses. Support easing back to the routine after the inactive period.	Living Application to recognise the periods of inactivity and provide gentle support for the re-start.
S3.3: Adapting to surroundings*	Adapt the features and support based on user's surroundings. Find exercise potentials in new surroundings.	n/a
S3.4: Adapting to own exercises	Adapt the features, measurements and support according to the user's own activities.	n/a
S3.5: Adapting to performed exercises	Adapt the training program based on the conducted activities.	The adaptive training program in Mobile Coach.

Table 5: The design strategies of the dimension three: Grow with Me. India specific design strategies are marked with *.

One of the findings of our studies was that the users got easily bored with the static applications and wished for more adaptative and dynamic approach. First, our participants wanted the exercise application to evolve along with the user's progress by providing appropriate advice, instructions, recommendations and feedback in different phases of the progress. The design strategy **Evolving with progress (S3.1)** was formulated based on that finding. Furthermore, our participants wished that the exercise application would adapt to the constantly changing conditions and exceptions from the routine, such as travel and illnesses, and support easing back to the routine after the inactive period. Thus, we suggest the design strategy **Adapting to situations (S3.2)**. Especially our Indian studies showed that the application should adapt the features and support based on user's surroundings, and find exercise potentials in new surroundings. Based on that finding we formulated the design strategy called **Adapting to surroundings*(S3.3)**. There were two other minor findings related to the adaptability of the application, which came up in our studies. The users appreaciated the exercise application that adapted the features, measurements and support according to the user's own activities. For example, the features, measurements and support for regular running activity would differ a lot from the user needs when going to an once-in-a-lifetime hiking trip. The design strategy **Adapting to own exercises (S3.4)** was formulated based on that. In

addition, users considered the adaptation of the weekly training program based on the conducted activities, as a motivational factor, which forms the last design strategy of the third dimension: **Adapting to performed exercises (S3.5).**

Relation to Prior Design Strategies

This section discusses the design strategies of the *Grow with Me* dimension in light of the prior design strategies.

S3.1: Evolving with progress. Fritz et al. (2014) have studied the persuasive technologies from the perspective of providing long-term support. They suggest an implication called *Motivating maintenance as well as change.* It means that the application should offer explicit motivation for the maintenance of practices or achievements in addition to prompts to introduce changes in behaviour. They also discuss the importance of the applications' abilities to provide support for the evolving communities and transitioning between communities during the wellness process, as well as to support the evolution of provided rewards. According to Morris (2012) "just as the therapeutic alliance evolves over the duration of treatment, health technologies must develop greater understanding of users over time and adapt to their changing needs." (p. 27). Thus, similar to our work, Fritz et al. (2014) and Morris (2012) recognise the importance of support from the application in different phases of the process of change. Also Consolvo et al. (2014) discuss the ways of how to access the starting level of the user and her/his progress, thus touching the topic of supporting different phases of the long-term process. The PSD model (Oinas-Kukkonen and Harjumaa, 2009) suggests three design principles that have confluences with S3.1, namely *Tailoring*, *Personalisation* and *Similarity*. The principle of tailoring states that the application is more persuasive if it is tailored to the user's potential needs, interests, personality, usage context or other relevant factors. The personalisation means that personalised content has greater capabilities for persuasion than those that are not personalised. In turn, the principle of similarity says that those applications that remind users of themselves in some meaningful way, are more persuasive than those that do not. For sure, the application that would appropriately adapt its support to the progress of the user would be more meaningful. The recent literature review about tailoring real-time physical activity coaching systems (den Akker, 2014) suggests seven tailoring

concepts, one of which is called *Adaptation*. By adaptation they refer to directing messages to individuals. They give an example of providing different kind of information to the users who are in different phases of behaviour change. They comment that adaptation seems to be a useful technique of tailoring, but according to their review, it has not been applied yet in the exercise applications. However, tailoring *Goal setting* and *Feedback* are commonly used techniques in exercise applications, according to their review (den Akker, 2014).

S3.2: Adapting to situations. Consolvo et al. (2014) state that even devoted persons sometimes need a break from the routine because of different reasons. They present that there are open questions, for example, about how technology could help users to get back on track again as soon as possible. They also discuss the potentials of wellness systems to be able to learn user's patterns and to recognise the times when the user is likely to slip from the routine and to differentiate them from the temporary changes due to other priorities of life, e.g. inactivity due to sickness.

S3.3: Adapting to surroundings*. The mobile personal trainer (MOPET) described by Buttussi and Chittaro (2008) guides users through outdoor activities in the fitness trails. In the system, GPS is used to track the user's position in the fitness trail and the location-based instructions are given throughout the workout on the trail. Ståhl et al. (2008) developed a mobile application that utilise context awareness in sense that it use time and location to suggest e.g. a suitable physical exercise task for the user to perform. Den Akker et al. (2014) discuss tailoring the exercise applications, and they list *Context awareness* as one of the tailoring techniques. It refers to utilising user's context (situation) to provide relevant content to the user. The context can mean many different things more than the physical location or surroundings of the user, but when it comes to utilising the surroundings, context awareness is closely related to our design strategy S3.3. Utilising context awareness in health related applications caused concerns among the participants of the study made by Dennison et al. (2013). The participants were sceptic about how accurately the phones could sense the context, and they stated that there would be great potential for mistakes. Errors in sensing of location, mood or other aspects of context would irritate them and could result in losing interest in the application. Thus, utilising context awaraness provides potential but challenging area for the designers of the future wellness applications.

S3.4: Adapting to own exercises. According to den Akker et al. (2014), *User targeting* is a technique aiming to fit the presentation, suggestions and recommendations to the individual. It can be made based on the personal information given by the user.

S3.5: Adapting to performed exercises. Den Akker et al. (2014) talk about a technique called *Self-learning*. It means that the application learns from the user's various interactions with the application, and changes with the user throughout her/his use of it.

6.4 Dimension Four: Utilise My Sociability

Social factors have great significance in increasing motivation towards physical exercise. It is easy to understand also with the common sense, that doing with others and knowing that someone is "watching", can affect positively to motivation. *Utilise My Sociability* dimension presents different design strategies related to increasing motivation with the social influence (Table 6).

Dimension 4: Utilise My Sociability		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S4.1: Sharing	Allow sharing with familiar persons.	Sharing wellness data in Photo Frame of Health. Sharing exercise data in Into.
S4.2: Co-operation and competition	Allow users to select between co-operation and competition. Allow competition with oneself.	The possibility to either co-operate or compete in Into
S4.3: Re-union*	Re-unite scattered units of close-ones as sources of wellness motivation and information.	Sharing wellness information (goals, status, recommendations) and presence with family members and close-ones in Photo Frame of Health.
S4.4: Group formation*	Consider group formation inside communities based on people's similar aspirations.	Forming ad-hoc communities based on similar interests in Web of Avatars. Group formation in Into.
S4.5: Role models*	Utilise celebrities as sources of motivation.	Bollywood dancers celebrating user's success, and a picture of a celebrity in Photo Frame of Health.
S4.6: Passing forward*	Allow passing the exercise application and goals forward.	Sending a wellness application for other person in Gift of Good Health. Inviting members to join the challenge in Into.

Table 6: The design strategies of the dimension four: Utilise My Sociability. India specific design strategies are marked with *.

In our studies, we found out that the participants wanted to share their exercise data mostly with familiar people. An exception was viewing exercise routes of strangers in new places where they were visiting, to find potential routes for themselves in the strange locations. Our design strategy **Sharing (S4.1)** suggests that the exercise application should allow sharing user-defined exercise data with familiar persons, and utilise strangers' data only in exceptional cases, for example, when the user is searching for new exercise routes. Our second design principle in the fourth dimension is called **Co-operation and competition (S4.2)**. This design strategy is based on the findings on how the participants appreciated the possibilities to select between co-operation and competition in the application, and how they wanted to compete with themselves. Furthermore, we found that especially in India, the participants were worried about the absence of family members as motivators and information sources towards wellness, as they were living apart from each others and having long distances, seeing only rarely. They wished for the application to re-unite scattered units of close-ones as sources of wellness motivation and information. Those findings led to the design strategy **Re-union* (S4.3)**. Familiar or semi-familiar people were usually preferred in social facilitation to the strange people. In India, we found that group-formation based on similar aspirations with semi-familiar people inside a community, for example a residential area, was accepted and welcomed. Thus, we propose the design strategy **Group formation* (S4.4)**. Even though the needs for S4.3 and S4.4 were emphasised in our Indian studies, there is no reason why these strategies would not be applicable also to western areas. However, next we describe two clearly India-specific design strategies. The first one is based on the strong tendency to idol worship and the perceived possibilities on their utilisation as motivational sources for wellness. Based on that finding we suggest the design strategy called **Role models* (S4.5)**, which relate to the utilisation of celebrities as sources of motivation. The second clearly India-specific finding related to the non-awareness of wellness applications at the time of the studies. For that we formulated the design strategy **Passing forward* (S4.6)**. By that we mean that the application could allow passing the exercise application and goals forward to other people, and thus, spread wellness applications and motivation.

Relation to Prior Design Strategies

This section discusses the design strategies of the *Utilise My Sociability* dimension in light of the prior design strategies.

S4.1: Sharing. Consolvo et al. (2006) suggested a design requirement called *Support social influence*. They found three classes of social influence that had impact on encouraging physical activity: social pressure, social support, and communication. In their later studies of social factors (Munson and Consolvo, 2012), they found that their participants had concerns towards sharing. For example, the users were concerned about oversharing boring data with others, as well as they did not receive appropriate support from others. Similar findings were reported by Dennison et al. (2013). Their study participants made it very clear that they would not want the application to broadcast their health related goals or behaviours via social media services. Those sites were not considered appropriate places to share personal information related to health, and look for help or support. However, in their study, there were signs of posting updates of physical activity performance or achievements to the social media sites, and being inspired by other people liking them. Klasnja and Pratt (2012), in their work of the design space of mobile health interventions, named *Facilitating social support from family and friends*, as one way to leverage social influence. Related implications from the PSD model (Oinas-Kukkonen and Harjumaa, 2009) are *Social learning, Social comparison, Social facilitation* and *Normative influence,* even though they do not speak out whether those implications apply to familiar persons or to other people in general. Den Akker (2014) brings the perspective of tailoring to the social influence by suggesting a technique called *Inter-human interaction*.

S4.2: Co-operation and competition. In the PSD model (Oinas-Kukkonen and Harjumaa, 2009), there are supporting implications called *Cooperation* and *Competition*. The authors call cooperation and competition as "human being's natural drives" (p. 495).

S4.3: Re-union* & S4.4: Group formation*. Klasnja and Pratt (2012) talk about *Peer-to-peer influence*, referring to social influence of people with similar goals. Morris (2012) suggests *Apply social influence* as a guideline for motivating change with the mobile device. She states that the most relevant and specific peer group should be identified for preferencing, as it is helpful to see other's success and

learn from their struggles. Also Klasnja and Pratt (2012) speak about *Peer modeling*, meaning the use of peers who have succeeded in accomplishing similar health goals. In the study of Dennison et al. (2013), the participants considered social sharing of health related issues acceptable in situtions, when group of people were working towards similar goals, for example.

S4.5: Role models* & S4.6: Passing forward*. For these design principles there were no supporting prior design strategies. The findings around these strategies offer fresh and interesting possibilities for the design of motivational exercise applications, especially when designing from the cultural perspective.

6.5 Dimension Five: Keep Me Engaged

The fifth dimension called *Keep Me Engaged* consists of the design strategies that focus on keeping the user's interest high towards the use of the exercise application (Table 7). This dimension includes aspects of playfulness and gamification, as well as elements of variety and surprise.

Dimension 5: Keep Me Engaged		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S5.1: New features and content	Provide new features and content along the continued usage.	Living Application to provide new features as rewards and to change goals, suggestions and advice based on the user's progress.
S5.2: Suprises*	Surprise the user positively.	Living Application to surprise the user every now and then.
S5.3: Playful features	Utilise appropriate playful features, e.g. goals, visualisations, avatars, rewards.	Visualisation of the goals and progress in Living Application and Into. Avatar as an advisor in Living Application. Postcards sent from the target destination as rewards in Into. The figure of an animal as a representation of speed in Into. Bollywood dancers to reward for achievements in Photoframe of Health. Picture of celebrity as a source of motivation in Photoframe of Health.
S5.4: Levels	Utilise phase-based approach.	Proceeding from phase to phase in the Living Application.

Table 7: The design strategies of the dimension five: Keep Me Engaged. India specific design strategies are marked with *.

In general, the users in our studies grew tired to the static nature of exercise applications, and appreciated the applications' ability of renewal. They wished that the exercise application would provide new features and content along the way to keep users engaged. Based on those findings we suggest the design strategy called **New features and content (S5.1)**. The Living Application concept was designed to provide new features as rewards when the user achieved a new level. However, the feedback of the evaluation participants towards rewarding with new features was not uniform. Half of the participants considered it as a positive thing, adding motivation towards the application as well as improving the usability of the application, as the user must not adopt all features and measurements at once. The other half of the participants perceived it as limiting their freedom of choice, and they wanted to have all features available from the beginning. We suggest that the application could provide new features and content along the way, but it should designed in a way that it would not feel restrictive. The next finding around the fifth dimension was that the elements of surprise particularly appealed to the Indian participants. Thus, we formulated the design strategy **Suprises* (S5.2)**, which means that the application should surprise the user positively. Furthermore, our next design strategy is called **Playful features (S5.3)**, based on the findings related to the motivational role of playful aspects. However, utilising playful elements as motivational factors in exercise applications seems to be a case-sensitive issue. The designers should consider carefully, which playful elements suit to the target profile of the application and thus, are appropriate for the users. Some elements are appealing and motivational for some users, while they may irritate and demotivate others. In our studies, the playful avatar as an exercise advisor was perceived positively by the Indians, while some of the Finnish participants considered it childish. In turn, the visualisation of the progress as travelling on the globe was received positively in both locations. Our last design strategy on the dimension *Keep Me Engaged* is **Levels (S5.4:)**. It deals with the basic characteristics of the gamified approach, i.e. phase-based approach. In our studies, the phase-based approach in the Living Application concept was received positively. The participants commented that the new challenges provided by each new level would help in maintaining their motivation.

Relation to Prior Design Strategies

This section discusses the design strategies of the *Keep Me Engaged* dimension in light of the prior design strategies. Gamification has been studied and utilised in the domain of exercise applications (e.g. Campbell et al., 2008; Deterding et al., 2011). Deterding et al. (2011) defines gamification as the use of game design elements in non-game contexts. Campbell et al. (2008) have summarised design principles for everyday fitness games, including principles such as *Micro goals*, *Marginal challenge* and *Fair play*. Klasnja and Pratt (2012) list *Utilising entertainment* as one of the strategies used in mobile-phone health interventions.

S5.1: New features and content. Fritz et al. (2014) suggest a related design implication *Supporting changes in activity and metrics* in their work about the long-term persuasion. They state that the designers should consider means of augmenting and evolving measurements and tracked activities over time. The PSD model suggests the design principles of *Reduction* and *Tunneling* (Oinas-Kukkonen and Harjumaa, 2009). Reduction means reducing complex behaviour into simple tasks, helping users perform the target behaviour. Tunneling means guiding users through a process, and thus offering persuasion along the way. Those design principles explain our finding that half of the participants wanted to get the features little by little, and get to know the application with time.

S5.2: Suprises*. Although the utilisation of surprising elements have not been widely explored in the literature of wellness technologies, Fritz et al. (2014) discuss considering a greater scope of reward types, for example by adding "real world" rewards to the application. One of their study participants allowed herself to have snack in the evening if she had been active enough during the daytime, which was a similar finding as in our study. In their study, it was not considered as a surprising factor but as a reward, but the borderline between surprises and rewards is wavering. In our studies, the Finnish participants were not as positive towards the surprising factors as the Indians, but the topic would need more exploration to be sure whether it is a cultural finding or due to other issues.

S5.3: Playful features. The perceptions on and the effectiveness of playful rewards on the exercise applications has been discussed by many. Many exercise applications provide some type of explicit rewarding system, for example, the user is rewarded with badges or trophies. Similar to our findings about the minor

motivational effect of these symbolic little rewards, Fritz et al. (2014) found that rewarding users with badges was perceived as an artificial thing. Still, the users wanted to have them even though they were considered somewhat trivial. On the other hand, the study reported by Zuckerman and Gal-Oz (2014) revealed that the users perceived the points earned by walking as meaningless. They also found that having the point system as a rewarding element was not more effective in adding physical activity than the basic version of the application without the point system. Also in the study of Munson and Consolvo (2012), they found that the small trophies and ribbons that they call literal rewards did not motivate most of the users of the GoalPost application. Most users were quite apathetic towards getting the reward. They futher speculate that one reason for the apathy towards the rewards might have been that the rewards never came as a surprise – they were totally expectable. This finding supports the existence of our previous design strategy S5.2, namely Suprises*. Finally, Zuckerman and Gal-Oz (2014) discuss the importance of meaningfulness when designing gamified (or playful) elements to the exercise applications. They suggest, based on on the original idea of Nicholson (2012) that the users could be involved in the customisation of the gamification system so that it would better corresbond with their own interests. For example, the users could create their own leveling or achievement system.

S5.4: Levels. Utilising levels is one of the basic characteristics of the gamified approach, also in exercise related games. Campbell et al. (2008) have suggested a supporting design principle for everyday fitness games, namely *Micro goals*.

6.6 Dimension Six: Visualise My Exercise

The last dimension of the present model of the design strategies for motivational exercise applications is *Visualise My Exercise* (Table 8). This dimension consists of the strategies that bring the mobile exercise support beyond its common form, quantified approach. This dimension responses to the users' and participants' wishes about the concrete, understandable, visualised and attractive presentations of exercise activity.

Dimension 6: Visualise My Exercise		
Design strategy	**Explanation**	**How appeared in our studies/designs:**
S6.1: Wellness experience	Support recording descriptive data in addition to numerical measurements. Track meaningful wellness experiences, not just measures.	Free form notes on Wellness Diary.
S6.2: Beyond numbers*	Consider another, non-numerical approach for visualising exercise data and progress. Visualise the metaphor of "being on the way" rather than only "reaching the target".	The exercise data visualised as a trip on the map in Into.
S6.3: Familiar, real-life metaphors	Utilise familiar metaphors and narratives from the real life.	Converting physical activity data as a trip on a familiar map of home country, utilised in Into.
S6.4: Beauty*	Compensate for the lack of the natural beauty in the built environment.	n/a

Table 8: The design strategies of the dimension six: Visualise My Exercise. India specific design strategies are marked with *.

In addition to measurable exercise data, such as length of the exercise, calories consumed, and the distance proceeded, there are personal experiences that cannot be quantified. Those need to be described or explained. Those include, e.g. emotional states, perceptions, and explanations. Thus, the applications should include an additional component for the users to record their subjective, descriptive data of the exercise, as the users did in our Wellness Diary studies. We call this design strategy **Wellness experience (S6.1)**. It means recording descriptive data in addition to numerical measurements. Ofcourse, adding a component for recording descriptive, non-measurable data is controversial with the demand for automatic, effortless tracking (S1.1). This controversy sets a challenge for designing the exercise applications in the future: would there be a way to collect descriptive data or wellness experiences with effortless means? Photography could be one way to be considered. Furthermore, especially the Indian participants were not familiar with the quantified approach for wellness, and they wanted for alternative, non-numerical approaches to be utilised in the applications. This design strategy was formulated as **Beyond numbers* (S6.2)**. We found that the users of Into appreciated and were motivated by the analogy of viewing physical activity performance as a trip progressed on a familiar map of home country. The metaphors from the real life could be further utilised in the exercise applications, as they are usually concrete

and understandable for the users. Thus, we suggest the design strategy called **Familiar, real-life metaphors (S6.3**). Our last design strategy for the motivational exercise applications, **Beauty*** (**S6.4)**, relates to the observations of the heavily constructed and polluted surroundings in the urban India. The surroundings did not provide possibilities for taking a relaxing walk or jog in the nearest forest or park, and that is why the Indian participants walked in restricted areas, for example inside gaited residential areas. The designers of the future exercise applications could consider how the application could compensate for the lack of the natural beauty in the built environment. One possibility would be to utilise the possibilities provided by the users' favorite natural places brought to the mobile application screen. The findings related to the compensation of the lack of the natural beauty was highlighted in our India-studies, but for sure, the suggested design strategy can be utilised also in the western areas.

Relation to Prior Design Strategies

This section discusses the design strategies of the *Visualise My Exercise* dimension in light of the prior design strategies.

S6.1: Wellness experience. Consolvo et al. (2006) got similar feedback from the participants of their study as we did. The participants wanted to supplement their exercise measurements with descriptive information of, for example, why they did not meet the goal on a certain day. For that purpose, their application provided a possibility to type comments. Later on, Consolvo et al. (2009) suggested a design strategy called *Comprehensive*, meaning that the application should not limit data collection and representation to the specific behaviours that the technology can monitor or sense. They do not explicitly talk about recording descriptive data, but their strategy can be understood in that broader sense.

S6.2: Beyond numbers*. Data abstraction could be a potential mean for responding to the user need related to non-numerical approaches in exercise applications. Consolvo et al. (2009) suggests *Abstract and reflective* as a design strategy for technologies supporting behaviour change. Later on, they talk about the stylised presentations referring to the means how wellness data can be presented in abstract representations that map data to images or animations (Consolvo et al., 2014). They list the benefits of the stylised presentations as follows: they increase

the privacy of the user's data; they can be attractive; and they provide means for personalising the way how the user gets the feedback. However, the meanings and mappings of them need to be learned before they can be understood, and they are not as precise as numerical data (ibid.). From the literature, many examples of physical exercise data abstraction can be found. Ståhl et al. (2009) used animated human-like figures to visualise the wellness data. Consolvo et al. (2008a; b) visualised the progress with a growing garden including butterflies and flowers. Similarly, Albaina et al. (2009) used an emotional flower in their photo frame concept to visualise walking activities. In addition, Lin et al. (2006) visualised the level of physical activity with a bowl of growing fishes, adding the playfulness to design. However, both Consolvo and Lin found that after a while, the users perceived the visualisations as repetitive and wished to have more variation in them. In their further work, Lin et al. (2012) designed an animated aquatic ecosystem with two types of fishes and the ambient lightning conditions of the ocean. For their part, Fan et al. (2012) used abstract informative art for visualising physical activity. They utilised three elements for the visualisation: color, movement and filling of screen. They learned, for example, that one should provide choices of different visualisations to allow people to customise their experience and choose the detail of information they want to see. Providing different visualisations would also increase variety and tailor to individual tastes.

S6.3: Familiar, real-life metaphors. Some of the visualisations presented among the previous design strategy, use metaphors from the real-life, such as flowers and fishes. Fan et al. (2012) for their part, decided to use informative art because they considered it more neutral and potentially less discouraging than living metaphors. However, it is probable that the visualisation need to have some kind of meaning for the user for it to be a succesfull motivator, as also discussed by Nicholson (2012), and Zuckerman and Gal-Oz (2014).

S6.4: Beauty*. Visiting natural setting has been proven to be effective in improving perceived health, and relieving symptoms of stress and negative feelings (Korpela and Ylen, 2007). Korpela et al. (2002) found out that even pictures of nature settings were associated with higher restorative potential and positive affect when compared to the pictures of urban settings. In the broader sense, the attractiveness of the wellness application has been discussed by Consolvo et al.

(2009). They suggest a design strategy called *Aesthetic* and state that all aspects of technology needs to be attractive to support the user's personal style. Similarly, the PSD model (Oinas-Kukkonen and Harjumaa, 2009) includes the design principle *Liking*, which means that a visually attractive system is likely to be more persuasive than a non-attractive system.

7. Discussion and Conclusions

This chapter discusses our findings on the motivational factors and the design strategies for mobile exercise applications in light of the relevant theoretical approaches presented in Related Work. In addition, it discusses issues on how to use the present model of the design strategies in the practical design work, as well as the novelty value and limitations of the model. Finally, the chapter discusses the validity, limitations, and generalisability of the research, suggests topics for the future research, and offers conclusions about the research.

7.1 The Model of Design Strategies in Light of Related Work

In the previous chapter, we presented 34 design strategies for motivational exercise applications and compared them to the design strategies proposed by other researchers. In this section, the dimensions of the model are discussed in light of theories presented in Related Work.

Support My Exercise dimension. The design strategies under the first dimension relate to tracking physical activity, goals setting, viewing the progress, and getting feedback and rewards (S1.1--S1.7). According to Michie et al. (2009), five behaviour change techniques are evident in effective physical activity interventions: *self-monitoring*, *intention formation*, *specific goal setting*, *review of behavioural goals*, and *feedback on performance*. Those behaviour change techniques are very close to our suggestions about design strategies on the first dimension. Thus, we argue that the design strategies on the Support My Activity dimension are the basic or fundamental strategies for motivational exercise applications, also noticed by Consolvo et al. (2014).

Goal setting, viewing the progress, and getting feedback get plenty of attention in the psychological theories on motivation. Goals have been shown to have the greatest effect in terms of motivation when they are important to the individual (Locke and Latham, 2002). A good goal should be set by the individual or with the help of an expert rather than being assigned without rationale. Good goals are realistic, and they work best if the individual is able to see progress towards the goal. Goals work best also when the individual receives positive feedback while

making progress towards the goal. (ibid.). According to Malone and Lepper's (1987) theory on motivation of learning, the *challenge* factor refers to working towards personally meaningful goals and getting feedback about the performance, which are contributors of intrinsic motivation. A feeling of *competence* is a strong contributing factor towards motivation, as well (Ryan and Deci, 2000). Perceptions of competence and *positive performance feedback* have been shown to increase intrinsic motivation (Vallerand and Reid, 1984; Ryan and Deci, 2000). In light of these theories, it is not surprising that, in our studies, both Finnish and Indian participants shared the view that the exercise applications should provide help in setting appropriate goals (short and long term), and show their progress towards these goals. The participants also wanted to be acknowledged and rewarded for their achievements.

Be My Advisor dimension. The second dimension of the model includes design strategies that relate to the advisory role of the exercise application (S2.1--S2.8). In both cultural research contexts, the participants expressed that the wellness application should take an advisory role and act as a personal trainer or a mentor, or even "a person who knows you". An advisory approach would suit well for mobile exercise applications, as they are most often present with the users, and thus can provide support in making better choices at the right moments (Morris, 2012). Mobile exercise applications have the potential to "nudge" (Thaler and Sunstein, 2008) individuals towards decisions that are in line with their goals.

The rationale for the need of a personal advisor may well be found among the hedonic attributes of the user experience framework (Hassenzahl, 2006). The hedonic attributes refer to the *emotional aspects* of user experience, and they have an important role in motivation towards the use of application. Thus, if the application is able to evoke positive feelings and form an emotional relationship between the user and the advisor on the application, motivation to use the application might be far better than in the application that does not play the role of an advisor who "knows" the user.

Grow with Me dimension. The third dimension involves design strategies concerning evolvement along with the user's progress, as well as adaptation to different situations, surroundings, and activities (S3.1--S3.5). An evolving approach is well suited to applications that aim at supporting users to engage in conducting

more physical exercise, because behaviour change processes include *different stages with different challenges* (Prochaska and Norcross, 2001; Schwarzer, 2008). In light of our findings, we believe that a wellness application that would not be static but would intelligently change its content and features depending on the user's stage, context, and situation would notably improve the application's ability to promote physical exercise in the long term. Static applications that invariably expect the user to always behave in the same way do not support different stages of change, and this could lead to user's decreased perception of competence. That could then inhibit the internalisation of wellness related goals (Ryan and Deci, 2000). An evolving application would respond better to user needs about the application to "know" the user, as this evolvement feels to users as though they have a personal and understanding relationship with the application. In addition, an application that adapts and evolves based on the user's needs and phases would bring *novelty* to the user interface, thus providing feelings of *stimulation* (Hassenzahl, 2003).

Consolvo et al. (2014) suggest that one way to determine an individual's level of physical activity is to assess that person's stage of change in the model of behaviour change (Prochaska and Norcross, 2001; Schwarzer, 2008). However, although the need for long-term support and evolving exercise applications is quite obvious, mobile wellness applications do not typically approach wellness from the long-term perspective (Consolvo et al., 2014). The complexity of the behaviour change process might have prevented the design of effective interventions for supporting people in their wellness related challenges in long term period (Klasnja et al., 2011). People rarely progress linearly through the stages of changes, but usually they cycle through stages several times before they enter the stage of termination (Consolvo et al., 2014). However, mobile technologies offer potential for the long-term support of wellness. With the help of cloud-based services, for example, users can access their data, progress, and achievements from various devices, and even if they switched from one device to another. (ibid.)

Utilise My Sociability dimension. The design strategies in the fourth dimension relate to the social factors on motivation, such as sharing, co-operation, competition and group formation (S4.1--S4.6). According to Malone and Lepper (1987), the social factors *competition* and *cooperation* play an important role in individual's intrinsic motivation with the means of comparison, peer pressure, and social

support. *Relatedness* has been shown to nurture intrinsic motivation, and proximal relational support is not always needed (Ryan and Deci, 2000). The feeling of belonging and connectedness with other people is crucial for the internalisation of external goals (ibid.). In our study findings, there were differences in the extent to which the participants in Finland and India emphasised the importance of social factors. While the social factors were rather important in both cultural contexts, the Indian participants raised specific issues that were not present in the studies among the Finns. Those issues are discussed in more detail in Section 7.2.

Keep Me Engaged dimension. The fifth dimension of the model includes design strategies related to maintaining user interest with the means of new content, unexpected elements, and playful features (S5.1--S5.4). When we evaluated the idea of providing new features as rewards of progress, approximately half of the participants in both cultural contexts considered that to be a motivational factor. An explanation for that can be found, again, in the hedonic attributes of the user experience framework (Hassenzahl, 2006). If the product does not manage to provide a feeling of *novelty and stimulation* after the initial use, the user may grow weary (ibid.). The application that changes its content and features brings novelty to the user interface and thus has greater potential to maintain the user's interest. However, the other half of the participants stated that bringing features to the application one by one would be a restricting feature. These participants wanted to have all possible features from the beginning and to be able to personalise the application according to their will. This may be explained by the user's perception of *autonomy* when using the application (Ryan and Deci, 2000). Limiting the freedom of choice was probably seen as a factor diminishing autonomy, which can negatively affect motivation (ibid.). The theory on learning motivation (Malone and Lepper, 1987) also lists *control* as one of the factors of intrinsic motivation. It means that an individual should have the feeling of being in command of the process (or usage of the application). In our studies, it seemed that half of the participants preferred the feelings of novelty and stimulation to being in control, while the other half had the opposite preference

Throughout our research, the Indian participants most often wished to have surprising elements in the exercise application to maintain their curiosity and interest, while the Finns did not appreciate the surprises as much. Therefore, in our

studies, the role of *unexpected elements* to maintain curiosity (Hekkert, 2006) seemed to be more important in the Indian case than in the Finnish case. All in all, the Indian participants preferred a more playful approach for receiving support from the application than did the Finnish participants, who had a more pragmatic perspective to the exercise applications. The Finns wanted to receive clear exercise programs with instructions, while the Indian participants clearly responded more positively to the idea of having an avatar as an advisor or the utilisation of their role models as a personal trainer in the application. Several phases of our study showed that the Indian participants would easily grow tired of an application that was not fun and exciting to use. More detailed discussion on the cultural differences on findings about surprising elements and role models can be found in Section 7.2.

Visualise My Exercise dimension. The last dimension of the model consists of design strategies that expand the mobile exercise application beyond its usual, quantified form (S6.1-S6.4). Instead of relying only on a quantified and numerical approach to presentation, the design strategies proposed on this dimension are a response to the participants' expectations about the more concrete, understandable, visual, and attractive presentations of exercise data, as well as the ability to track "holistic wellness experiences" instead of only numbers. Out of the dimensions of the present model of the design strategies for motivational exercise applications, Visualise My Exercise seems to be the most novel one, in the sense that its contents cannot be explained very well with the theories presented in Related Work. The closest theoretical aspect can be found on the theory of intrinsic motivation on learning (Malone and Lepper, 1987). There, the *fantasy* emphasises the role of imagination and creative thinking in motivation. The designers of the future exercise applications have new challenges in creating novel visualisations and presentations of exercise data in a way that would go beyond the numbers.

7.2 The Cultural Findings

There were several cultural differences identified in motivational factors between the participants from Finland and those from India. The Indian participants' positive perceptions on surprising elements (**S5.2: Surprises**) and role models (**S4.5: Role models**), as well as their tendency to quickly become bored when viewing graphs about the exercise (**S6.2: Beyond numbers**), revealed that the existing approaches

on exercise applications might not support motivation for people who come from other cultures than western. These findings open the door slightly to the differences in needs and engagement when designing motivational applications for people outside the western world. It can be assumed that people in India might want more versatile, stimulating, funnier, and multifaceted approaches for the exercise applications than what western people are used to. As a member of a western society, and having been living for some time in one of the metropolitan cities of India, the author has observed connections between how the cultural area shows up itself and what the representatives of that culture expect from applications. In Finland, life is quite straightforward and the living surroundings are usually peaceful and clean. In India, life appears to be more hectic, colourful, and full of fuss, with crowds of people, lots of noise, busy traffic, and a multitude of actual colours. In addition to the differences between the everyday life settings, one explanation for the observed preferences in pragmatic vs. stimulating elements on applications can be found in cultural theories. In the Hofstede's theory on cultural dimensions (1991), Finland gets higher scores than India in the *uncertainty avoidance* factor. According to the theory, Finns are more likely to try to minimise the unknown and unusual circumstances, and prefer to proceed with careful step-by-step planning. The Indians are, in contrast, more tolerant of change, and feel comfortable in unstructured or changeable situations. Thus, the Indians may also need more stimulation on the application for it to be motivational than Finns, who tend to prefer more structured situations and approaches. There are also confluences to the theories of motivation. In the theory of Malone and Lepper (1987), there are two factors of motivation that may have different roles in Finland and India. The role of *curiosity* – of knowing that something interesting will occur in the future– seemed to be a bigger motivator for the Indian participants than for the Finns, while the role of *control* – of feeling that one is in command of the process – seemed to be more important to the Finns.

The India-specific findings related to sociability included the need for re-uniting scattered social networks as wellness motivators (**S4.3: Re-union**), the role of familiar persons promoting wellness applications (**S4.6: Passing forward**), and the need for a sense of human touch for the advisor in the applications (**S2.2: Human touch**). These can also be explained with cultural theories. In Hofstede's model

(1991), India scores higher than Finland in the *collectivism* factor. Collectivism means the integration into groups. In collectivist societies, individuals are predominantly members of a lifelong and cohesive group, while in individualistic cultures individuals make efforts towards gaining personal achievements and rights, and stand up for themselves. That does not mean that Finns would not appreciate and be motivated by social factors, but it means that social factors may have a stronger impact on the participants from India.

Finally, we observed differences in the effects of diverse surroundings on planning and conducting physical exercise (**S3.3: Adapting to surroundings**). Adapting the exercise applications based on users' living surroundings or conditions has not been utilised yet, as far as we are aware. In the future, the applications could take into account the potential that the close surroundings provide. For example, in Finland and India, the potentials are very much different. In Finland, the application could prompt and make specific exercise suggestions on a walking trail nearby. In India, the application could make suggestions based on the activities provided by nearby exercise clubs or immediate residential areas. In addition, future applications could be able to compensate for any lack of natural beauty (**S6.4: Beauty**).

7.3 How to Use the Model in Design Work

The present model includes 34 design strategies for motivational physical exercise applications, divided in six dimensions (categories). Designers in the domain of exercise applications can use the design strategies as *inspirational material* for guiding their design work. It can also be used as *a checklist of strategies* that can be utilised when designing motivational exercise applications. The resulting exercise application *does not need to utilise all of the strategies*, but *it is probable that several strategies will be needed* in order to ensure that the application will be motivational. The designers need to study their target user group and *find out what motivational strategies would work best*. For example, some user groups might be well satisfied with only the basic strategies described in *Support My Exercise* Dimension, while some other user groups might need strategies from *Keep Me Engaged* or *Utilise My Sociability* dimensions. Thus, the first thing for the designers is *to understand the target users*. The designers might want to utilise user-centred design methods by arranging focus groups, a set of interviews, or a

questionnaire to explore what dimensions and design strategies of the model would be applicable to their target group. As the potential motivational strategies for the target group are studied, the designers could *sketch their own realisation of the strategy* on the exercise application. For example, if the design strategy **S5.2: Surprises** would be potentially motivational for the target user group, designers should consider novel ways to surprise the user in an acceptable and motivating way. Or, if the design strategy **S6.3: Familiar, real-life metaphors** has been observed to be potentially motivational, then the designers should start considering new concepts for such metaphors in terms of the user groups' lifestyles and experiences. The designers should *continue with an iterative manner of design*.

7.4 The Contribution and Novelty Value of the Model

The model presented in this thesis is a comprehensive overview of the design strategies for motivational exercise applications. As a summary, the contribution, novelty value and difference compared to the relevant prior lists and models are the following:

- The present model is a *comprehensive*, *categorised* and *focused* model of design strategies for motivational exercise applications
- The design strategies have been formulated based on the findings from a rich set of *empirical user studies* with a relatively large number of participants
- The suggested design strategies are *illustrated* with examples of design solutions that raise from the constructive design research process
- The design strategies are *systematically discussed* in light of the prior design strategies as well as relevant theories
- The model includes a *cultural perspective*, which has not been included in prior models
- The model includes *novel design strategies* for motivational exercise applications

The prior models or lists of the design strategies for exercise or wellness applications typically included a limited set of varying design strategies and were typically not organised under any higher level categories (Table 1). The design

strategies for motivational exercise applications were quite scattered prior to the model presented in this thesis. The designers thus benefit from a comprehensive model of potential strategies. When examining the relevant models and lists of design strategies that existed prior to our research, it seems that the most comprehensive model was the Persuasive Systems Design (PSD) model (Oinas-Kukkonen and Harjumaa, 2009). It includes 28 design principles categorised under four categories. However, in spite of its comprehensiveness, it does not include any design strategies that relate to playfulness, gamification and engagement, which can be found in the model presented in this thesis. In addition, the PSD model draws from theoretical knowledge; our model, on the other hand, draws from empirical studies. However, despite the different research approaches between the PSD model and our work, many design strategies are closely related, including **S1.4: Goals setting** versus *Suggestions* (Oinas-Kukkonen and Harjumaa, 2009) and **S1.6: Acknowledging** versus *Praise* (Oinas-Kukkonen and Harjumaa, 2009). It is interesting to take a look at how the principles of the PSD model "come into life" with our findings from empirical studies.

The other prior models and lists typically include less than 10 design strategies, and many of them have only four or five strategies. Out of the models presented in Related Work, there are four strategies in the lists of Consolvo et al. (2006), Fan et al. (2012), Munson and Consolvo (2012), and Fritz et al. (2014). In the model presented by Klasnja and Pratt (2012), there are five strategies summarised. Campbell et al. (2008), Morris (2012), and Den Akker (2014) list seven strategies, while Consolvo et al. (2009) provide a list of eight strategies. Utilising social factors is the only aspect that is mentioned in almost all of the lists of design strategies proposed. Concerning other aspects the lists include a uniform set of strategies. Thus, prior to our work, the designers needed to seek knowledge on the motivational aspects of exercise applications from many sources to get a comprehensive picture.

In the literature, there exists comprehensive, although more generic models of design strategies, such as Design with Intent (Lockton, 2013). The extensive toolkit includes 101 patterns for influencing people's behaviour through design. The patterns on the tookit are divided into eight lenses, out of which especially the Interaction and Ludic lenses include similar patterns as we have proposed. The design patterns on Design with Intent tookit are theory-driven while our model is

based on empirical research. The focus of their work is on sustainable behaviour rather than physical exercise, but it is interesting to notice that there are similarities between the Design with Intent tookit and our work. One can discuss the number of patterns or design strategies included in the models, and if it is better to provide more or less of those. According the "Less is more" rule suggested by Nielsen (1994), adding information contents and choice of features adds the complexity of the system. This rule may also be applicable to the amount of the provided design strategies, and thus, a model that can be viewed by the designers at one glance may be more usable in the design work than a model with more than 100 points.

To our knowledge, the present model includes at least six novel design strategies for motivational exercise applications, out of which four come from the studies that focused on the Indian perspective (marked with *). The novel strategies are:

- **S2.7: Glimpse to the future**
- **S4.5: Role models***
- **S4.6: Passing forward***
- **S5.2: Surprises***
- **S6.3: Familiar, real-life metaphors**
- **S6.4: Beauty***

The strategy **S2.7: Glimpse to the future** motivates through "prophecies" made by the exercise application. The application tracks the user's exercise activities and provides a peek to the achievements and consequences that the user could attain if he or she continued with the regime. The application could even suggest changes in order to help the user gain better achievements.

S4.5: Role models and its perceived motivational aspect were found especially in the Indian studies. This strategy relates to the usage of known persons, such as celebrities and politicians, as role models in the application. For example, the selected role model could act as a personal trainer in the application for motivating towards physical activity, or there could be possibilities to use the same training program and goals as the role model has.

The strategy called **S4.6: Passing forward** relates to the observed unawareness of wellness applications, especially in India. There could be possibilities to motivate individuals to use the application if it is given to a relative or friend as a gift, including the recommendation to use it as well as a suggestion of a training program

and goals. Then, the wellness application might feel more personal. In addition, there are thousands of wellness applications available on the markets, but it can be difficult for application seekers to decide what application to download. Getting the application and a recommendation from someone you know might decrease the difficulty of choice. There is already a possibility to buy games as presents for other people (e.g. http://store.steampowered.com/), but an application with some personalised content, such as goals or training programs, would probably be more motivational for the users than just the application alone.

S5.2: Surprises is about the means by which the application can astonish the user. The approach of surprises attracted especially the Indian participants. This strategy provides a new perspective to the usage motivation as well as user experience of the exercise applications, as traditionally, user control of what happens on the application has been one of the important aspects of application design. However, our findings around the topic indicates that there are possibilities for utilising the element of unexpectedness to help keep motivation high. To our knowledge, the element of surprise has not yet been utilised in wellness applications, but its role has been recognised in user experience frameworks (e.g. Hassenzahl, 2006).

S6.3: Familiar, real-life metaphors could be utilised more in visualising exercise data, rather than showing the data in a quantified manner. Metaphors that are meaningful to and understandable for users can bring additional motivation to the use of application. Designers should consider the appropriate metaphors for exercise applications, in addition to those that have been presented in this thesis and in the literature (e.g. Ståhl et al., 2009; Consolvo et al., 2008; Lin et al., 2012).

S6.4: Beauty provides new challenges for the designers of future exercise applications. The designers should consider how the applications could compensate for the lack of natural beauty in some urban environments. One possibility would be to utilise the possibilities provided by the users' favourite natural places brought to the mobile application screen. In our studies, the findings related to the compensation for the lack of natural beauty were emphasised in the India-studies, but it is certain that the strategy could be utilised also in western cultures.

7.5 Limitations and Exclusions in the Model

Our model concentrates on motivational design strategies and excludes pragmatic design strategies from consideration. Pragmatic design strategies include usability, practical issues, ergonomics, and user control (Hassenzahl, 2006); they definitely affect the usage motivation towards the application, but in this work those factors are taken for granted. There exist several handbooks and guidelines about basic user-centred design that discuss those aspects of design (e.g. Hartson and Pyla, 2012; Ballard, 2007). Because those can be seen as the most basic issues, they are not included here, although it must be noticed that they should be well-designed.

In addition, privacy and credibility related issues are out of the scope of this thesis, although they are important to consider when designing applications in the sensitive domain of health and wellness. Additionally, the following design strategies proposed by other researchers did not appear in our studies: *Involving the health care team* (Klasnja and Pratt, 2012), *Raise emotional awareness* (Morris, 2012), and *Reframe challenges* (Morris, 2012). Otherwise, the present model includes the design strategies proposed by the prior lists of design strategies, presented in Related Work, and some additional, novel design strategies (Section 7.4).

7.6 Validity, Limitations, and Generalisability of the Research

The constructive design research process consisted of five phases: 1) Pre-studies, 2) Explorative studies, 3) Concepting and evaluation, 4) Cross study analysis on motivational factors, and 5) Formulating design strategies. While interviewing was the main data collection method of the empirical studies, other methods were used when appropriate, such as participatory design task, observation, questionnaires, and data logs. Content analysis was the main data analysis method. The seven user studies (phases 1–3) involved end users and potential end users. For each user study, we recruited a new group of participants. In total, there were 152 participants involved in the interviews, participatory tasks, and focus groups. In addition, the online questionnaire in the heart rate monitor study (P1) had 860 respondents. The health promotion study (P3) included 119 subjects, but only a subset of them were interviewed or responded to the online questionnaires. The main contributions of the

thesis, i.e. the set of motivational factors and the model of design strategies for motivational exercise applications, are based on the cross study analysis of the empirical studies. The motivational factors were analysed from the findings consisting participants' experiences (what aspects had motivated them), perceptions (what aspects they think motivates them) and expectations (what aspects would motivate them). The model of the design strategies was formulated based on the identified motivational factors.

The validity of the findings of this thesis, which is mostly based on qualitative and exploratory data, is grounded in four ways. 1) The findings are the results of studying people in real life settings with several methods and applications. 2) The findings are based on several user studies, and many of them were repeated throughout the various study phases and across multiple participants. 3) The analyses of the data from user studies were conducted by at least two researchers and, in the cultural studies, there was always a local researcher present in all phases. 4) The findings are explained and reflected in light of the theoretical approaches from psychology and design, as well as cultural aspects. The findings are also compared to the design strategies suggested by others.

One can always discuss whether the limited number of participants in qualitative studies is representative enough. In our studies, there were more than 150 persons involved in producing qualitative data, which is a quite extensive number. In addition, the bigger questionnaires involving 860 (heart rate monitor study questionnaire) and 87/60 respondents (two health promotion study questionnaires) provide additional value to the representativeness of the sample. However, in our studies, the recruitment of voluntary participants mostly happened through the extended networks of the local researchers involved and through advertisements or hobby clubs, by trying to use a consistent recruitment criterion. Only in the health promotion study did the recruiting happen based on strict criteria and screening (as the study was part of a randomised-controlled trial). If the recruitment was done with strict criteria and screening in all studies, it might have had an effect to the validity of the results, but it would have made the research process much more complicated.

One may see a kind of paradox in the user profile of the studies and the topic: what is the point of studying how to motivate people who already have exhibited

some kind of motivation towards exercise, or at least are interested in exercise technologies? Why not study complete couch potatoes who totally lack motivation? We selected this user population because we can learn a lot from the early adopters. They are the forerunners and they buy wellness technologies to get motivated. Even they face barriers and challenges during their wellness processes and need support. They also represent the potential user segment who will buy the products. Studying other user profiles, such as those who totally lack the motivation or never even think of their health and wellness, is a topic for future research.

During the research process, there were four existing mobile exercise applications, a magical gadget (a mock-up that could have any functionalities based on each participant's imagination), four concept designs, and one working prototype involved in the user studies. The main emphasis was on the Wellness Diary application, as it was used in two studies. The Wellness Diary was selected due to its good usability, versatile features and wellness parameters, and its neutral approach. The other applications were selected according to their availability and practical issues, such as the research partners involved. Of course, the varying sample of applications might have had some effect on the results. However, when considering the resources and contexts of the studies, the sample of the applications can be considered to be quite representative.

One can also argue about the reliability of the data analysis. Qualitative content analysis has always had a subjective nature, which means that the perceptions and expectations of the researcher can have unintended impacts on the analysis. We tried to minimise this by having at least two researchers involved in the data analysis of each user study.

The main focus of the research was to identify motivational factors towards the use of exercise applications and, from these, derive design strategies for motivational exercise applications. Thus, the thesis explored usage motivations, not the motivations towards conducting physical exercise itself. Studying methods in terms of their direct affect on the amount of physical activity in people's lives might have had more relevancy in general, but as this thesis contributes to the field of HCI, the scope is design-oriented. Of course, usage motivations and increase in physical activity are somewhat connected. Research indicates that physical activity can be

increased with the use of mobile exercise applications (e.g. Zuckerman and Gal-Oz, 2014; Tudor-Locke, 2002).

This thesis focuses on the motivational factors and design strategies in physical exercise applications. Whether the model of the design strategies can be applied to the design of other motivational applications remains unknown. Based on the similar design strategies proposed by other researchers (Table 1), some of which have a broader perspective to wellness than just physical activity, one could assume that most of the design strategies presented in this thesis could also be applied to motivational applications that support other aspects of wellness, such as healthy eating and weight management. However, given the sensitive nature of some wellness attributes, one must be very careful when making generalisations about the proposed design strategies in other domains of motivational applications.

Last but not least, the model of design strategies presented in this thesis has not been verified as a whole. While some of the design strategies have been lightly evaluated in one of the original articles included in the thesis (P6), the systematic validation of the model needs further work. The emphasis of the research process was on pre-studies and explorative studies (Table 2), as the focus of the work was to produce *generative rather than evaluative* knowledge (Höök and Löwgren, 2012).

7.7 Future Work

The results presented in this thesis have led to several interesting questions that remain in need of further investigation. Most importantly, the presented design strategies and the model should be validated. One should study the effectiveness of the design strategies, both to the usage motivation of the applications and to the increase of physical activity.

The model can also be developed further. The presented design strategies are based on studies conducted with working age persons. Research accommodating other profiles could produce additional strategies to the model. In the ideal case, the model would include several different user profiles and list the most effective strategies for each user profile. It is also probable that, as technological possibilities evolve, new strategies for motivational exercise applications will arise. The model should be evolved based on technological developments as they occur. For example,

the wearable exercise technologies such as activity bands should be studied to find what new motivational design strategies might apply to them.

There is one relevant analysis missing in this thesis: how the proposed design strategies have already been utilised in present exercise applications and devices. We are aware of the fact that many of the strategies discussed here have already been actualised in off-the-shelf products. The analysis concerning the existence of the proposed design strategies could be conducted in the future research.

An even more challenging opportunity for future work would be to develop a life-cycle type solution for promoting physical activity in the long-term. It is likely that the different strategies presented in this thesis would have different impacts on different phases of people's lives. For example, the playful strategies might be more powerful for young people, while mature persons might appreciate more pragmatic ways of support. This area provides interesting challenges for researchers in the domain of wellness technologies.

The findings of this thesis provide insights to cultural aspects studied in two specific locations: Finland and India. The research topic could be studied in several other cultures, as well, to get a broader knowledge of the cultural aspects of motivational exercise applications. As physical inactivity is a global problem, the topic of the research is relevant in almost all the world's cultures.

7.8 Conclusions

This thesis presents two main outcomes based on a user-centred, constructive design research process conducted in two differing cultural locations: Finland and India. The first outcome is *a rich set of motivational factors towards the use of mobile exercise applications*. The findings indicate that one of the main challenges in designing exercise applications is to make the applications motivational in the long term. Users got bored with the use of a static exercise application very soon. This was particularly evident among participants from India. Among the motivational factors that affect the use of exercise applications, there are several promising areas for future systems.

All in all, differences among Indian and Finnish participants were identified in their general approaches to exercise applications. The Indians appreciated more stimulating and playful approaches, while the Finns were satisfied with more

pragmatic approaches, including straightforward instructions and graphs. However, the preferences in those aspects sometimes were individual-dependent and not culture-dependent.

The second outcome is a *comprehensive, structured and focused model of 34 design strategies for motivational, mobile exercise applications*. The design strategies were formulated based on the motivational factors that were analysed from the *empirical studies* carried out throughout the research process. The model consists of six dimensions or categories: *Support My Exercise, Be My Advisor, Grow with Me, Utilise My Sociability, Keep Me Engaged,* and *Visualise My Exercise*. Out of the strategies, *six are novel* in the context of exercise applications. *Nine strategies were identified particularly from the findings made in India*, while the rest of them were visible in the findings made in both studied cultures. The model of design strategies is systematically *compared to the prior design strategies* for exercise and wellness applications, as well as *discussed in light of basic theories* of motivation and user experience, and a widely used cultural model.

Prior to the model, design strategies have existed scattered in several lists and models, each including a different set of strategies. The presented model provides both a covering overview of the design strategies and serves as a practical tool for designers as they begin to conceptualise the design of their motivational exercise applications. More research is needed to validate the model and study the effectiveness of the design strategies, both in terms of the usage motivation of the applications and the increase of users' engagement in physical activity.

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Appendices

Appendix A: Summaries of the Study Participants

In the *heart rate monitor study*, the eight interviewees were 25-46 years old, included three females and five males, and their usage experience of HRMs varied between three months and 2,5 years. Out of the 860 respondents to the online questionnaire on the same study, 38% belonged to the age-group of 31-40 years, and 33% of them to the group 21-30. The third biggest age-group was 41-50 years (20% of the respondents). One fourth of the respondents were females. Over 60% of the respondents were actively using heart rate monitors (at least once a week). 17% of the respondents had formerly used HRMs but had stopped using them.

In the *Sports Tracker study* we focused on three user groups of existing users of the Sports Tracker application, based on their previous experience in using the application: Novice users (less than one month of use), Experienced users (1-6 months) and Veteran users (more than six months). All 28 participants were experienced mobile phone users and had a daily access to the Internet. They used Sports Tracker on their personal mobile phones. Half of the participants were 31-40 years, 30% were 21-30 years and the rest were 41-50 years. 15% of the participants were females. The participants were from all over the world, but most of them from Europe.

In the *health promotion study* there were 119 participants who had at least two health risks and willingness for life-style related changes. 70% of them were females. The average age of the participants was 45 years. They used mobile phones daily, but most of them used only basic features (calling, sms). None of the participants had used the mobile applications on focus prior to the study.

In the *study with Wellness Diary* we had eight Finnish and eight Indian participants. The average age of the Finnish participants was 33 (range 25-45), and half of them were females. In India we had five females and three males between 25-50 years, on average 36 years. The level of physical activity varied among them, but there were no completely inactive or extremely active ones. Finnish participants were more aware or experienced with wellness technologies, e.g. heart rate monitor

or pedometer, than Indians. However, none of the participants had prior experience in the Wellness Diary application.

The *study with Magical Gadget* included 12 voluntary participants, six in India and six in Finland. In both locations there were three females and three males. The age-range of the Indians was 24-30 (average 28 years), while in Finland it was 25-45 (average 31 years). All participants were quite active in physical exercising. As in the previous study, the exposure to wellness technologies was more limited among the Indians than Finns.

The *study of the Living Application and social concepts* happened in four focus groups with a total of 19 voluntary participants, 11 people in Finland and eight in India. In Finland, there were eight females and three males, and in India, four females and four males. The average age of the Finnish participants was 49 years (range 26-70), which was unintentionally higher than the average age of the Indian participants, 35 years (range 25-50). All participants were active mobile phone users, and were actively involved in doing physical activities at the time of the study. In general, the Indian participants had very limited exposure to wellness technologies, while the Finns were keen on using, e.g. heart rate monitors.

The *study of Into* included 12 Finnish persons in a paper prototype study, and in the main study there were 37 participants. There were 31 females and six males among the participants of the main study, and they were 20-55 years old (most of them were 25-39). They were experienced mobile phone users and most of them had some experience in using wellness technologies, such as heart rate monitors and pedometers. Almost 90% of the participants exercised at least once a week.

Appendix B: Applications, Concepts, and Prototypes

In the research process, we studied the following commercial applications and gadgets: heart rate monitor, the Sports Tracker mobile and web applications, the Wellness Diary mobile application, and the Mobile Coach mobile application. The Living Application concept was our own design, as well as the other three concepts called the Gift of Good Health, the Photo Frame of Health, and the Web of Avatars. Into mobile application, used in the final study, was our own working prototype. In addition, we used a Magical Gadget task in one study.

Heart rate monitors

At the time of the study, heart rate monitors had become popular off-the-shelf products for tracking physical activity. They were wrist-worn watches that were worn during the exercise, but they could be worn all the time, as their form-factor was similar to ordinary watches. They enabled users, e.g. to look at the heart rate during the exercises to keep the physical activity within healthy levels. The basic heart rate monitors were quite simple devices on their functionalities. They offered basic features, such as current heart rate, setting of heart rate limits, and a relatively small memory for saving the data. There were also advanced models available, for example Suunto t4, which saved various data about the exercise, such as training effect and level, and gave advice on how the user should train in order to reach the next training level.

The Sports Tracker

At the time of the study, the Sports Tracker mobile application had been launched one year ago. The application features were updated regularly during the first year after the launch. Sports Tracker ran on the Nokia S60 platform phones and utilised in-built GPS. The mobile application could be used for tracking, viewing, storing and comparing user's exercises in outdoor sports. It collected, e.g. route, speed, pace, distance, time and altitude. The data was saved in the training diary and could be viewed in many ways during the exercise and afterwards. In the web service, users could share own exercise data with other members of the community, and look at others' data. The sharing could be done either by "live sharing" during the exercise, or by uploading the data to the service afterwards.

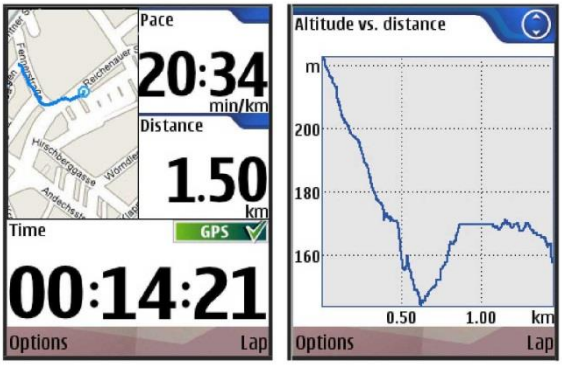

Figure 13: Examples of views of the Sports Tracker mobile application. 1) A map and numeric data of the current workout. 2) A graph of the changes during the workout (altitude vs. distance).

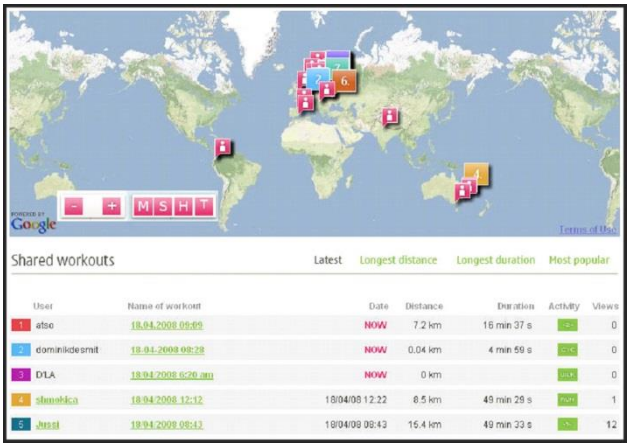

Figure 14: The Sports Tracker web service – a page showing shared workouts on the map, and the list of shared workouts.

The Wellness Diary

The Wellness Diary was, at the time of the studies, an S60 mobile application for the daily journaling of a wide variety of wellness-related self-observation parameters. There were altogether 17 parameters, including weight, exercise, steps, eating, stress level, sleep duration and quality, and alcohol and tobacco consumption. The user could select the most suitable ones out of the parameters. The entries were made to the application manually on the input forms, preferably on the daily basis. The input field contained a free note field where the user could add her/his notes. The Wellness Diary provided graphical feedback of the progress.

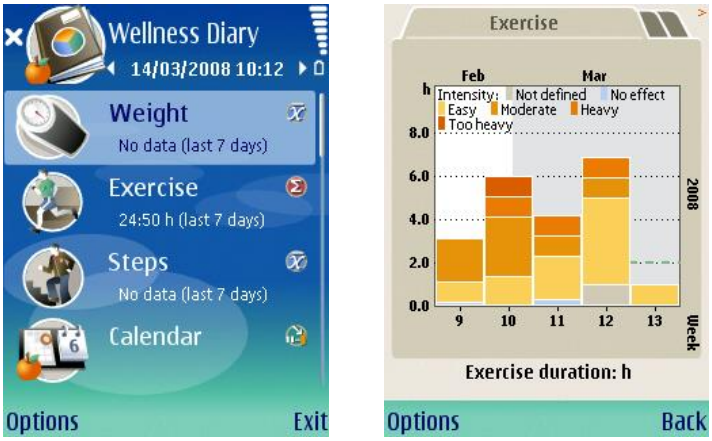

Figure 15: Examples of the views of the Wellness Diary. 1) The main view. 2) The feedback graph of exercise.

The Mobile Coach

The Mobile Coach was a mobile application for physical activity support. It generated training plans based on user's personal goals, including recommendations of the intensity and duration of each training session. It adapted the training program based on the exercises actually conducted. The user made the inputs of the conducted exercises by entering the duration of the exercise and at least one intensity measure: self-assessed intensity, distance, average heart rate or measured training effect from the heart rate monitor. The Mobile Coach provided graphical feedback of the workouts compared to the plan.

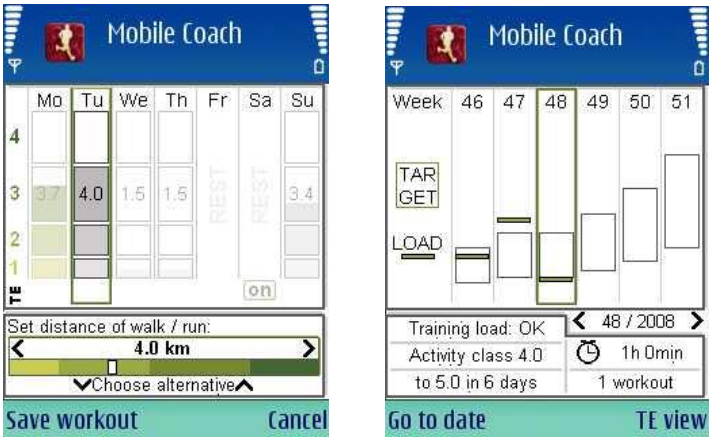

Figure 16: Examples of the Mobile Coach screens. 1) The view for entering the performed exercise. 2) The exercise summary of the week.

The Living Application

The Living Application concept was designed to run on smartphones, using their in-built sensors and other technologies to track user's behaviour. It was designed to calculate and track several attributes pertaining to physical activity and wellness. For example, the accelerometer could gather data about step count, activity type and energy consumption; the GPS could provide information about location, route, speed and distance travelled. External technologies, such as heart rate monitoring belts, weighing scales or activity trackers could be integrated to the application. The Living Application saved the collected data to the diary and it was analysed by the application.

The Living Application concept took a phased approach. In each phase, it provided an exercise program and a suitable exercise goal based on the user's level of progress. The application was designed to evolve with the user. It adapted to the different phases of the user's wellness process. The user could progress to higher levels when she/he achieved the set goals. As the user achieved the target, a new feature was introduced as a motivational reward. Thus, initially, the amount of features, as well as the variety of provided feedback and analysis, was limited, but the variety on them increased during the use of the application.

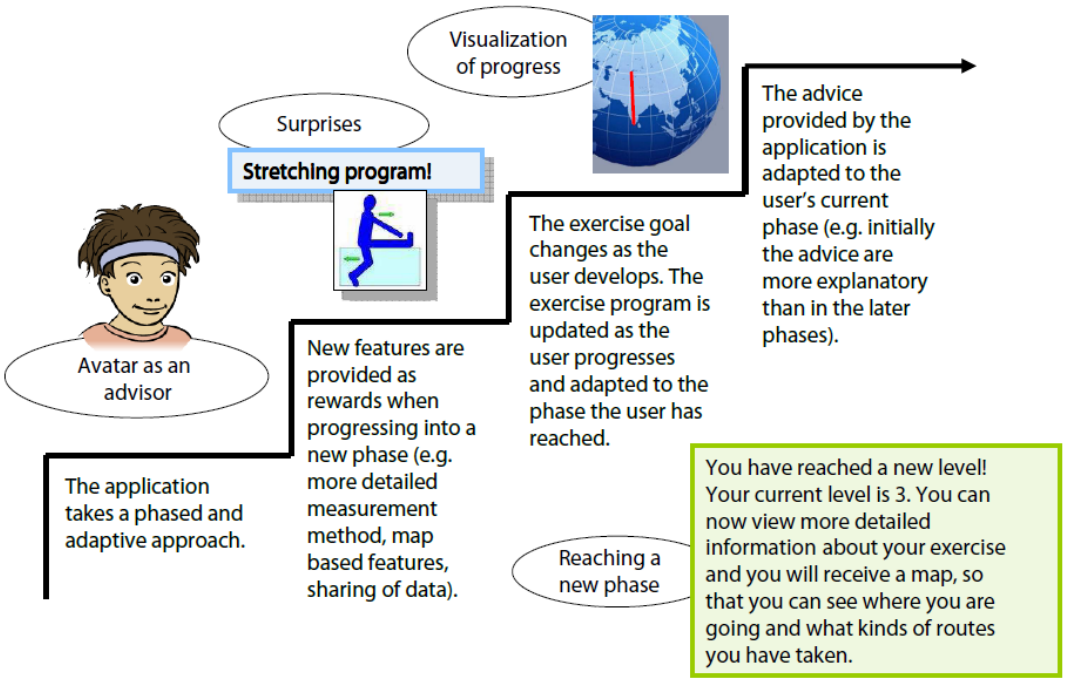

Figure 17: Overview of the Living Application concept (Graphic design: Jussi Huhtala).

Figure 18: In the initial phase of use, the Living Application collects background information from the user in order to set suitable goals. The avatar called Into acts as a personal advisor. A screenshot of the conceptual design (Graphic design: Jussi Huhtala).

Figure 19: The user gets encouraging and motivational feedback during the exercise. A screenshot of the conceptual design (Graphic design: Jussi Huhtala).

Figure 20: User's progress shown on the visualisation of a globe. A screenshot of the conceptual design (Graphic design: Jussi Huhtala).

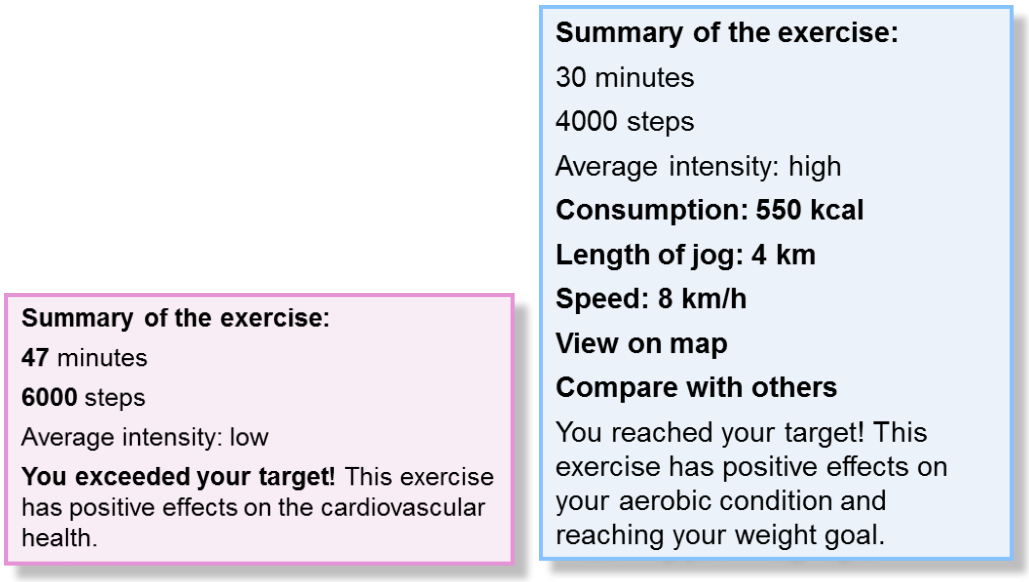

Figure 21: Screenshots of the conceptual design. 1) Summary of the exercise and encouragement provided to the user after an exercise activity in the initial use. 2) A more detailed summary of the exercise session in a later phase of use.

The Gift of Good Health

In the Gift of Good Health concept, the wellness application was sent to the other person's mobile phone as a gift, thus giving a first push to use the application. The application sent could include suggestions of goals or even a training program, set by the sender.

Figure 22: A screenshot of the conceptual design of the Gift of Good Health (Graphic design: Muzayun Mukhtar).

The Photo Frame of Health

The concept called Photo Frame of Health alloved close-ones to share their health related information with each other. The information could include, e.g. goals, personalised status messages and health tips. The information was designed to be visible in the digital photo frame that worked together with a mobile application. The photo frame was selected because it is a traditional way to reminisce those that are significant ones in our lives.

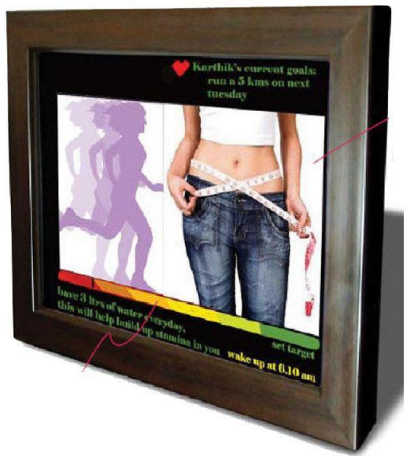

Figure 23: A screenshot of the conceptual design of the Photo Frame of Health (Graphic design: Muzayun Mukhtar). A view with the user's own and another person's goals, the progress towards the goals, as well as a picture of a celebrity as an inspirational factor.

Figure 24: A screenshot of the conceptual design of the Photo Frame of Health (Graphic design: Muzayun Mukhtar). Animated Bollywood dancers celebrating the success on the application when the user achieves the wellness target.

The Web of Avatars

The concept Web of Avatars was designed to connect wellness enthusiatics with similar profiles, targets and interests. It was designed to utilise ad-hoc communities in crowded places and use close proximity connections.

Figure 25: Screenshots of the conceptual design of the Web of Avatars (Graphic design: Muzayun Mukhtar). 1) The avatars of the users with similar profiles are connected by the means of close proximity connections, and represented as neuron networks. The thickness of the axon between neurons represents the activity of the connection between the users. 2) An avatar with a message to be shown for other users.

Into

Into was a mobile java S60 application that combined social team play with other playful elements to increase motivation towards physical exercise. It recorded the user's steps with an in-built accelerometer-based pedometer. The user proceeded on

a map of Finland based on her/his step count. The user could create a challenge of proceeding from one city or town to another. The users could form teams and set a team challenge, and then, the total step count affected to how fast the team travelled on a map.

Figure 26: Into, a social and playful mobile application for increasing motivation towards physical activity.

Figure 27: Screenshots of Into (Graphic design: Jussi Huhtala). A) The combined progress of the team shown in numeric information as a line on the map. B) A figure of an animal showing the speed of the team.

Figure 28: Screenshots of Into (Graphic design: Jussi Huhtala). A) The list view of the members of the team, and their achievements. B) The received postcards from the reached destinations.

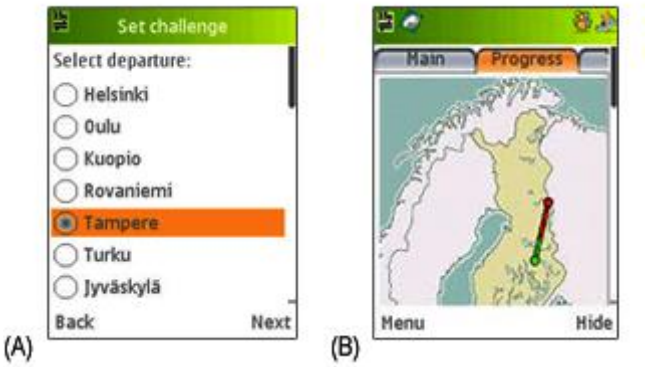

Figure 29: Screenshots of Into (Graphic design: Jussi Huhtala). A) The view for setting the departure point of the challenge. B) The progress visualised on a map of Finland.

The Magical Gadget

Figure 30: A selection of mock-ups that represented Magical Gadgets.

Appendix C: The Model of the Design Strategies for Motivational, Mobile Exercise Applications – Cut It Out!

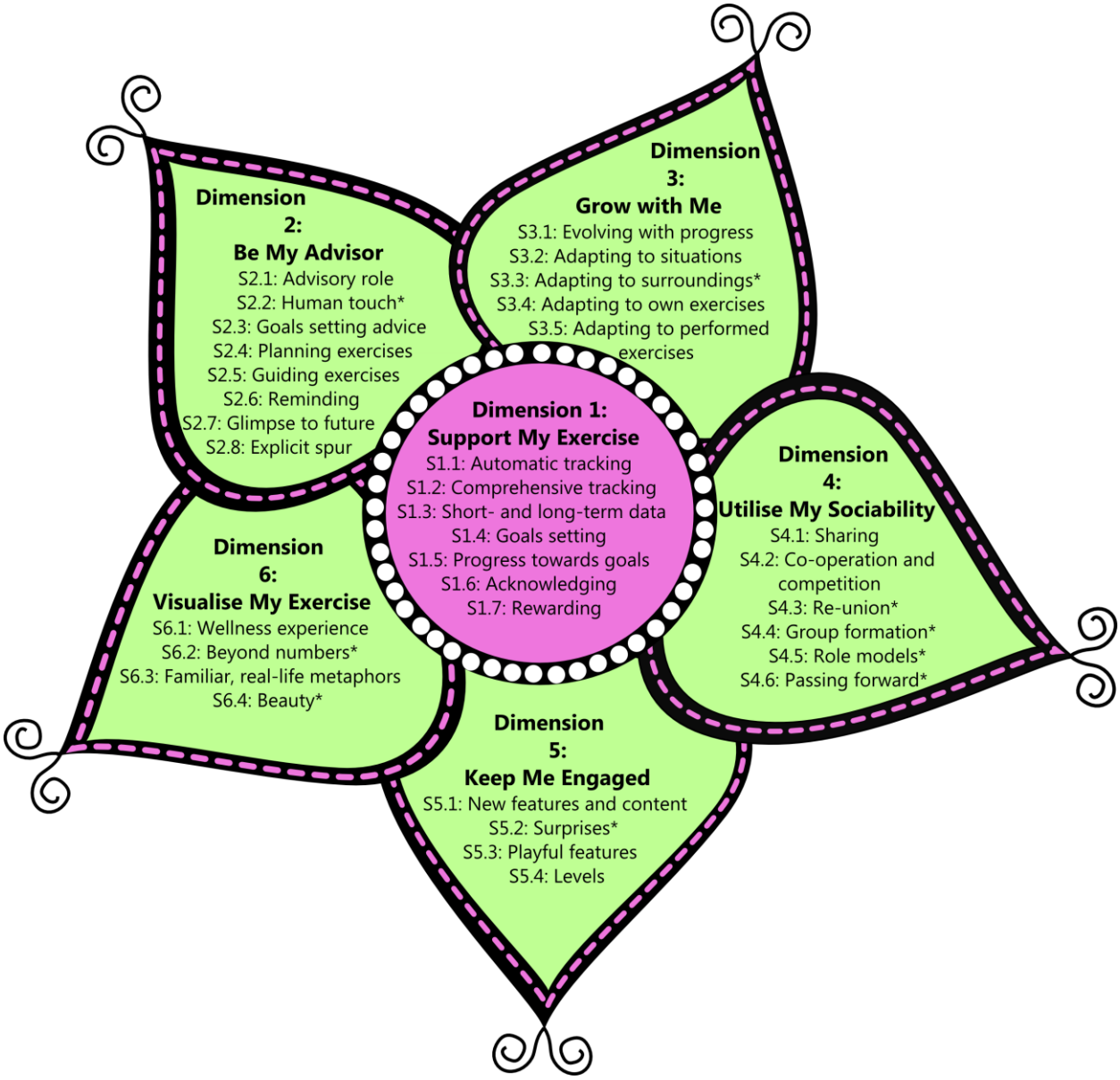

Figure 31: Cut the model of the design strategies for motivational, mobile exercise applications. Place it next to your desk when you start designing your engaging exercise application!

Original Publications

Publication 1 (P1)

Ahtinen, A., Mäntyjärvi, J., & Häkkilä, J. (2008). Using heart rate monitors for personal wellness – The user experience perspective. ***Proceedings of the 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*****, 1591-1597.**

Publication 2 (P2)

Ahtinen, A., Isomursu, M., Huhtala, Y., Kaasinen, J., Salminen, J. & Häkkilä, J. (2008). Tracking Outdoor Sports – User Experience Perspective. ***Proceedings of Ambient Intelligence - European Conference, Lecture Notes in Computer Science, 5355,*** **192-209.**

Publication 3 (P3)

Ahtinen, A., Mattila, E., Väätänen, A., Hynninen, L., Koskinen, E., Salminen, J., & Laine, K. (2009). User experiences of mobile wellness applications in health promotion: User study of Wellness Diary, Mobile Coach and SelfRelax. ***Proceedings of the 3rd International ICST Conference on Pervasive Computing Technologies for Healthcare.***

Publication 4 (P4)

Ahtinen, A., Ramiah, S., Blom, J., & Isomursu, M. (2008). Design of mobile wellness applications: Identifying cross-cultural factors. ***Proceedings of the 20th Australasian Conference on Computer-Human Interaction*****, 164-171.**

Publication 5 (P5)

Ahtinen, A., Isomursu, M., Mukhtar, M., Mäntyjärvi, J., Häkkilä, J., & Blom, J. (2009). Designing social features for mobile and ubiquitous wellness applications. ***Proceedings of the 8th International Conference on Mobile and Ubiquitous Multimedia,*** **article 12.**

Publication 6 (P6)

Ahtinen, A., Isomursu, M., Ramiah, S. & Blom, J. (2013). Advise, Acknowledge, Grow and Engage: Design Principles for a Mobile Wellness Application to Support Physical Activity. ***International Journal of Mobile Human Computer Interaction, 5*****(4), 20-55.**

Publication 7 (P7)

Ahtinen, A., Huuskonen, P., & Häkkilä, J. (2010). Let's all get up and walk to the North Pole: Design and evaluation of a mobile wellness application. ***Proceedings of the 6th Nordic Conference on Human-Computer Interaction*****, 3-12.**

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ISBN 978-952-15-3562-8
ISSN 1459-2045