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Pasi Karppinen

STUDYING USER EXPERIENCE OF HEALTH BEHAVIOR CHANGE SUPPORT SYSTEMS

A QUALITATIVE APPROACH TO INDIVIDUALS' PERCEPTIONS OF WEB-BASED INTERVENTIONS

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

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PASI KARPPINEN

STUDYING USER EXPERIENCE OF HEALTH BEHAVIOR CHANGE SUPPORT SYSTEMS

A qualitative approach to individuals' perceptions of web-based interventions

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Abstract

Behavior change support systems (BCSSs) help people to achieve personal goals that they cannot necessarily achieve on their own. Typical BCSSs include health-related systems and applications. Significant policy and research attention has been aimed at information technologies that enable behavior change in regard to individuals' health and wellbeing activities.

The aim of this dissertation is to build a comprehensive view of health BCSSs, ranging from technology adoption to engagement, persuasion, and habit formation. As its main research question, the present thesis asks: *What can user experiences of health BCSS reveal about behavior change?* In addition, it proposes a framework for different approaches, which can help developers solve ethical issues in their BCSS design.

This dissertation comprises four qualitative studies and one conceptual study. Hermeneutics has been the most influential research method in conducting these studies. Ontologically, hermeneutics leans toward socially constructed reality. The primary conceptual lenses for interpreting the data are the BCSS framework and Persuasive Systems Design model.

This thesis extends prior research on eHealth, including non-adoption, flow esperience, use adherence, habit formation, and ethics. The results emphasize that persuasive systems design can affect user experience in different stages of system adoption and learning a new, healthier lifestyle. The presented work addresses health behavior change as a complex issue. Many individuals regard system usefulness in terms of perceived value for themselves rather than in terms of the system's instrumental value. People are less likely to use the systems if they do not fit into their daily routines. Flow experience appears not to play as fundamental part in the BCSS use experience as is expected. The results suggest that self-monitoring, reminders and tunneling can help users to achieve better outcomes. These persuasive features can help increasing subject's compliance and commitment, which in turn can help individuals to achieve better habits. Additionally this thesis presents a framework where different ethical approaches are divided to three distinct categories.

Keywords: eHealth, health behavior change support systems, hermeneutics, information systems, persuasive systems design, qualitative methods

Karppinen, Pasi, Käyttäjäkokemus käyttäytymisen muutosta tukevissa tietojärjestelmissä. Laadullinen tutkimus yksilöiden kokemuksiin web-pohjaisissa interventioissa

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Tiivistelmä

Käyttäytymismuutosta tukevat tietojärjestelmät auttavat ihmisiä saavuttamaan henkilökohtaiset tavoitteensa, joita he eivät välttämättä yksin saavuttaisi. Tyypillisesti tällaiset järjestelmät ja applikaatiot liittyvät terveyteen. Sekä tutkimuksessa että julkishallinnossa on kiinnitetty huomiota, kuinka yksilöiden terveyttä ja hyvinvointia voidaan edistää informaatioteknologian avulla.

Tämän väitöskirjan tarkoituksena on rakentaa kokonaisvaltainen näkemys terveyttä edistävistä käyttäytymismuutosta tukevista tietojärjestelmistä lähtien järjestelmän käytöstä ja osallistavuudesta, suostuttelevuuteen ja tapojen muodostumiseen.

Väitöskirjan keskeisin tutkimuskysymys on: *mitä käyttäjien kokemukset terveyttä edistävistä käyttäytymismuutosta tukevista tietojärjestelmistä paljastavat mitattavasta käyttäytymismuutoksesta?* Lisäksi tämä väitöskirja tarjoaa viitekehyksen, joka voi auttaa suunnittelijoita ratkaisemaan eettisiä ongelmakohtia, kun he suunnittelevat käyttäytymismuutosta tukevia tietojärjestelmiä.

Väitöskirja pitää sisällään neljä kvalitatiivista osajulkaisua ja yhden konseptuaalisen osajulkaisun. Hermeneutiikka on osajulkaisujen kannalta keskeisin tutkimusmenetelmä. Ontologisesti hermeneutiikka nojaa sosiaalisesti konstruoituun todellisuuteen. Aineiston tulkitsemisen kannalta keskeisimmät konseptuaaliset viitekehykset ovat olleet BCSS framework ja Persuasive Systems Design model.

Väitöskirja laajentaa aiempaa tutkimuksellista näkökulmaa eHealth-teemasta pitäen sisällään näkökulmat järjestelmän hylkäämisestä, flow-kokemuksesta, järjestelmän käyttöön sitoutumisesta, elintapojen muodostumisesta ja eettisyydestä. Väitöskirjan tulokset korostavat, että suostuttelevien järjestelmien suunnittelumenetelmät voivat vaikuttaa käyttäjäkokemukseen eri vaiheissa järjestelmän käyttöönotosta uuden terveellisemmän elintavan omaksumiseen. Väitöskirjassa esitellyt osajulkaisut osoittavat, että terveyttä edistävä käyttäytymismuutos on monimutkainen kokonaisuus. Moni haastatelluista koki järjestelmän hyödyllisyyden liittyvän enemmän itsensä kehittämiseen kuin välineelliseen hyötyyyn. Ihmiset olivat vastentahtoisia käyttämään järjestelmää, jos se ei sopinut heidän arkielämäänsä. Väitöskirjan tulokset antavat ymmärtää, että itsemonitorointi, muistutukset ja tunnelointi auttavat käyttäytymismuutosta tukevien tietojärjestelmien käyttäjiä saavuttamaan parempia lopputuloksia. Nämä suostuttelevat elementit voivat helpottaa käyttäjiä noudattamaan ohjeita ja sitoutumaan muutosprosessiin kohti terveellisempiä elämäntapoja. Väitöskirja tarjoaa lisäksi viitekehyksen, jossa erilaiset eettiset lähestymistavat on jaotelty kolmeen eriteltävään kategoriaan.

Asiasanat: elektroninen terveys, hermeneutiikka, käyttäytymismuutosta tukevat tietojärjestelmät, laadulliset menetelmät, suostuttelevien järjestelmien suunnittelu, tietojärjestelmät

Mom & Dad
I am sure you would have liked this

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Abbreviations

BCSS	behavior change support system
BMI	body mass index
CHIT	consumer health information technology
eHealth	transfer of health resources and health care by electronic means
ICT	information and communication technologies
ID	identification
IS	information systems
IT	information technology
M	mean
MED	median
MVC	model-view-controller
n	number
PrevMetSyn	prevention of metabolic syndrome
PSD	persuasive systems design
PT	persuasive technology
REST	representational state transfer

List of original publications

This thesis is based on the following publications, which are referred throughout the text by their Roman numerals:

I Karppinen P, Lehto T, Oinas-Kukkonen H, Pätiälä T & Saarelma O (2014) Using hermeneutics to uncover anomalies for non-adoption of behavior change support systems. PACIS 2014 Proceedings. Chengdu, China, AIS: Paper 110.

II Karppinen P, Alahäivälä T, Jokelainen T, Keränen A, Salonurmi T & Oinas-Kukkonen H (2014) Flow or no flow? A qualitative study of health Behavior Change Support System. Proceedings of the 2014 47th Hawaii International Conference on System Sciences. Waikoloa, USA: 3044–3053.

III Karppinen P, Oinas-Kukkonen H, Alahäivälä T, Jokelainen T, Keränen A, Salonurmi T & Savolainen M (2016) Persuasive user experiences of a health Behavior Change Support System: A 12-month study for prevention of metabolic syndrome. Int J Med Inf 96: 51–61.

IV Karppinen P, Oinas-Kukkonen H, Alahäivälä T, Jokelainen T, Keränen A, Salonurmi T & Savolainen M. Opportunities and challenges of Behavior Change Support Systems for enhancing habit formation: qualitative study. Manuscript.

V Karppinen P & Oinas-Kukkonen H (2013) Three approaches to ethical considerations in the design of behavior change support systems. PERSUASIVE 2013. Berlin Heidelberg, Springer-Verlag: 87–98.

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1 Introduction

Lifestyle-related noncommunicable diseases (such as cardiovascular disease, diabetes, and cancer) are the leading global causes of death, resulting in more deaths than all other causes combined, as stated by the World Health Organization (2010). Important behavioral risk factors, including tobacco use, physical inactivity, and unhealthy diet, are responsible for about 80% of coronary heart disease and cerebrovascular disease. Evidently, the lifestyle that people adopt directly influences their health and wellbeing. Calls to action regarding the global burden of lifestyle-related diseases are occurring

According to the International Telecommunication Union's statistics in 2015, 82.2% of individuals living in developed countries were using the Internet. The potential of information technologies to facilitate enduring change in individuals' health and wellbeing activities has gained significant research and policy attention. Payton *et al.* (2011) argue that there has been a shift from being passive patients to active consumers of health information, healthcare devices, and monitoring systems. By providing consumers with access to their personal health information, how people manage their health and wellbeing can be influenced (Payton *et al.* 2011).

Despite the ever-increasing availability of technology, Webb *et al.* (2010) found that Internet-based interventions had, on average, a small effect on health behavior. In Kaipainen *et al.*'s (2012) study, participant attrition was 75% after initial registration. More than a decade ago, Eysenbach (2000) proposed that the foremost challenge in developing comprehensive systems for consumers of health informatics was the sparse amount of knowledge regarding how individuals interact, process, and use health information. Even today, Eysenbach's arguments seem to be valid. A study by Brouwer *et al.* (2011) shows that a large variety of behavior change techniques and strategies have been used for various lifestyle behaviors. Oinas-Kukkonen (2013) argues that one of the problems is that web interventions are often treated by researchers as "black boxes" that merely serve the purpose of delivering the information to the person. Oinas-Kukkonen (2013) suggests a related concept: behavior change support systems (BCSSs). BCSSs highlight the autogenous and voluntary approaches in which people use information technologies to change their own attitudes or behaviors through building upon their own motivation or goals (Oinas-Kukkonen, 2013). Oinas-Kukkonen (2013: 1225) defines BCSS as follows:

A behavior change support system (BCSS) is a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception.

BCSSs are fundamentally persuasive, aiming to influence users (Oinas-Kukkonen 2013). One of the centerpieces in this research area is Oinas-Kukkonen and Harjumaa's (2009) Persuasive Systems Design (PSD) model. The PSD model is the state-of-the-art tool for evaluating and designing BCSSs (Oinas-Kukkonen, 2013), and it has been utilized greatly in the area of eHealth research (e.g., Drozd *et al.* 2012, Langrial *et al.* 2012, Lehto *et al.* 2012, Myneni *et al.* 2013, Harjumaa *et al.* 2014). However, qualitative studies are still needed to discover how individuals actually experience using health BCSSs and their persuasive features. Kelders *et al.* (2012) suggested as a future research area in-depth qualitative analyses to increase the knowledge of web-based interventions' characteristics. According to Lehto (2013), studies tend to ignore the underlying persuasive techniques, and more emphasis should be put on studying how system features and functionalities contribute to the success of the BCSS. Not only how technology affects individuals should be studied but also how users interact with the systems (Lehto 2013).

Over the last 25 years, information and communications technology (ICT) has become pervasive in different areas of human activity, leading to discussions regarding the core of the information systems (IS) research field (Benbasat & Zmud 2003, Walsham 2012). Walsham (2012) argues that IS field should focus on the fundamental question: *Are we making a better world with ICTs*? He underscores the need for a strong ethical agenda in the future. Information systems influence people's attitudes and behaviors in one way or another, and what is too often neglected is how information technology is never neutral (Oinas-Kukkonen 2013, Oinas-Kukkonen & Harjumaa 2009). In the area of BCSSs, system designers should also be aware of the power technology exercises over its users (Oinas-Kukkonen 2013).

As a response to these challenges, this dissertation consists of four qualitative studies from different perspectives of BCSS usage. The studies include responses from non-adopters to individuals who have used a BCSS for a year. The fifth study in this dissertation provides guidance on how different ethical approaches can be taken into account when designing BCSSs.

1.1 Research objectives

This thesis aims to provide a broad and in-depth picture of the health BCSS use experience. It binds a story from BCSS acceptance to engagement and from persuasive feature perception to habit formation. This thesis consists of five distinct articles. The main research question of this thesis is: *What can user experiences of health BCSSs reveal about behavior change?* In addition, Study V discusses ethical issues related to BCSSs. The general characteristics of studies I–V are summarized in Figure 1.

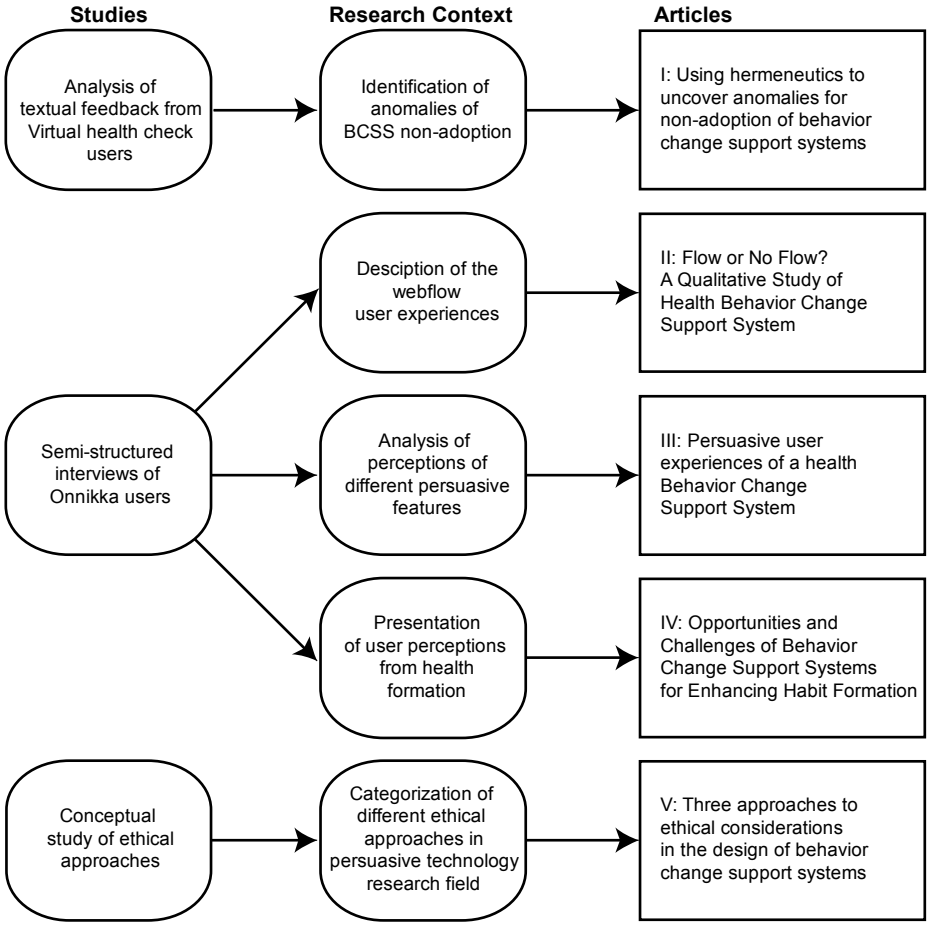

Fig. 1. Studies, research context, and related articles

Study I is related to the technology acceptance research tradition. Naturally, IS cannot support individuals' health monitoring and self-management if people do not use them. Technology acceptance is one of the most studied areas in the IS discipline (Venkatesh *et al.* 2003), and in recent years it has extended to areas such as consumer behavior (Venkatesh *et al.* 2012), consumer health information technology (Or & Karsh 2009), and persuasive systems (Lehto & Oinas-Kukkonen 2015). In explaining and predicting technology acceptance, the predominant constructs have been *ease of use* and *usefulness* (Davis 1989, Venkatesh *et al.* 2003). Recent study by van Genugten *et al.* (2016) analyzed 52 online interventions targeting various health behaviors, and they discovered that interventions that take little time to understand and use are most effective. Williams *et al.* (2009) proclaim that the quantitative approach has dominated the technology adoption research within the IS field, and there is evidence of researchers neglecting other paradigms, such as interpretive and descriptive approaches. Further, Benbasat and Barki (2007) commented that there is no clear understanding about what actually makes a given technology be perceived as useful. In Study I, there was an opportunity to examine vast textual feedback written by individuals who did not use actual virtual health coaching after they had done an initial virtual health check. A virtual health check can be seen as the "welcome doormat" to a comprehensive BCSS health intervention aimed to enhance an individual's health and wellbeing. The objective of the Study I was to discover *what open textual feedback from non-adopters can disclose about the issues surrounding why a comprehensive BCSSs were rejected by these individuals.*

Study II relates to users' flow experiences of BCSS use. According to van der Heijden (2004), new types of IS users are accustomed to seeking engagement and entertainment through ICT services. Holistic experiences with technology, such as enjoyment (van der Heijden 2004) and flow (Agarwal & Karahanna 2000), are important explanatory factors in technology acceptance theories. One of the theories used to study the user experience's hedonic side has been the Flow theory by Csikszentmihalyi (1975). For understanding Internet use and online consumer behavior, flow experience has played a role since nearly the dawn of the World Wide Web (Hoffman & Novak 1996, Novak & Hoffman 2000). For example, Korzaan (2003) found a connection between flow and online purchase intentions, whereas Koufaris (2002) predicted that flow has a correlation with the intention to return to a website; Skadberg and Kimmel (2004) in turn argued that people in flow learn more from a website. Quite surprisingly, flow has hardly been studied at all in the field of consumer health information systems technologies (CHIT), as Or and

Karsh's (2009) study unveils. They reviewed 52 articles that studied CHIT acceptance among patients. Based on their review, only the study by Wilson and Lankton (2004) included hedonic values in its research setting. In Study II, users of the weight loss web intervention called "Onnikka" were interviewed to *discover if users experience flow when using BCSS.*

Study III focuses on the perceptions of different persuasive features. Kelders *et al.* (2012) demonstrated in their study that web interventions' use adherence can be improved by persuasive design and certain intervention characteristics. Persuasive systems may have various strategies to influence users' behaviors and attitudes, and the design model by Oinas-Kukkonen and Harjumaa (2009) helps to design and develop them. The most discussed part of the PSD model, as in Kelders *et al.* (2012) study, is its four distinct categories of persuasion features: 1) primary task support, 2) dialogue support, 3) perceived system credibility, and 4) social influence. Study III sought answers to *what were the main reasons for using or not using the system, how the persuasive features were perceived, and to what extent did the perceptions differ between individuals who managed to lose 5% or more of their body weight and those who could not*.

Study IV concentrates to healthy habit formation with the support of a BCSS. The role of creating a habit is important in health behavior change, as many health goals are reached only by repeated action (e.g., maintaining weight or remaining physically active). Habits are considered to play a fundamental role in behavior, and the formation of healthy habits may be the key to aiding maintenance beyond the intervention period (Gardner 2015). Behavioral gains are often lost when an active intervention period ends as Jeffery *et al.* (2000) underscore. Despite the development of BCSS-related frameworks and design models (Oinas-Kukkonen & Harjumaa 2009, Oinas-Kukkonen 2013), there are no explicit suggestions for BCSS developers regarding how to support habit formation. Study IV focuses on responses regarding habit formation and aims to discover *how Lally and Gardner's (2013) stages of habit formation resonate with participants' BCSS use perceptions and how the framework maps with the PSD model*.

Study V builds on the notion that ethical considerations are important to take into account in BCSS research (Oinas-Kukkonen 2013). BCSSs are designed to deliberately create a change in the state of a user, and attempting to change users' behaviors or attitudes through these systems can become something of an ethical minefield (Davis 2009). It is therefore quite surprising that ethical considerations have remained largely unaddressed in the BCSS research (Tørning & Oinas-Kukkonen 2009, Oinas-Kukkonen 2013). The study by Berdichevsky and

Neuenschwander (1999) was among the first academic works to directly address the ethical issues concerning persuasive technology and design. Also, Fogg's (2003) pivotal book of persuasive technology addresses ethical issues, and the interest in persuasive ethics has grown further, as evidenced by the studies of Gram-Hansen (2009), Davis (2009), Smids (2012), Spahn (2011), and Yetim (2011a). These works are valuable for a persuasive system designer; however, their suggestions for resolving ethical issues differ from one another notably. Study V seeks solutions in regard to *how BCSS designers can choose between different ethical approaches*.

1.2 Overall scope of the thesis

The context of this thesis is eHealth despite the fact that BCSSs can be used in other contexts as well, such as to motivate customers to generate and share feedback (Stibe & Oinas-Kukkonen 2014). Possibly the most cited definition of eHealth is from Eysenbach (2001):

> *e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.*

Eysenbach's (2001) definition is descriptive in regard to what the term eHealth connotes in this dissertation as well. However, it needs to be noted that studies I–IV are conducted from the perspective of BCSS users, and other stakeholders' views are not explored. Moreover, the participating subjects in studies I–IV were not acquired from hospitals or other health organizations.

The World Health Organization (2006) defines health as follows: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Huber *et al.* (2011) criticizes the definition as too ambitious, since the requirement for complete health would leave most of us unhealthy most of the time. He sees health as the ability to adapt and to self-manage, which is a more fitting description of health from the viewpoint of this dissertation. It also corresponds with Schroeder's (2007) arguments that behavior patterns are the most significant determinant of health. According to McGinnis *et al.* (2002), in the United States, behavior patterns contributed to 40% of deaths that could be avoided

by preventive interventions, whereas 10–15% of deaths could be prevented by better availability or quality of medical care.

Health behavior is described by Gochman (1998) as something that people do or refrain from doing although not always consciously or voluntarily. By this definition, medical treatment is not considered to be health behavior, since it is done *to* people, not *by* them. Gochman (1998) also sees mental events and feeling states as behavior, not only observable actions. As an example, a person's health status itself is not behavior; however, one's perception of his or her health status is a behavior, whether it is perception of recovery, improvement, or another change in health (Gochman 1998).

The BCSS framework by Oinas-Kukkonen (2013) is the theoretical centerpiece of this dissertation. There are several eHealth frameworks that are not discussed in this thesis. Van Gemert-Pijnen *et al.* (2011) made a review of eHealth frameworks and selected 16 different frameworks that matched their inclusion criteria. These eHealth frameworks, their goals, and their definitions of target technology are presented in Appendix A. The deliberate effort to impact people's attitudes and behavior distinguishes BCSS from other related concepts, as Oinas-Kukkonen's (2013: 4) defines:

> *BCSSs are inherently transformative, deliberately attempting to cause a cognitive and/or an emotional change in the mental state of a user to transform the user's current state into another planned state and to cause a corresponding change in the user's behaviors.*

Benbasat and Zmud (2003) argue that the core of IS research should focus more on the IT artifact, the practices and capabilities involved developing and using IT based systems. Sarker *et al.* (2013) guides that the discipline needs to be flexible in this issue, but social part is truly currently over-emphasized, and IT is often treated as merely the context of a study. The empirical data in this dissertation have been collected from two separate web-based health interventions. If the argumentation by Agarwal and Lucas (2005) is followed, this dissertation can be criticized as being too micro focused. They call for more macro-focused research on the transformational facets of technology to disseminate their importance to individuals, organizations, industries, and the economy. In summary, this doctoral thesis focuses on *IT artifacts and individuals who seek to maintain or enhance their personal health independently with the help of BCSSs*.

1.3 Dissertation structure

The structure of this doctoral thesis is as follows. The latter part of the first section describes the research context, research approach and methods, and data collection. Section 2 presents the key theories and frameworks relevant to this dissertation. Section 3 summarizes the results of studies I–V in an article-by-article manner. In Section 4, the theoretical and practical implications of the findings are discussed, the reliability of this work is debated, and further studies are recommended. Lastly, Section 5 concludes the work.

1.4 Research context: the BCSSs

The empirical data for this dissertation have been collected from two BCSSs: *Virtual health check and coaching*, and *Onnikka web intervention system for the prevention of metabolic syndrome*. Both of these web systems are introduced in the following subsections. Study V is conceptual, and no empirical data were collected for it.

1.4.1 Virtual health check and coaching

Virtual health check and coaching was developed by the Finnish Medical Society Duodecim in 2012. The BCSS consists of two consecutive parts: i) the virtual health check and ii) virtual health coaching. After completion of the virtual health check and receipt of the report, the user is expected to activate the virtual health coaching by selecting the appropriate coaching modules (Figure 2).

Fig. 2. Overview of the virtual health check and coaching system

The virtual health coaching provides personalized exercises, suggestions, and feedback on a regular basis via e-mail and web interface. The coaching programs are founded on evidence-based cognitive behavioral exercises, and the content of

the programs has been developed by professionals from respective areas of health and wellbeing. (Full list of references regarding coaching programs can be found following the link "Research evidence" on the Virtual health check's web-page: https://star.duodecim.fi/star/setLang.do?method=english.)

This non-clinical system is based on information regarding a health-enhancing lifestyle, the impact of lifestyle on quality of life, life expectancy, and the possibilities of acquiring a healthier lifestyle. The estimates for life expectancy and disease risks are based on the Finnish Finrisk, Finnish Mobile Clinic, and Mini-Finland health examination surveys conducted by the National Institute of Health and Welfare and the Social Insurance Institution of Finland (for more details on life expectancy measurement, see Peltonen *et al.* 2008). The modifiable life style factors taken into account include nutrition, physical exercise, alcohol consumption, smoking, sleep habits, and stress. In addition, respondents' blood pressure, blood cholesterol values, and parents' ischemic heart disease (IHD) morbidity can be included in the system's estimation algorithms. Certain health-related factors are not taken into account due to a lack of reliable information, such as the use of salt, hard fats, or drugs. Chronic diseases are not included in the virtual health check, with the exception of diabetes. The virtual health check is not meant to diagnose a disease or to predict falling ill with particular disease; rather, its estimates are statistical averages for a given age and gender group with a defined health behavior pattern (Figure 3). The average life expectancy given by the system reflects the average life expectancy of those Finns whose answers were similar to those of the respondent. The advice given by the program is meant to support individuals' health and wellbeing. Individuals who are concerned about their health and general wellbeing are encouraged to consult a medical practitioner.

Fig. 3. Screenshot from a lifestyle estimate provided by the virtual health check

1.4.2 Case Onnikka

A web-based health BCSS called Onnikka was designed in the Prevention of Metabolic Syndrome (PrevMetSyn) lifestyle intervention research project for participants who are at risk of developing a metabolic syndrome or are already suffering from it. Onnikka was designed jointly by researchers of internal medicine, IS, and informatics at Oulu University. During Onnikka's design process, the PSD model (Oinas-Kukkonen & Harjumaa 2009) was followed.

The Onnikka system is a stand-alone web information system not linked with face-to-face counseling and that can be accessed with personal credentials for a duration of 52 weeks. The technological implementation of Onnikka was carried

out using web technologies that users could access on their desktop or mobile devices. The design process and architecture of the system are described in Alahäivälä *et al.* (2013).

The homepage of Onnikka (Figure 4) provides a starting point for users to access the different functionalities of the system, such as submitting self-monitoring entries or reading the weekly content.

Fig. 4. Homepage of the Onnikka system

Each week contains a weekly article, an exercise, and a brief health tip based to the phase of intervention and tailoring preferences. The information content follows the cognitive-behavioral approach (Beck 1995), where the aim is to help users to cope with dysfunctional thoughts interfering with their behavioral goals and to support their self-efficacy regarding eating, exercise, weight monitoring, and weight loss. Since not all persons have the need for counseling specifically on eating behavior, additional informational content and exercises were designed to be visible only to a certain group of tailoring-enabled individuals based on their behavioral profiles, which follows the principles of *tailoring* in the PSD model (Oinas-Kukkonen & Harjumaa 2009). Table 1 summarizes the persuasive features implemented in Onnikka, the categories they belong to, and how features were implemented in the system design. The PSD model is introduced more thoroughly in Section 3.

Table 1. The persuasive features in Onnikka

Persuasion category and feature	Implementation
Primary task support	
Self-monitoring	Weight diary
	Food diary
	Exercise diary
	Mood diary
Reduction	Weekly content on separate themes
	Progress bar on the homepage visualizing remaining time of the intervention
Tunneling	Unchangeable rhythm of weekly content, exercises, and tips
Tailoring	Additional e-mail messages, information content, and tailored exercises for those in need of advice on eating behavior
Dialogue support	
Reminder	Weekly e-mails to log into the system followed by another reminder to log in if the user had not logged in by Thursday
Praise	Encouraging textual feedback after successful weight-loss performance
Suggestions	Tips for good eating behaviors sent to the tailored group
Liking	Visual appearance of a modern web application, using photographs of local environments and people
Social support	
Social learning	Discussion column board
Social facilitation	Number of logged users for the current intervention week and the number of comments given shown on the front page
Credibility support	
Trustworthiness & Expertise	Content is based on the latest official health recommendations and medical research
Verifiability	Links to external sources

The content of the site followed the principle of *reduction* by simplifying a complex behavior—weight management—into separate themes (nutrition, exercise, etc.), helping users to target their behavior change efforts to the most-needed areas. The progress bar visualizing the remaining time in the intervention is also a reduction feature. A feature closely related to reduction is *tunneling*, which was implemented as the unchangeable rhythm of providing new content. Users can browse back over the previous content and entries; however, it is not possible to get access to the weekly content in advance.

Self-monitoring is the core primary task functionality of the Onnikka system. Users can submit entries about their weight, mood, exercise, and eating habits to track their behavior. The weight entries can be browsed in table form or as a

visualized graph, and persuasive messages are conveyed in the submission process, which follows the recommendations of the *praise* feature in the dialogue support category. To follow mood and motivation, users can write diary entries with "smileys" indicating their feelings during the current intervention week. To monitor exercise, users may submit entries in which they describe the type of exercise, the level of strain, and the amount of exercise done. Lastly, participants can submit entries to a food diary. Users can add information about their eating time, meal type, description, and the place where a meal is eaten. Additionally, users can mark the meal as "unnecessary" or "good," reflecting their eating habits.

Reminders were the most important feature adapted from the dialogue support category. Onnikka sent weekly e-mail messages to participants on Mondays, and another message was sent on Thursday if they had not yet logged into the system during the week. Additionally, short lifestyle suggestions were sent occasionally on Fridays to users in the tailored group so that they would remember their goals over the weekend. According to the PSD model (Oinas-Kukkonen & Harjumaa 2009) systems can utilize either computer-human or computer-mediated persuasion. Computer-mediated dialogue means that people are persuading others through computers, for example by using e-mails, chats or social media. The dialogue support features presented here are computer–human persuasion.

Social support was implemented as a discussion column attached to each weekly health information section. Users were able to share their thoughts anonymously using pseudonyms. It was decided that the discussion column would be a place for peer support only, and nutrition therapists and system developers would not interfere in the discussions. The *social facilitation* feature was implemented as an information element on the homepage, indicating the total number of logged participants for that intervention week.

During the design process, the principles in the credibility support category were paid less attention, since the authorities behind the system (university and hospital district) were believed to provide sufficient credibility. Onnikka had links to external sources, from which subjects could verify the information offered in the system and gain additional knowledge.

1.5 Ontological assumptions and data collection

This dissertation leans on the interpretive qualitative research tradition. This view ontologically sees the world as socially constructed, which is gained through language, consciousness, and shared meaning (Klein & Myers 1999). Reality is a

social product, which can be understood through the social actors who make sense of the world and construct it (Orlikowski & Baroudi 1991). The positivist approach on the contrary, sees society functioning according to general laws like the physical world. According to Lee (1991) positivism maintains that only by applying the methods of natural science, will social science ever match natural science in control, prediction and explanation. Difficulties in capturing social reality in formal propositions are viewed in positivism to be the reasons why social science has not reached the same level of scientific maturity compared to as natural science (Lee 1991).

Klein and Myers (1999) suggest a set of principles for interpretive field studies in IS science and consider the hermeneutic circle as the fundamental principle of interpretivism. The development of an interpretation is an iterative process, where the understanding of the whole is gleaned through the meaning of the separate parts, and the meaning of separate parts is determined by the whole (Klein & Myers 1999, Sarker & Lee 2006). The research approach of this thesis is highly influenced by hermeneutics, and it was also adapted as the research methodology in studies I, III, and IV.

Hermeneutics was developed as a method for interpreting ancient religious texts. There were no possibilities of returning to the authors for clarification on the correct interpretation, and the historical and cultural distance between the authors and the readers of the text led to a struggle in understanding the correct meaning of the text (Gadamer 1975, Ricoeur 1991, Sarker & Lee 2006, Stahl 2014). It was also realized that the reader's historical situation co-determined the text's interpreted meaning, and according to Stahl (2014) this led to the recognition that attaining a "true" meaning of a text is not possible. Neither reader nor author holds enough background information to ensure total overlap of meaning (Stahl 2014). Consequently, hermeneutics is often referred as the theory of the interpretation of meaning (Patton 1990: 114, Butler 1998, Cole & Avison 2007), and over time social scientists have also adapted hermeneutics for understanding everyday written texts, speech acts, and human behaviors (Sarker & Lee 2006).

Hermeneutics is an umbrella term for several different approaches (Sarker & Lee 2006, Cole & Avison 2007). This dissertation mainly follows the thoughts of Gadamer, which positions this work along the constructivist tradition (for more on different hermeneutic traditions, see, e.g., Butler 1998, Cole & Avison 2007). Butler (1998) refers to Gadamer's (1975) ontological theory of understanding when he underscores that the understanding itself is realized in language, and the realization of understanding is interpretation. In other words, all understanding is

interpretation, and all interpretation takes place in the medium of language (Butler 1998). As Lee (1994) and Stahl (2014) argue, hermeneutics, emphasizing understanding, is suited for the social sciences that aim to understand human activity, not to predict it. From this perspective, it is not surprising that in the constructivist research tradition, the aim is not to test or verify existing theories but rather to identify new concepts and findings tied to the studied contexts (Orlikowski & Baroudi, 1991). Theories and frameworks have been utilized in this thesis mainly as a lens through which to make sense of the collected data. They have also helped to form a pre-understanding of the area of study, guide data collection, and develop coding schemas for data analysis (for more on the upfront theory component, see Sarker *et al.* 2013).

There are no explicit guidelines in hermeneutics regarding how to conduct the actual data analysis, and some researchers use analysis procedures from other methodologies, such as discourse analysis (Dickey *et al.* 2007) or open coding from grounded theory (Tingling & Parent 2004). No specific methodological school was followed in studies I–IV, but instead the general principles of coding and indexing were employed, which are the most widely used practices in qualitative data analysis, as stated by Miles and Huberman (1994). NVivo 10 software was used in the process to manage codes and categories in studies I–IV, but none of the automated classification tools were used. An example how taxonomies were formed and linked to the major categories are presented in Table 2. The following subsections introduce the data collection more deeply and clarify how the principles of hermeneutics impacted the process.

Table 2. Examples of indexing and forming taxonomies (I, published by permission of Association for Information Systems)

Examples	Taxonomies generated
I made the test and I got my personal report. I still don't understand what "coaching" are you talking about in this survey? I want to activate the coaching, from which I heard now for the first time. It wasn't mentioned in the health report mail.	Had not noticed -> Unintentional -> Effort -> IT
I haven't watched the TV-series, so I don't know well enough of what this is all about. Health and well-being are close to my heart anyway.	TV-show -> Uninformed -> Context
When I moved away from home, my lifestyle changed, and it took me a while before I understood to try what things suit me best. Now that I sleep, eat, and exercise better than before, I feel better and have more energy. I believe that when taking care of myself, I'm able to influence the future	

Examples	Taxonomies generated
In the test there were a lot of questions to which you simply cannot give one right answer, and in some sections the options that I had to choose from were totally rubbish	Test instruments -> Credibility -> Affect
It was very nice and I'll bet that many will get help from this to start changing their lifestyle for the better.	Positive -> Un-categorizable

Virtual health check data collection

Participants in Study I were recruited through an e-mail invitation to an online survey among the users of virtual health check in November 2012. Virtual health check and coaching were introduced as part of a lifestyle television series, which was broadcasted on a Finnish national channel during 2012-2013. In the series the participating celebrities would first take the virtual health-check in order to estimate their current lifestyle and how it affected their well-being. After determining the baseline they took part in lifestyle improvement training. Finally, in the last episode of the series, the health check tests were taken again and results were discussed.The 2012-2013 season focused on the mental well-being and stress control. The virtual health test and e-mail coaching were both freely accessible to the public.

Data were collected over a period of seven days using an online survey software tool (Webropol). The survey consisted of demographic questions, seven-point Likert scale items, and open-ended questions. The data in Study I include the textual responses of 2,543 participants, who gave feedback to either or both of the two open-ended questions in the survey (optional):

- Please provide a reason/reasons why you are not interested in activating the virtual health coaching
- Please provide open feedback regarding the system.

Three-quarters (77.0%) of the respondents were women, and more than two-thirds (71.7%) were over 50 years old. The majority of the respondents were either employed (45.5%) or retired (38.1%), and less than three-quarters (22.6%) of the subjects had a university degree. The data of Study I do not include the answers from the users who actually participated in the virtual health coaching; consequently, this did not allow comparisons of the demographics between the groups. Or and Karsh (2009) reviewed 185 articles related to consumer health IT acceptance, and their findings revealed that age did not have a consistent influence on adoption intention, although from 39 studies, 19 indicated that a higher age is

more likely to be linked to rejection than acceptance. According to Or and Karsh (2009), gender was the second most studied variable, but in the majority of studies (84%), it did not have a significant effect on acceptance. Higher education had an effect on increasing consumer health IT acceptance in 68% of the studies (Or & Karsh 2009).

The first dataset for Study I was retrieved from the question "Please provide open feedback regarding the system." The data consisted of an unexpectedly vast amount of positive feedback, which did not appear to make sense according to the pre-understanding of BCSS research and technology acceptance research. Although technology acceptance models do not have an attitude construct (e.g., Davis 1989, Venkatesh *et al.* 2003), it was expected that the data would consist merely of direct criticism toward the usefulness and usability of the system. *Ease of use* and *usefulness* are seen as the key constructs affecting behavioral intention to use the technology (Davis 1989, Venkatesh *et al.* 2003). Cole and Avison (2007) argue that one of the benefits of hermeneutics is the freedom to pursue anomalous findings. Desire to make sense of the data was the underlying motive in Study I, similar to that in Sarker and Lee's (2006) hermeneutic study.

During the second hermeneutic circle in Study I, additional textual data were received from the survey question "Please provide a reason/reasons why you are not interested in activating the electronic health coaching." The question offered 10 different choices for non-adoption, of which one was the open-ended "Other reason." It is fairly common in the hermeneutic research tradition that themes and categories change during iterations, and researchers gather more data between the hermeneutic circles (e.g., Sarker & Lee 2006). It was decided that these new data would be analyzed similar to the way the previous dataset was. Participants could give several reasons for rejecting the electronic coaching. Table 3 presents exemplary responses from two individuals who submitted answers to both open-ended questions.

Table 3. Example responses to open-ended questions (I, published by permission of Association for Information Systems)

Other reason	Open feedback
I live abroad	I have healthy living habits. I don't drink alcohol, and I've used decades of different health foods, I've exercised throughout my life, I'm wealthy. Why does the eHealth check gives me only 81 years of expected lifetime? My father is already 90-years old and smoked for 60 years. My mother died of Parkinson's at 85-years old. Previous test gave lifetime expectancy of 92 years??? This is why I don't trust your vague tests that are inconsistent and don't take into account essential matters, for example, I eat omega-3 capsules daily and you don't ask anything about that, only about eating fish. Isn't it the same thing? If I select "I don't eat fish," the lifetime expectancy slumps. You don't take any dietary supplements into account, like vitamins D,C, B etc... Genetics affects, according to medicine, about 70% to lifetime expectancy.
Bad timing	On the previous page there was a question if I'm going to activate eHealth coaching later. I didn't notice this opportunity at all when I did my test.

The given responses were separated from the user information and merged into one data source. Socially constructed entities' existence depends on people, but they outlive and transcend the individuals who are sustaining them at any point in time (Sarker & Lee 2006). In other words, the respondents do not "own" the meaning of the text, and texts can be interpreted independently.

Stahl (2014) claims that highlighting unexpected findings that force readers to reflect on their assumptions is one of the main evaluation criteria for interpretivist IS research. Hermeneutic methods make use of the anomaly through gaining a better understanding of the information in context (Trauth & Jessup 2000, Cole & Avison 2007). Hermeneutics aims to transcend existing notions about a given phenomenon by actively challenging the perceptions of current knowledge (Cole & Avison 2007).

Onnikka data collection

The PrevMetSyn research project was a randomized lifestyle intervention study with two different counseling groups: A, with eight group counseling visits and B, with two group counseling visits. Group C was the third experimental group that used the BCSS without any face-to-face counseling. A total of 12,500 invitation letters were sent to Finnish citizens in the Northern Ostrobothnia hospital district area. The selected study subjects were working-age men and women who were

overweight or obese, with or without metabolic syndrome. A total of 259 Onnikka users were divided into five different starting groups, who started the experiment at different times between March 2013 and March 2014.

User interviews were carried out in three different hermeneutic cycles. The dataset for Study II consists of the first set of interviews. Twelve individuals took part in the interviews between June 5 and 7, 2013, in their 12th intervention week. The second set of interviews was conducted between November 6 and 21, 2013. At the time of the interviews, these 12 subjects were in intervention weeks 25–27. The third set of interviews was conducted between September 22 and October 21, 2014; this group contained 20 participants—four individuals from each of the five different starting groups. Nine subjects in this last cycle were between intervention weeks 30 and 52, and for 11 subjects access to the system had already ended, ranging from 2 to 27 weeks afterthe end of BCSS intervention period. One of the selected subjects ended his participation during the PrevMetSyn research project, and therefore the interview material used in studies III and IV include the responses of 43 Onnikka users instead of 44.

The demographics of the interviewed Onnikka users, their system use adherence, and their BMI information are presented in Table 4. Participants were recommended to log into Onnikka at least once a week, and subjects who have 100% adherence in Table 3 logged into the system weekly throughout the whole 52-week intervention period.

Table 4. The demographics of the interviewed Onnikka users (III, published by permission of Elsevier)

ID	Intervention week	Gender	Age	Baseline BMI	Counseling group	Tailored	System logins	Use adherence
01	12	Male	44	28.9	A	Yes	154	90%
02	12	Female	49	32.9	A	Yes	99	98%
03	12	Male	40	28.3	A	No	31	33%
04	12	Female	47	32.8	A	No	11	6%
05	12	Female	58	30.6	B	Yes	81	88%
06	12	Male	46	31.0	B	Yes	74	94%
07	12	Male	55	32.0	B	No	70	96%
08	12	Female	56	30.3	B	No	74	94%
09	12	Female	46	28.3	C	Yes	15	8%
10	12	Male	34	32.1	C	Yes	36	67%
11	12	Male	53	30.0	C	No	60	83%
12	12	Female	57	30.0	C	No	99	96%
13	25	Female	58	27.8	A	Yes	57	65%

ID	Intervention week	Gender	Age	Baseline BMI	Counseling group	Tailored	System logins	Use adherence
14	25	Female	53	27.4	A	No	14	19%
15	25	Female	22	33.4	B	Yes	61	17%
16	25	Female	42	33.9	B	No	166	92%
17	25	Female	48	30.4	C	Yes	134	92%
18	26	Male	42	27.6	A	No	39	38%
19	26	Male	58	34.8	B	Yes	56	56%
20	26	Male	44	34.8	C	Yes	39	40%
21	26	Female	42	28.5	C	No	43	38%
22	27	Male	30	27.9	A	No	72	96%
23	27	Male	52	30.2	B	No	62	88%
24	30	Female	46	32.0	C	No	24	35%
25	31	Male	30	29.7	A	Yes	76	83%
26	31	Female	46	33.1	A	No	272	92%
27	32	Male	30	32.8	B	Yes	24	38%
28	43	Male	46	28.5	A	Yes	63	94%
29	43	Female	58	31.5	C	Yes	86	40%
30	44	Male	36	31.4	B	No	162	98%
31	44	Female	49	31.5	C	No	44	35%
32	52	Female	46	27.2	A	No	49	83%
33	+2	Male	54	27.2	C	Yes	66	71%
34	+3	Male	50	27.8	B	No	13	12%
35	+4	Female	50	29.5	C	No	17	23%
36	+18	Male	33	31.6	A	Yes	2	4%
37	+18	Female	58	29.7	C	No	74	96%
38	+19	Female	46	30.8	A	Yes	17	19%
39	+19	Male	54	30.6	B	No	187	100%
40	+27	Male	55	32.2	A	Yes	33	19%
41	+27	Male	45	30.4	B	Yes	23	27%
42	+27	Female	61	29.9	B	No	500	100%
43	+27	Female	56	28.5	C	Yes	401	100%

The interviews were in-depth and were based on an evolving set of primarily semi-structured questions (Appendix B). All the interviews were conducted via phone and were recorded and transcribed.

The constructivist hermeneutic research tradition sees the researcher to always be implicated in the phenomena being studied, and he/she can never assume a value-neutral stance (Orlikowski & Baroudi 1991). Klein and Myers (1999) underscore that what is important is the acknowledgment of this relationship between the researcher, the subjects, and the phenomena and explicating it as part

of the research. The following seven guidelines proposed by Myers and Newman (2007) were applied when conducting the interviews:

1) Situating the researcher as an actor. Before the beginning of the actual interview, the researcher introduced himself, explained the procedure of the interview and how the collected data would be used, and explained how to contact him afterwards. The researcher emphasized that he was neither a health professional nor involved in the system's coding process and therefore was an independent actor regarding Onnikka.

2) Minimize social dissonance. During the conversation, the interviewer sympathized with the life situation of the subject and openly made corresponding remarks concerning his own life. In Finland, where the interviews were conducted, society is relatively "flat," so no extra preparatory effort was needed to minimize the social dissonance related to, for instance, age, gender, or social status.

3) Represent various "voices." Before the interview, Onnikka's login information was used to identify a wide variety of active and non-active users but at the same time to keep a balance between males (n=21) and females (n=22); subgroups A (n=15), B (n=14), and C (n=14); and whether a subject received tailored additional information (n=22) or not (n=21). During the last stages of this research case, the detailed usage amount of different system tools were also utilized to select subjects for interviews. Interviewed subjects' ages ranged from 22 to 61 (M=47.1), their baseline BMI ranged from 27.2 to 34.8 (M=30.5), and the total number of system logins ranged from 2 to 500 (MED=61). The sampling method is best described as *maximum variation (heterogeneity) sampling* (Patton 1990: 234), where the strategy is to capture and describe central themes that emerge from the heterogeneity.

4) Everyone is an interpreter. Interpretive research holds the idea that the world is socially constructed and that gathered results should not be seen as indisputable facts. Simple and broad questions, such as "How has it been using Onnikka?", were asked in the first part of the interview to relax the interviewee and to obtain his/her initial thoughts regarding the system. During the course of an interview, more detailed questions were asked, such as regarding the use experience with a certain tool or perception of a particular persuasive feature.

5) Use of mirroring in questions and answers. Even though semi-structured lists of questions had been prepared, mirroring was used during the course of the interviews. The order of questions and their exact wording could vary according to the themes that the subject was describing. Moreover, if the subject had not used

certain tools, or he/she had difficulty remembering them, some of the questions were omitted.

6) Flexibility. Participants were encouraged to speak spontaneously, and there were no time limits for the interview. The duration of a single interview varied from 25 minutes to nearly two hours.

7) Confidentiality of disclosure. In each study, participation was voluntary, and nobody was coerced into participating in the research. Permission to record the interview was gained before starting the actual interview. To ensure confidentiality, only research numbers were included in the recordings so that they could be linked with the system's user data. The privacy and anonymity of the research participants was closely guarded, and the participants were guaranteed that identifying information would not be made available to anyone who is not directly involved in the study.

2 Theoretical foundation

This section provides the theoretical background for the work presented in this thesis. It describes related frameworks on the design and evaluation of BCSSs and introduces the theories used in studies I–V.

2.1 Behavior Change Support Systems

In his conceptual and theory-creating article, Oinas-Kukkonen (2013) introduced several theoretical frameworks that can be used as a starting point to carry out research on behavioral changes. The design and development of BCSSs is a diverse issue, because it connects to technological services, applications, platforms, and functionality; the quality and content of information; personal goal-setting by the end-users; and social networks/environments, among other issues. In many cases, the BCSSs must be always available, as they have to address global and cultural issues with a multitude of standards, habits, and beliefs. BCSSs are deeply involved with the persuasive technology research field, meaning that they do not merely involve collecting and transferring information, but rather they support their users to achieve the behavior change at which they are aiming. By a definition, BCSS do not use deception or coercion when persuading its users (Oinas-Kukkonen 2013). These types of systems employ various strategies to influence users' behaviors and attitudes. Oinas-Kukkonen (2013) refers to 14 different behavior change-related theories or models in his article. This section introduces the theories and models emphasized in this dissertation.

The acceptance and adoption of information technology has been often referred to as the most mature research stream in the IS literature (Kroenung *et al.* 2013). The dominant model in this area is the Technology Acceptance Model (TAM) (Davis 1989), but several other models have been developed and refined (e.g., Venkatesh & Davis 2000, Venkatesh & Brown 2001). Venkatesh *et al.* (2003) reviewed eight acceptance theories and their extensions and formulated and validated a United Theory of Acceptance and Use of Technology (UTAUT). The majority of these models are based on the theories of reasoned action (Fishbein & Ajzen 1975) and the theory of planned behavior (Ajzen 1991). Kroenung *et al.* (2013) underscores that these theories concentrate on two paradigms: first, the user's conscious evaluation (the formation of beliefs and attitudes) about using technology and seconds the premise that intention activates IT use (Venkatesh *et al.* 2003, Jasperson *et al.* 2005).

The ability to impact users' attitudes is important, since as Oinas-Kukkonen (2013) stresses, a change-in-full occurs only when an attitude change takes place. The Elaboration Likelihood Model (ELM) (Petty & Cacioppo 1986) puts forth that people are likely to make their judgment on peripheral cues if they are less motivated or unable to judge the message from its contents. Direct persuasion has been shown to be more enduring (McGuire 1973, Petty & Cacioppo 1986), but in the current information overflow, indirect routes are used increasingly more often than before (Oinas-Kukkonen & Harjumaa 2009). In addition, Distraction Conflict Theory (DCT) suggests that interruptions result in deteriorating performance, and they may also result in the loss of working memory contents or confusion between cues in memory, which further inhibits decision performance (Speier *et al.* 2003).

Persuasion has traditionally been regarded as a communication process in which a persuader sends a persuasive message to a persuadee or audience (Bostrom 1983, Simons *et al.* 2001), but other change types are also needed. Behavior change is often a long-lasting process that requires commitment and compliance from the user (Oinas-Kukkonen 2013). According to Oinas-Kukkonen (2013), a one-off behavior change can be easier to achieve than a long-term behavior change. As Oinas-Kukkonen (2013) underscores, in some cases where users, in spite of proper attitudes, may lack the skills to put their knowledge into practice, BCSSs should aim to activate several change types simultaneously.

Making commitments will help users change their behavior, and Oinas-Kukkonen (2013) refers to Cognitive Consistency Theory (Festinger 1957, Fraser *et al.* 2001), which claims that psychological inconsistency disturbs people, and they feel obliged to reorganize their thinking and restore consistency. In addition, Cialdini (1993) has presented six persuasion principles that trigger compliance, or, in other words, that make people respond favorably to a request made by another person. According to Cialdini (1993), the majority of persuasive tactics fall within six categories: reciprocation, commitment and consistency, social proof, liking, authority, and scarcity. These principles are used in human communication to trigger wanted behavior, that is, to cause automatic response in the receiver. Individuals often respond to these triggers without thinking by using rules of thumb or learned stereotypes. Cialdini (1993) also emphasizes that, if people have enough capabilities and motivation, they may also react to triggers in a controlled way, meaning a tendency to react on the basis of a thorough analysis of the information.

2.2 Persuasive Systems Design model

Oinas-Kukkonen and Harjumaa's (2009) PSD model is a design and evaluation tool for BCSSs (Oinas-Kukkonen 2013). The model includes seven postulates of persuasive systems as well as analyses of intent, event, and strategy of persuasion. It also defines 28 potential system features, which are divided into four categories: primary task support, dialogue support, credibility support, and social support (Figure 5).

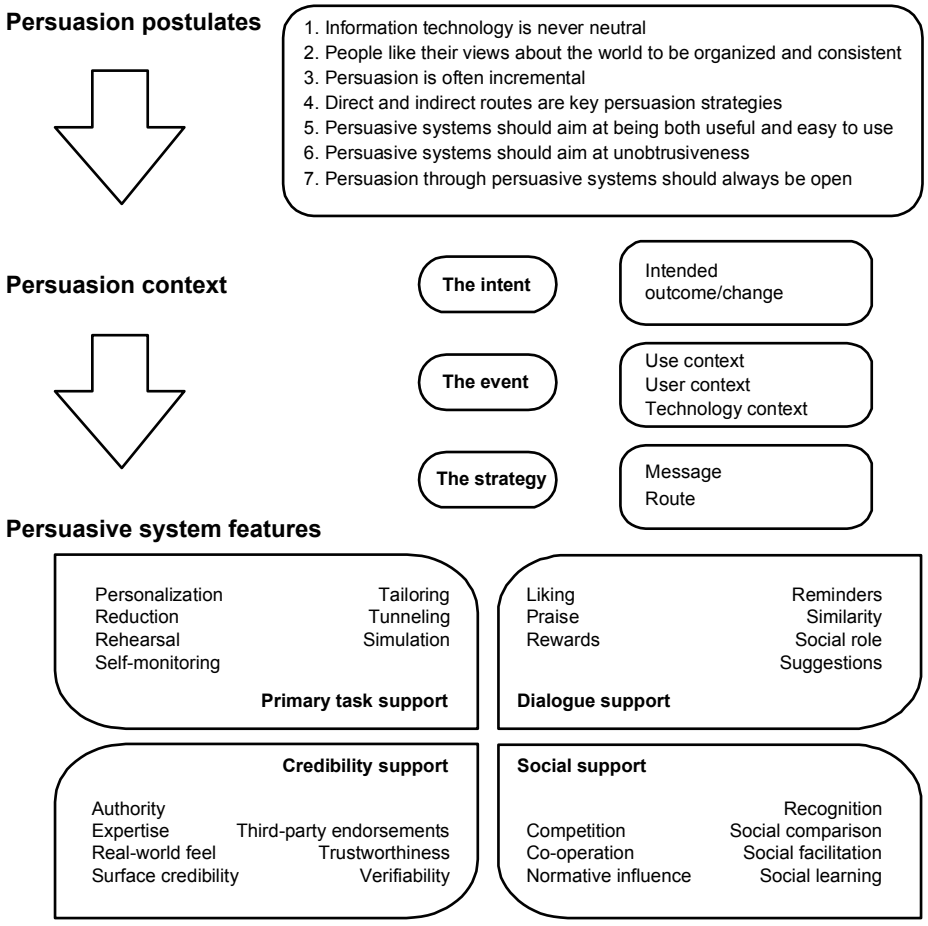

Fig. 5. PSD model primarily based on Oinas-Kukkonen (2013)

According to Oinas-Kukkonen (2013), before analyzing the context or considering persuasive features, the designer should obtain a deeper understanding of persuasion on a postulate level. The postulates should be thought of as main statements of system design rather than detailed instructions (Oinas-Kukkonen 2013).

The fifth postulate "Persuasive systems should aim at being both useful and easy to use" is based on the well-known determinants of the Technology Acceptance Model (TAM) by Davis (1989). If a system is useless or difficult to use, it is most probably hardly persuasive at all.

The first postulate is that "Information technology is never neutral"; rather, it is always influencing people's attitudes and behavior, whether or not it is intended (Oinas-Kukkonen & Harjumaa 2009, Oinas-Kukkonen 2013). According to Harjumaa (2014), this postulate states that persuasion should not be considered as a single act but rather as a process, as the background theories by McGuire (1973), Petty and Cacioppo (1986), and Simons *et al.* (2001) suggest. This postulate relates closely to postulate seven: "Persuasion through persuasive systems should always be open" (Oinas-Kukkonen 2013). According to Harjumaa (2014), this postulate originates from Fogg (2003), Cassell *et al.* (1998), and Miller (2002), who argued that persuasion allows people voluntary participation in the persuasion process. These two postulates underscore how ethical issues should not be forgotten, and they are an inseparable part of BCSS design.

Three PSD model postulates are based on findings in psychology. The second postulate states that "People like their views about the world to be organized and consistent," and, according to Harjumaa (2014), it originates from Cognitive Consistency Theory (Festinger 1957, Fraser *et al.* 2001) and Cialdini's (1993) principle of commitment and cognitive consistency. The third postulate "Persuasion is often incremental" means that it is easier to initiate individuals into doing a series of actions through incremental suggestions rather than a one-time consolidated suggestion. According to Harjumaa (2014), this postulate does not originate directly from any of the existing key theories but has been stated by Mathew (2005). The fourth postulate "Direct and indirect routes are key persuasion strategies" derives from Petty and Cacioppo's (1986) Elaboration Likelihood Model (ELM) and claims that using an indirect route in persuasion is one of the key persuasion strategies. The sixth postulate also originates from the ELM and states that "Persuasive systems should aim unobtrusiveness"; avoid disturbing users while they are performing their primary tasks. The principle of

unobtrusiveness also means that the opportune (or inopportune) moments for a given situation should be carefully considered.

The second main element in the PSD model is the analysis of persuasion context, which includes recognizing the intent of the persuasion, understanding the persuasion event, and defining the persuasion strategy (Oinas-Kukkonen 2013).
To analyze the **intent** of a BCSS, as part of persuasion context analysis, Oinas-Kukkonen (2013) suggests using the Outcome/Change matrix (O/C matrix). The O/C matrix (Table 5), developed by Oinas-Kukkonen (2013), helps in analyzing the intent and the outcome of a persuasive system. Successful outcomes in the matrix are the formation, alteration, or reinforcement of attitudes, behaviors, or compliance. A forming outcome (F-Outcome) stands for the birth of a pattern for a situation that did not previously exist. In practice, stopping a behavior also results in a new behavior (F-Outcome). An altering outcome (A-Outcome) stands for changes in a user's response to an issue, like increasing exercise. A reinforcing outcome (R-Outcome) stands for the reinforcement of current behaviors or attitudes, which makes them more resistant to change. The importance of reinforcement is evident when treating addictions, such as smoking or alcohol abuse, where the BCSS user needs support to continue with the new behavior. For another related matter, BCSS can be built on a therapy routine that requires a great deal of compliance from the user.

Table 5. Outcome/Change design matrix based on Oinas-Kukkonen (2013)

	F-Outcome	A-Outcome	R-Outcome
C-Change	Forming an act of complying	Altering an act of complying	Reinforcing an attitude
B-Change	Forming a behavior	Altering a behavior	Reinforcing a behavior
A-Change	Forming an attitude	Altering an attitude	Reinforcing an attitude

In the O/C matrix, the changes are also divided into three categories: a change in the act of complying, a behavior change, or an attitude change (C-, B-, and A-Change, respectively). The goal of the C-Change is simply to make sure that the person complies with the system's requests. The goal of a healthcare application can, for instance, guarantee that its user takes his/her daily medication. A system supporting a B-Change aims to elicit a deeper behavior change rather than mere compliance. A one-off behavior change is naturally easier to achieve, whereas a long-term behavior change is clearly more difficult. The goal of the A-Change is to influence a person's attitudes rather than just their behavior.

Oinas-Kukkonen and Harjumaa divide analyzing the **event** into three dimensions: understanding the use context, user context, and technology context. The use context holds within domain-dependent features; for example, in the health and wellbeing domain, this normally means involving healthcare professionals in the design process and creating content for the system (Harjumaa 2014). The user context includes user-dependent features, such as the user's goals, motivation, lifestyle, and others, whereas the technology context includes technology-dependent features. New technologies become available at great speed, and the opportunities and risks need to be understood thoroughly.

According to Harjumaa (2014), the understanding of **strategy** holds basically the same as the third postulate: direct and indirect routes are key persuasion strategies. Especially if the use context is challenging in such a way that the user cannot carefully evaluate the content of the message, it is important to support the indirect route.

The third main element in the PSD model are the 28 design principles for persuasive system content and functionality. As mentioned, these features are divided to four categories: the primary task, dialogue, system credibility, and social support.

The persuasive features in the **primary task support** category aim to reflect an individual's behavior goals and track progress toward them. This category also covers essential issues such as reducing the cognitive load and disorientation in system use. According to Harjumaa (2014), all design principles in this category are based on the work of Fogg (2003)—more precisely on the tool category.

The **dialogue support** category consists of persuasive features that are related to human–computer interaction and user feedback. It outlines the principles that keep the user active and motivated when using the system. According to Harjumaa (2014), the design principles in this category are partly based on Fogg (2003) and more specifically on the social actor category (attractiveness, similarity, and praise) and media category (virtual rewards). Reminders and social role are novel design principles, according to Harjumaa (2014).

The **credibility support** category describes features that help in the design as more credible and thus more persuasive systems. A user should be able to trust the given information, accept the system's advice, and believe that they will lead to aimed outcomes. According to Harjumaa (2014), the design principles in this category have been adopted and modified from Fogg (2003).

Persuasive techniques in the **social support** category aim to motivate users by leveraging social influence. Technology-mediated communications can aid in

forming and maintaining online relationships, which in turn facilitate social support (Lehto 2013). According to Harjumaa (2014), these principles have been adopted from Fogg's (2003) principles on mobility and connectivity.

2.3 Flow experience and user engagement

Flow experience can be described as a state in which a person is fully immersed in an activity with a deep sense of control but without reflective self-consciousness. The steps of the activity are perceived to be natural, and they feel as if they occur without conscious thinking. The action is running smoothly toward a person's goals without much effort. The activity feels enjoyable and rewarding in itself (Engeser and Schiepe-Tiska 2012). The Flow concept originates from Csikszentmihalyi's (1975) work, and he makes a distinction between enjoyment and pleasure. Pleasure is a feeling of contentment when all the basic needs are fulfilled, whereas enjoyment is a feeling when a person has gone beyond his old limits and has achieved something unexpected and new. Many subjects that Csikszentmihalyi interviewed underwent much effort for the activity that produced flow experience. According to Csikszentmihalyi (1990), when experiencing flow the "self" becomes complex and the person learns to become more than what he was before. In other words, through flow we are extending our individual limits, and this is the way the "self" grows. It is precisely this notion of extending individual boundaries that is the motivation to combine BCSSs with flow experience.

The definition of flow has a high level of agreement (Engeser & Schiepe-Tiska 2012), but as Finneran and Zhang (2005) argue, in IS research there is no consensus on what the antecedents or consequences of flow experience are. Nearly a decade later Hamari & Koivisto (2014) measured flow in the context of gamification, and they too came to the conclusion that there is no sufficient evidence about causal relationships between the components of flow. Finneran and Zhang (2005) present how flow experience is conceptualized, operationalized, and measured in numerous ways when studying computer mediated environments, and as a solution they suggest using qualitative approaches. In Study II, qualitative data were collected using components from Oinas-Kukkonen *et al.*'s (2011) Webflow model as a basis for generating questions for the semi-structured interview. Webflow is a research vehicle based on the works of Csikszentmihalyi (1975), Novak *et al.* (2000), and Trevino and Webster (1992). Oinas-Kukkonen (2011) defines Webflow experience as follows:

Webflow is an optimal perceived user experience which improves a web user's orientation and navigational use, as well as vice versa, and which is predicted by balanced user skills and the feeling of the web to be enjoyably challenging, the feeling of being in control of web use, and the perceived ease of use and usefulness of the web.

Webflow-based surveys have been conducted in mobile environments, as in early wireless access protocol (WAP) (Oinas-Kukkonen 1999) and modern smartphone implementations in the healthcare information system domain (Oinas-Kukkonen *et al.* 2011).

In this thesis flow is used as a representative of user engagement, although engagement is undoubtedly much broader concept. Engagement as a term has been used in various ways, which creates challenges to synthesize the proposed measures and models (Yardley *et al.* 2016). According to Yardley *et al.* (2016) engagement is often described as intervention use and usability, and factors that influence these. This kind of distinction however dismisses the emotional involment and commitment. Flow motivates engaging into an activity "for its own sake" (Csikszentmihalyi 1990).

Even though flow is described as the optimal experience, it does not mean that flow is an exceptional "once in a lifetime experience." Flow can be part of everyday life. As Pilke (2004) discovered in her study, flow is not familiar only when playing games or surfing on the web but also in other ICT-related activities, such as programming, writing, and image editing can produce flow. Csikszentmihalyi (1990) uses the term "autotelic personality" to explain how some individuals can achieve flow in a variety of activities, some of which most of us would think of as boring or even oppressive. Individual differences can generate different flow experiences even though the activity is the same (Finneran & Zhang 2005). Csikszentmihalyi (1988) argues that the autotelic personality is not something that individuals are necessarily born with, and anyone can improve their flow experience skills with practice. Although the autotelic personality is an essential element in Csikszentmihalyi's (1990) Flow theory, few researchers include it in their models (Finneran & Zhang 2005). Even the popular instrument for measuring flow, the Flow Scale-2 (DFS-2) by Jackson & Eklund (2002), does not include the autotelic personality as presented by Ross & Keiser (2014).

2.4 Habit formation

In the IS research field, habits have been studied mainly from the viewpoint of IT adoption (e.g., Polites & Karahanna 2012, 2013, Wilson & Lankton 2013). According to Wilson and Lankton (2013), the findings related to habit strength and future behaviors can be split between studies that see habit as a moderating effect on the intention–behavior relationship (Limayem *et al.* 2007, Limayem & Cheung 2008) and others that model direct effects (Limayem & Hirt 2003, Kim & Malhotra 2005, Lankton *et al.* 2010, Wilson *et al.* 2010, Pahnila *et al.* 2011, Venkatesh *et al.* 2012).

Only a few studies in the IS research field have focused on the methods to form and interrupt habits; for example, Polites and Karahanna (2013) give recommendations on how old system habits can be disrupted and how to encourage new system habits in a work-related organizational context (Polites & Karahanna 2013). When studying habits in the BCSS context, a new layer of perspective is required. It is not only the IS use that is under a microscope but also how it enhances habit formation in real-life settings. Study IV emphasizes, in addition to IS BCSS use habit, whether individuals can form healthy habits by themselves with the help of a behavior support system.

Habits are conceptualized in psychology as behavioral patterns enacted automatically in the context in which the behavior has been repeated consistently before (Verplanken & Aarts 1999, Wood & Neal 2009, Lally & Gardner 2013). According to Lally and Gardner (2013), the concept of automated behavior is rooted in classical behaviorism (e.g., Thorndike 1911, Skinner 1938, Hull 1943), and although a habit is known to affect behavior, promoting habit formation is a relatively novel research area in the health psychology field (Lally & Gardner 2013, Gardner 2015). Gardner (2015: 4) sees a habit

> *as a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations.*

Habit is an impulsive pathway, where context–behavior associations prompt behavior with minimal forethought rapidly and efficiently. On a reflective pathway are reasoned cognitions, which direct behavior slowly with deliberate effort. When a habit forms, action control transfers to environmental stimuli, and reliance on cognitive processes decreases. Therefore, habits should persist even if conscious motivation is diminished. Habits can shield intended behavior from derailment, which might otherwise occur when willpower is depleted. However, Gardner's

(2014) definition emphasizes that a behavioral response is not an inevitable outcome of a habit cue. Contextually stimulated automatic responses can be inhibited consciously with sufficient self-regulatory resources, and behavior may therefore not be a necessary consequence of habit cues (Gardner 2015).

Lally and Gardner (2013) argue that programming alternative responses to cues inhibits old unwanted habits by bringing the decisions to consciousness. Neuroimaging studies suggest that when multiple responses are activated simultaneously, the prefrontal cortex is activated, which is involved in the deliberative direction of actions (Botvinick *et al.* 2001, Yeung *et al.* 2004). The ability to exert self-control is important in addition to reasoned cognitions. When a person is deliberating between the two options, designers of health interventions should ensure that intentions to perform new behaviors remain prioritized at the decision point (Adriaanse *et al.* 2010). This remark pinpoints incisively why persuasion is an important element of health BCSSs.

According to Lally and Gardner (2013), reaching automaticity can be considered the final stage of behavior change. They offer strategies to support the development of automaticity and divide habit formation into four stages, as follows:

1. intention formation,
2. translation of intention into action,
3. promotion of repetition of a new behavior, and
4. facilitating the relationship between repetition and habit formation.

Lally and Gardner (2013) recognize that automaticity is more realistically conceived of as a continuum, but the distinction is useful from a practical perspective. According to Lally and Gardner (2013), for a behavior change, a decision to take action must first be made. Secondly, intention to act has to be translated into behavior. Decisions are significant predictors of the initiation of behavior, but "intention-translation" is not always perfect. Sheeran's (2002) review revealed that among those who intended to engage in a certain behavior, the average rate of performance was just 47%. This gap can be partly explained by lost motivation to perform the behavior, but according to Lally and Gardner (2013), volitional (or "post-intentional") factors are the second class of reasons that can explain why people fail to act on their intentions. These factors are related to the ability to put plans into action and remembering them (Lally & Gardner 2013, Schwarzer 2014b). Thirdly, the behavior must be repeated in the presence of the same contextual cues to form a habit (Wood & Neal 2007, Lally *et al.* 2010, Lally & Gardner 2013). Repetition requires continued intrinsic motivation and the

support of self-regulatory techniques (Lally & Gardner 2013, Michie *et al.* 2009, Rothman 2000). Also, goal-directed actions that generate positive emotions can strengthen commitment to change (Louro *et al.* 2007), and self-monitoring can be one tool to recognize anticipated outcomes (Lally & Gardner 2013). After habit strength peaks, repetition has little impact on habits (Lally *et al.* 2010), and consequently, the fourth stage pertains exclusively to habit formation. The new action must be repeated in a fashion conducive to the development of automaticity (Lally & Gardner 2013), which includes creating salient cues for the activity, emphasis on consistency, reducing behavioral complexity, and avoiding extrinsic rewards—which have the potential to hinder the habit-formation process.

Despite being motivated to perform a new behavior, when an opportunity arises, many individuals act according to their old habits (Lally & Gardner 2013, Wood *et al.* 2005). It is possible for habitual behaviors to be automatic, yet infrequent (Gardner 2015), and these "implicit habits" offer one explanation as to why behavioral interventions typically yield short-term gains, which are likely to erode as old behaviors re-emerge (Gardner 2015, Jeffery *et al.* 2000)^{1,2}. One solution is to avoid any environment that cues unwanted habits (Verplanken & Melkevik 2008, Wood *et al.* 2005), but eventually, rather than trying to forever avoid cues triggering unwanted habits, new alternative responses are needed (Bouton 2000, Lally & Gardner 2013). Vigilant monitoring offers an effective way to inhibit unwanted habits by paying attention to potential slip-ups (Lally & Gardner 2013).

2.5 Ethics

If a BCSS does what it is designed for, it changes users' behavior. System developers should be aware of the power technology exercises over its users (Oinas-Kukkonen 2013). System use can also cause unpredictable consequences despite developers' good intentions. Several different approaches are available to address ethical issues, but how can a system designer choose between them?

This thesis uses the term "ethics," similar to the way Stahl (2012) and Chatterjee and Sarker (2013) do, to indicate abstract and theoretical reflections on moral statements. In other words, ethics can be thought of as the theoretical justification of morality (Chatterjee & Sarker 2013).

Ethics has been traditionally divided into three ethical schools: *consequentialism, deontology theories*, and *virtue ethics* (Stahl 2012, 2014, Mingers & Walsham 2010, Chatterjee & Sarker 2013). One of the fundamental

distinctions within ethics is whether an act is judged in terms of intrinsic rightness or in terms of the consequences that it has (Mingers & Walsham 2010). *Consequentialism* holds that correct actions are ones that maximize the overall good or minimize the overall harm. According to Stahl (2012), the consequentialist ethical theory descended from Jeremy Bentham (2009), James Mill (1829), and John Stuart Mill (2002). The main idea of consequentialism ethics is to compare the aggregated utility and disutility of each alternative option. The ethical decision is the one that maximizes overall utility. In essence, this approach concentrates exclusively on the outcomes or consequences of decisions.

In contrast to the consequential school, the *deontological* school of ethics argues that an action is right if it follows certain rules that are in place (Chatterjee & Sarker 2013). The judgement shifts from the consequences of an act to the act in itself (Mingers & Walsham 2010). According to Kantian deontology (1994), linked to categorical imperative, the ethical evaluation of a maxim depends on whether it can be universalized or imagined as a universal law. Conformance to these rules ensures that an act is ethical (Stahl 2012, Chatterjee & Sarker 2013).

Apart from act-centered theories, *virtue ethics* emphasize the role of character and virtue in moral philosophy (Chatterjee & Sarker 2013, Stahl 2012). Virtue ethics focuses more on the doer of the act rather than the act itself (Stahl 2012). According to Stahl (2012), this ethical school goes back to Plato (1945) and Aristotle (2007) and finds its current instantiations in contemporary virtue ethics (MacIntyre 1985). MacIntyre argues that we are human beings through our socialization within a community, and we gain our ethical codes from that community. Different communities generate their own ethical practices and standards, whether they are cultural, ethnic, or religious. It is never possible to go beyond all traditions to a universal eternal viewpoint (Mingers & Walsham 2010). The focus of virtue ethics is on how one can be a good agent in a context or a community of practice (MacIntyre 1985).

In the persuasive technology research field there are traces of all three main ethical schools. As early as in 1999, Berdichevsky and Neuenschwander presented their guidelines with eight persuasive technology principles. Berdichevsky and Neuenshwander (1999) identify themselves as rule-based utilitarians; in other words, they stipulate ethical rules only if always following them results in more compelling benefits. One example of consequentialism is their sixth principle (Berdichevsky & Neuenschwander 1999: 52):

The creators of a persuasive technology should disclose their motivations, methods, and intended outcomes, except when such disclosure would significantly undermine an otherwise ethical goal.

As an example of virtue ethics, Gram-Hansen (2009) refers to the works of the Danish philosopher K.E. Løgstrup (1905–1981), who defines ethics as an intuitive result of human nature, not a moral rule based on reason. Humans are born with several characteristic features such as benevolence, compassion, trust, love, and open speech (Gram-Hansen 2009).

Although approaching ethics from different traditions, both Berdichevsky and Neuenschwander (1999) and Gram-Hansen (2009) come to practically similar ethical conclusions, which are deontological. Berdichevsky and Neuenschwander (1999: 52) state as their most important "golden rule": "The creators of a persuasive technology should never seek to persuade a person or persons of something they themselves would not consent to be persuaded to do." On the other hand, Gram-Hansen (2009: 202) concludes quite similarly in her article: "Humans must be conscious that any type of human interaction results in a situation where one human becomes responsible for the life of another human being and in accordance with such acknowledgement; humans must strive towards doing to others as they trust others to do to them."

As these examples show, "the ethics of persuasive technology" is not one coherent view. According to Stahl (2012), the challenge is how to use normative insights and understandings that range from implicit intuitions up to elaborate ethical theories, how to live with their inconsistencies and contradictions, and yet how to use them to improve the status quo. As a potential solutions Stahl (2012) suggests establishing arrangements that allow individuals to develop and voice their moral views and to engage with others in ways that are conducive to mutual understanding.

The Value Sensitive Design (VSD) methodology by Friedman *et al.* (2006) is considered one of the most comprehensive frameworks for advancing value-centered research (Yetim 2011b). VSD views ethics as substantially dependent upon human interests and reflecting what people consider important in life (Friedman *et al.* 2006). The key element in VSD is the stakeholder analysis, which can reveal situations in which designers must make tradeoffs between conflicting values (Friedman *et al.* 2006). Stakeholder analysis aims to consider groups that do not have the power to make decisions or to participate in decision-making processes but are nonetheless dependent on the decisions being made (Stahl 2008). It needs

to be noted that the goal of stakeholder analysis is not to involve individuals within the actual process. Discourse ethics, on the other hand, aims to reach a consensus about the moral evaluation of a situation. Participants engage as equals in a discourse (Mingers & Walsham 2010). Mechanisms of discourse ethics rely on the cooperation of the individuals involved, which allow individual differences to lead to a collectively acceptable outcome (Stahl 2008).

3 Research contribution

This section presents the key findings from studies I–V in an article-by-article manner.

3.1 Study I: Uncovering anomalies for non-adoption of BCSS

The results of Study I are organized based on the work by Benbasat and Zmud (2003) on the IT artifact. Open-ended data were classified into four distinct main categories—IT, Affect, Self, and Context—where each category is one step further from the IT artifact (Figure 6. In the following section, the categories are presented accordingly, from the inside layer to the outer-most.

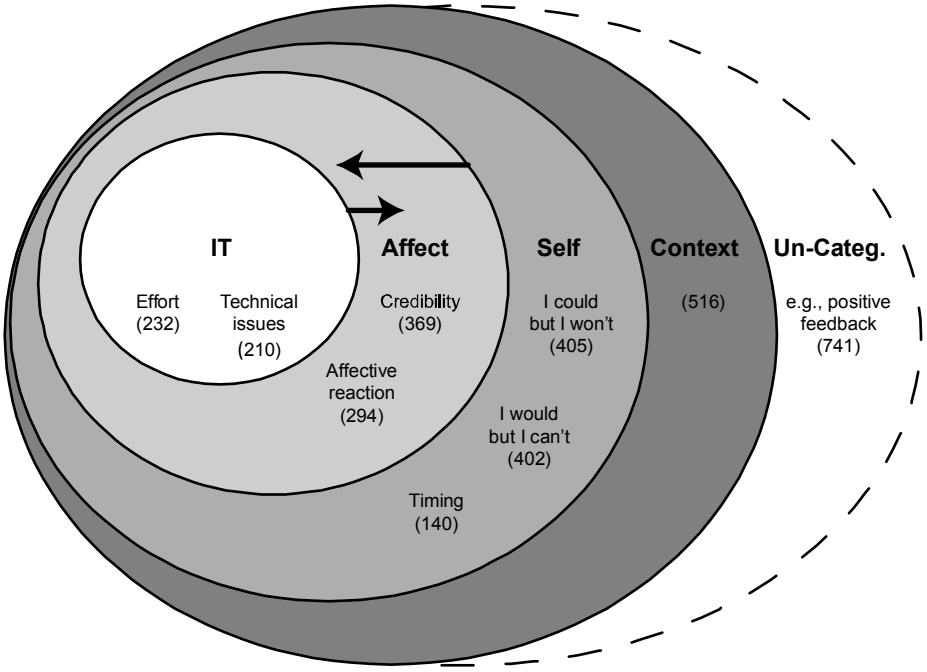

Fig. 6. Categories, subcategories, and the number of responses. Figure modified from Benbasat and Zmud (2003)

IT category

The IT category includes responses in which the BCSS was described as reason for not activating virtual health coaching (Table 6). The subcategory *Effort* was named after Venkatesh *et al.*'s (2003) construct that measures the degree of ease associated with the use of the system. After the participants did the virtual health check, they had the possibility to activate virtual health coaching. Often, participants in this subcategory were puzzled as to whether or not they were part of the virtual health coaching (n=97). Most of them got the notion of not participating in the coaching for the first time when they received the survey. There was also a high number of users (n=90) who perceived that they had made a mistake in the joining process but did not know how to fix the problem. Lastly, in the *Effort* subcategory, there was a group of respondents (n=45) who felt they did not have sufficient skills to activate the coaching from the very beginning.

According to the user feedback in the *Technical issues* category, several participants (n=149) did not receive their personal health reports via e-mail as promised, and many could not activate virtual health coaching because of this, or they had other technical problems with the system. For some respondents (n=31), the technical flaw was caused by issues other than the BCSS (e.g., malfunctioning PC or Internet connection). Lastly in this subcategory is a group of participants (n=30) who did not want to activate virtual health coaching originally but later had second thoughts and could not activate the coaching afterwards, as they experienced technical problems.

Table 6. Examples of the "IT" category (I, published by permission of Association for Information Systems)

Subcategory 1	Subcategory 2	Example
Effort (232)	In or out? (97)	Er?? I think that I activated coaching, at least I was meant to do it and I've been wondering, why I haven't heard anything from there. I expected to have exercise and nutrition guidance.
	Mistake (90)	When I made the test I didn't notice how to join to coaching. Afterwards I couldn't activate coaching, because my e-mail was already in use. I would have wanted to participate.
	Skills (45)	Using a computer is still quite hard for me. I would like to activate the coaching.
Technical issues (210)	Technical problems (149)	It was promised that I would get an e-mail of some sort after the test. Feedback was in the kind of form that it didn't open, so I don't have a clue what you've sent me. I'M TOTALLY LOST.

Subcategory 1	Subcategory 2	Example
	Facilitating conditions (31)	My computer does not function 100% because I have a mobile Internet connection.
	Second thought (30)	System announced that my e-mail was already in use and didn't accept my participation. I did the test the day before and didn't think of joining then. But surely one can change his mind!!??

The collected data suggest that when regarding IS targeted for health BCSS consumers, attention should be paid to the technical functionalities of the system. Numerous responses in Study I indicate how technological issues directly affect to actual use. The study by Or and Karsh (2009) revealed that technical issues have not been seriously taken into account when studying the acceptance of consumer health IT. What Study I emphasizes is that in nearly all technology acceptance studies, the subjects have had user experience of the system, and what is in fact investigated is whether or not they are inclined to continue using the system in the future. The responses in Study I consisted of non-adopters from which a notable number had the behavioral intention to adopt the technology—but not the technological means. For example, the UTAUT and UTAUT2 models by Venkatesh *et al.* (2003, 2012) implicitly presume that the studied system is working properly, and only facilitating conditions are measured. In technology acceptance models, "ease of use" is usually described as an attribute that has an effect on behavioral intention (Venkatesh *et al.* 2003; Venkatesh *et al.* 2012). In this research case, the problems with usability directly affected actual use and not so much through users' behavioral intention. Based on Study I, there were hundreds of people left outside of virtual health coaching, because they did not know how to activate it.

Affect category

The Affect category holds reasons for non-adoption that are related to the emotional and cognitive responses of virtual health check use (Table 7). The category is close to the IT category, since participants justify their decisions by their BCSS use experience (the arrow from the IT layer to Affect in Figure 6 represents the direction of typical argumentation in this category). Credibility is one of the most important issues for criticism in this category. Many respondents (n=186) complained that the health check instruments were unreliable, and often it was stated that there were critical measuring features missing that would have had an effect on the outcome. It was often argued (n=86) that one could not give personal information for the

calculations so that essential parts of everyday life were not taken into account. Several respondents (n=71) specifically questioned the estimation of life expectancy provided by virtual health check, and some (n=57) criticized the underlying health postulates of the test.

In this category there was also a vast number of responses that expressed the affective reaction of the participants. Most of these responses indicated that many people (n=131) used the initial virtual health check as sufficient proof or confirmation of their healthy behaviors. For several participants (n=120), the virtual health report was an eye-opener that was enough to nudge them toward the behavior change process. There were also some (n=23) alarming tones in which participants got depressed after receiving their discouraging results. There were only a few respondents (n=13) who were not affected in any way by the system and therefore rejected the coaching.

Table 7. Examples of the "Affect" category (I, published by permission of Association for Information Systems)

Subcategory 1	Subcategory 2	Example
Credibility (369)	Unreliable instruments (186)	In questions related to nutrition, the size of the respondent was not taken into account, e.g., a small female cannot eat six slices of rye bread, no matter how healthy it is.
	Lack of personalization (86)	In the nutrition part there should have been asked special diets. Because I'm lacto-ovo vegetarian, I don't eat fish. I use oils to get Omega 3, 6, and 9.
	Unreliable results (71)	The test lost its credibility when it gave the life expectancy of 69 years, even though I'm not overweight, don't drink or smoke, and hardly ever get stressed.
	Overall credibility (57)	The part related to nutrition was too one-sided. Is it so, that one survives until an elderly age only by eating fresh fruit and vegetables? That's bogus, I say.
Affective reaction (294)	Reinforcing (131)	Good concept overall, nothing new to me though. I've done the necessary changes years ago, where this coaching is heading to. I did the test just out of curiosity.
	Eye opener (120)	The test was good. It makes you reflect on your own lifestyle and makes you think how to improve it.
	Depressing (23)	When my claimed lifetime expectancy is shorter, than for instance my mom or both of my grandmothers, it makes me almost feel sick mentally, even though I live healthy in my opinion.
	No reaction (13)	It didn't wake any interest whatsoever.

According to these results, non-credibility is one of the major reasons for rejecting a BCSS. Credibility is not part of traditional technology acceptance models (Davis 1989, Venkatesh *et al.* 2003), but in the (PSD) model, it is one of the key categories of persuasion (Oinas-Kukkonen & Harjumaa 2009). The results suggest that one of the possible ways to gain better credibility is to increase the personalization of the system. However, there were many responses in the data indicating that users often have unrealistic expectations, and the system should basically cover every aspect of their lives to provide output that is sufficiently reliable. It is not clear how much perceived non-credibility is actually affected by the system and how much is caused by emotional discomfort. One of the PSD models postulates that individuals like their views about the world to be organized and consistent (Oinas-Kukkonen & Harjumaa 2009), and it is possible that subjects undermine the BCSS's credibility in order to maintain their cognitive consistency (Cialdini *et al.* 1981).

Self category

The Self category (Table 8) holds data where respondents found the reason for not adopting the virtual coaching from themselves rather than from the use of IT artifact (the arrow from the Self layer to IT in Figure 5 represents the direction of typical argumentation in this category). The Self category is further divided into three subcategories. The *I could but I won't* subcategory is related to individuals who would potentially have the required resources to participate in the coaching but for one reason or another were not willing to participate. Most of the respondents (n=187) in this category considered themselves so healthy that they were not in need of coaching. Another large group (n=117) in this subcategory included individuals who felt capable of achieving their behavior change goals without coaching. The last group in this subcategory were "rebels" (n=41), who embraced their unhealthy living habits and did not worry about the consequences of their health.

The subcategory *I would but I can't* includes those participants who found some personal trait, capacity, or external condition that was a barrier to their participation. The most common personal traits (n=200) mentioned were laziness, lack of self-discipline, and stress. This is rather unfortunate, because one of the key themes of the coaching program was mental wellbeing and stress relief. Many respondents (n=118) referred to their personal capabilities, usually health issues, for not activating the coaching. Most of them assumed that they would need to do physical exercise, although there were various training programs that did not

include exercising at all. Some of the elderly respondents commented openly that it is too late for them to start training whatsoever. Also, the external conditions of one's private life were mentioned often (n=84) as a reason for rejecting the coaching. Various (sometimes heartfelt) external reasons surfaced from the texts, such as being a caregiver or the death of a loved one. Interestingly, lack of money was mentioned occasionally, even though the coaching itself was totally free of charge. However, in some responses it was highlighted that money is needed for healthy living as well.

Many respondents commented that when they had to make the decision, they postponed it for a more appropriate time. In this *Bad timing* subcategory, there were many (n=97) who had not yet decided whether or not to participate in the coaching. Others in this subcategory (n=43) said directly that they did not have enough time and were unwilling to commit to the program because of this.

Table 8. Examples of the "Self" category (I, published by permission of Association for Information Systems)

Subcategory 1	Subcategory 2	Example
"I could, but I won't" (405)	Healthy (187)	The test was nice to do even though I'm fine with myself and my life and I live healthy and I'm a positive person. The only thing I could change in my life is to sleep longer, but in my opinion I sleep enough, after all I'm a pensioner, and I can take a nap if I need to. And life is WONDERFUL!
	Self-efficacy (177)	I also know the changes I'd need to do and how to make those, so I like to proceed at my own pace with more flexibility.
	Rebels (41)	It seems alright, but I wouldn't like to give up a few bad habits...Why be too strict. Carefree years are better than years full of rules and plans.
"I would, but I can't" (402)	Personal traits (200)	For several years, I have tried to drastically change my lifestyle, but it always falls apart on my own laziness and lack of self-discipline. Stressful work drains all the energy, taking care of own health suffers.
	Personal capacity (118)	I have such a bad injury in my back that I've had to give up walking, which I loved to do. It also increased my weight to top figures.
	External conditions (84)	The cause itself is good, but I'm bitter that I can't change the hardest issue in my life, my husband's illness. It affects my life so that I can't move or participate outside of our home as much as I'd like to.

Subcategory 1	Subcategory 2	Example
Timing (140)	Bad timing (97)	I did the test with an interested mind and it's possible that at some point I'll join the coaching. Health issues interest me also because of my working history.
	Lack of time (43)	I don't want to commit myself to a program that I might not be able to carry out due to my busy work schedule.

As discovered from the data, there is an important divide between two archetypes of users: "I could use, but I won't" and "I would use, but I can't." Based on the findings, one cannot claim that either healthiness or severe illness is associated with decreased acceptance (Or and Karsh [2009] found a similar discrepancy); rather, Study I suggests that both ends are present. Those who had excellent health did not see the need for the system, but, on the other hand, severe health problems were experienced as unbridgeable obstacles to participation. This is an important finding when considering the perceived usefulness of the system. In the consumer health IT area, the same construct could be kept within two distinctive groups of users, who need to be addressed differently.

Context category and un-categorizable feedback

In this study, the Context category (Table 9) refers not to the virtual health check itself but to the actual health coaching and activities closely related to it. The responses in this category were fairly broad; for example, several participants got annoyed by the TV series that promoted the virtual check and coaching. Clearly, the system designer cannot have an impact on the context of where and how the system is presented; however, it is important to emphasize the importance of detailed information. Users cannot necessarily make the distinction between a system's features and its context. As stated in the PSD model (Oinas-Kukkonen & Harjumaa 2009, Oinas-Kukkonen 2013), it is important to reveal designer bias, since persuasion through BCSS should always be transparent. In this study, some of the users had clearly misunderstood what the virtual health coaching was all about and explained that they were too shy to participate in a TV show and did not want to jeopardize their privacy. Generally, many users in the Context category would have wanted to know more about the actual coaching before making the final decision on participation. Activating the coaching was free of charge, and only an e-mail address was required from the participants. Even though there were "no

strings attached," some users felt that the decision had to be made too spontaneously and were left out of the electronic health coaching as a consequence.

Table 9. Examples of the "Context" category (I, published by permission of Association for Information Systems)

Category	Example
Context (516)	Why are there celebrities in the show? It eats credibility.
	I wish there would be more places to exercise... like schools could be open in the evening.
	I have to search more information what are the obligations of participation and does it cost.

The last major finding in Study I was an unexpected large amount of positive feedback (n=741), which can be seen as contradictory to the traditional view of technology acceptance, as the following quote from Davis (1989) implies: "A system high in perceived usefulness, in turn, is one for which a user believes in the existence of a positive use-performance relationship."

The hermeneutic circle in this study was initiated from the notion that the collected data did not make sense. The unexpected vast amount of positive feedback was the original catalysis for Study I. Positive feedback was usually highly generic, and it seldom reflected specific system features or even the context in which the system was offered. There is nonetheless a clear indication that for many individuals, a positive attitude toward the technology in use is not enough to trigger the actual adoption process. Positive feedback can be understood from the viewpoint of the users who had everything under control or were capable of making the needed behavioral changes without system support. Those who received positive reinforcement from the virtual health check or an inspirational nudge for a lifestyle change did not necessarily feel the need to activate the virtual health coaching. If a user does not perceive the system to be useful, it does not automatically mean that he/she has a negative attitude toward the system. Table 10 summarizes the key anomalies that were considered to be the most valuable findings of Study I.

Table 10. Key anomalies of BCSS non-adoption (I, published by permission of Association for Information Systems)

Category	Anomalies
IT	Technical and usability problems can directly affect actual use
Affect	Perceived non-credibility of a BCSS can be caused by emotional discomfort

Category	Anomalies
Self	Non-adopters consist of two distinct subject groups
Context	Users have challenges in differentiating the BCSS from its surrounding context
Un-categorizable	Positive attitude towards the BCSS does not automatically improve its acceptance

3.2 Study II: Flow experience in the BCSS context

The results of Study II are presented by going through interview questions based on the Webflow model and constructs (Oinas-Kukkonen 2009). Webflow is a single item construct model, which studies the relations between flow and nine elements, as presented in Figure 7. Also, system login data from the twelve participants after 10 weeks of use were included in the analysis.

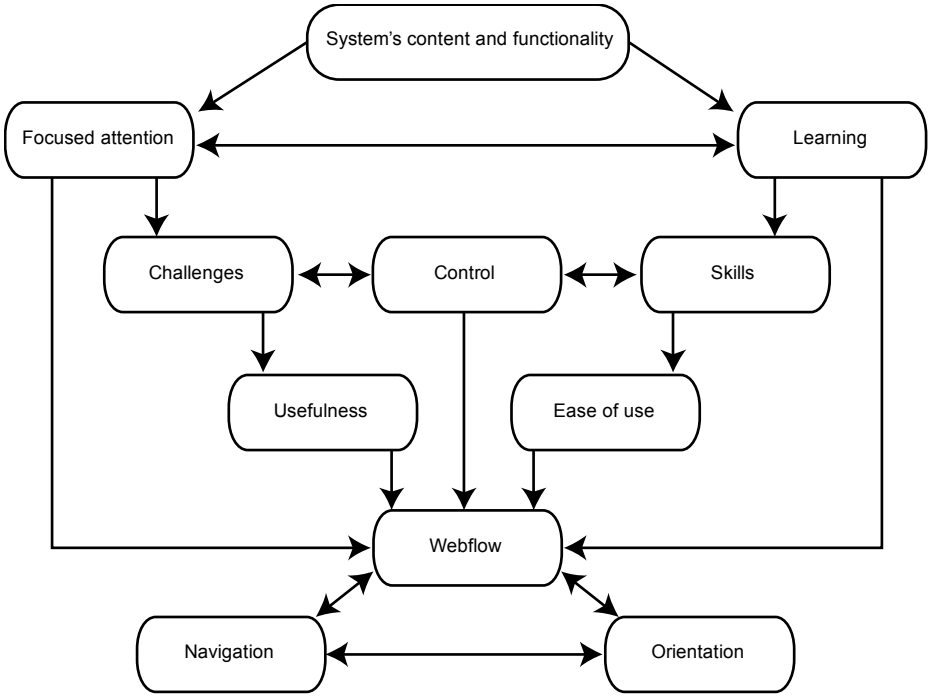

Fig. 7. Webflow model as presented in the study by Oinas-Kukkonen *et al.* (2011)

The **focused attention** question assessed how focused users were when they used the system. Six participants said that they were focused most of the time when using the system, and four individuals perceived that they were not focused during the

system use [*following quotations are published by permission of Insitute of Electrical and Electronics Engineering*].

> *ID 04: I'm an entrepreneur and quite busy all the time... I run through it at home or at work. I don't focus on it too much.*

Two participants said that they were more focused at the beginning of the research project but that recently they had not been focused as much when using the system. In the Webflow model (Oinas-Kukkonen 2000), focused attention is hypothesized to have a direct effect on flow. Eight subjects said that they perceived themselves to have been focused or somewhat focused when they used Onnikka, but only three of them stated that they had reached flow. Focused attention is also an intermediate variable between challenges and the system, since, through persuasive content and functionality, user attention focus may increase (Oinas-Kukkonen 2000). In Study II, focused attention and challenges do not interlink clearly together. It is possible that, since Onnikka also provides tasks outside of the system, completing the tasks does not require focusing on actual system use.

In the Webflow model, **learning** impacts the flow experience directly. Oinas-Kukkonen *et al.* (2011) claim that learning actually plays a dual role when the system is used for acquiring more knowledge. When a user learns, (s)he more likely experiences flow, and when (s)he perceives flow, (s)he more likely perceives her/himself to be learning (Oinas-Kukkonen *et al.* 2011). In Study II, six respondents felt that they had learned new things, and, from these, three experienced flow. The other half felt that the information was familiar from other sources as well. In the Webflow model (Oinas-Kukkonen 2000), learning is an intermediate variable between skills and the system, because users may learn new skills through using the system. In Study II, learning does not have such an obvious link with skills, but then again, only web use skills were enquired about. According to the results of Study II, learning rather goes hand in hand with challenges instead of skills. Subjects who saw Onnikka as challenging enough claimed to learn new things and vice versa. Only one participant out of 12 said that she learned new things from Onnikka but also wanted to be challenged more.

> *ID 06: You'll learn if you do all the weekly tasks actively. At the same time, it makes this [Web system] even more personal.*

Five of the respondents felt that Onnikka was **challenging** enough, and five participants had expected that Onnikka would be more challenging. In the Webflow model (Oinas-Kukkonen 2000), **usefulness** is an intermediate variable between

challenges and flow. Greater challenges mean that consumers perceive the system to be useful, which can in turn cause flow. This study shows somewhat different results than expected. Four respondents stated that the system was useful, but at the same time, they were hoping that the system would challenge them more. Onnikka was reported to be more or less useful for all users in Study II except for one subject. However, two participants' answers revealed that they estimated usefulness on a more general rather than personal level.

> *ID 09: Yes, it's useful... but maybe I would have let it slip through my fingers if I had come across it [outside the research project].*

The reasons for the system's usefulness varied among the subjects. For example, some were keen on monitoring their own progress, while others liked to gather new information.

In the Webflow (Oinas-Kukkonen 2000) model, the feeling of being in **control** over the system is an antecedent of flow. In Study II, nearly all the participants reported experiencing the feeling of control, but only three reported experiencing flow. A feeling of control seemed to resonate with ease of use rather than flow experience. Subject ID 01 who had feelings of insecurity also did not think that the system was easy to use in the beginning.

> *ID 01: Maybe at first I felt [insecure], but not anymore. Nowadays, I use it with my smart phone. I have it in my bookmarks, and in the morning, when I go to the scale, I turn it on immediately.*

Surprisingly, after giving quite similar answers about the feeling of control, the respondents estimated their web use **skills** very differently from one another. Four subjects felt that they were better-than-average users, and five claimed that their web use skills were worse than others. Three subjects could not say whether they had better web skills than other people on average. Most of the participants were middle-aged, and the spectrum of their web use history was wide. Some are very skilled, while others use computers only when they have to.

> *ID 09: I'm definitely not skillful. I don't know English to begin with. I don't surf to any of those sites [on the Web].*

In the Webflow model, ease of use is an intermediate variable between skills and flow (Oinas-Kukkonen 2000), and it hypothesized that when a user has a high level of skills, this implies that the system is **easy to use**, which in turn can cause flow. All the interviewed subjects felt that Onnikka was not difficult to use. Only two

subjects reported they had challenges at the beginning but learned to use Onnikka eventually.

Of the three subjects who experienced flow when using Onnikka, two of them reported being less skillful web users than an average person. This is rather unanticipated, because, for instance, in Pilke's (2004) study, the most frequently mentioned obstacle to the flow experience was insufficient skills in using the system through its user interface. One possible explanation is that, since Onnikka was designed to be as easy as possible to use, a user's skill level did not make a difference to the user experience. Regarding the Flow theory, the most crucial antecedent is that the skills and challenges are in balance with the action. However, as Finneran and Zhang (2005) ask, what kind of skills actually should be measured when studying the flow experience in ICT? In the case of BCSS, it would have been more meaningful to ask about the life management of the particular area the system supports.

> *ID 11: Yes, it is enough of a challenge. It doesn't stop at one spot; rather, it brings new stuff all the time. When, for instance, the theme was exercising, it activated me more [to move]. It starts to become more or less like a habit. It's been good with that.*

The last theme of the Webflow constructs are the perceptions of **orientation and navigation** of the system. The orientation question addressed how easy it was for the user to understand the information that Onnikka offered. Almost all the answers were straightforward, and only one subject was unable to give a definite answer to this question. The participants felt that it was easy to comprehend the information provided by Onnikka.

> *ID 08: Yes. I don't get any feeling of being lost. My workplace's website is far more complicated... but then again, it has to cover so many different areas from this.*

Nearly all the participants also felt that it was easy to navigate in Onnikka. One participant had little problems in the beginning but learned how to navigate in the long run. One respondent found an illogical path when trying to find archived information from previous training weeks but he was able to use the system despite of the found flaw. In the Webflow model, orientation and navigation are antecedents as well as consequences of flow (Oinas-Kukkonen 2000). According to Oinas-Kukkonen's (2011) Webflow definition, orientation and navigational use are improved by flow, but in return, both enhance flow. Neither navigation nor

orientation stimulated any strong opinions or rich feedback from the subjects. In general, both areas were considered to work well without any major hindrances. Webster and Ahuja (2006) use flow constructs to measure whether disorientation or navigation had an effect on user performance and intention to use websites. They found a strong relationship between disorientation, engagement, performance, and intention to use a website. Interestingly, they discovered no difference in disorientation between the simple navigation system and the basic global navigation system (Webster & Ahuja 2006). This may imply that, despite the design of a small and closed web-based system such as Onnikka, the planning of the navigation is no less important than that in vast systems. According to Pöyry *et al.* (2013), in online environments, flow corresponds to exploratory browsing (Pace 2004, Cotte *et al.* 2006), and those users explore new sites to find something exciting and interesting regardless of time and effort (Novak *et al.* 2000, Cotte *et al.* 2006). This could give one plausible explanation of why so few users experienced flow while using the Onnikka system.

According to Csikszentmihalyi (1990), once individuals experience **flow**, they will double the effort to feel it again. In Onnikka's case, the most frequent user in Study II also experienced flow, but still there is not a clear trend that would support this conclusion for the whole study group. In addition to asking whether users experienced flow during BCSS use, the subjects were asked how easy it was for them to experience flow in other activities, such as work or hobbies. Three users said they experienced flow when using Onnikka, and all of them felt that it was easy to achieve flow in other activities as well. Four participants thought that they could reach flow in other activities but not when using Onnikka.

> *ID 04: No, I haven't been able to reach flow... [following question about personal ability to experience flow]. Yes, I do get it at work.*

Five subjects said that it was difficult for them to experience flow to begin with, and for two of them it was not because of their own inability, but rather their life situation prohibited it. Two participants reported that they did not achieve a flow state even though their replies provided strong support for all of the Webflow model's other constructs. In their case, what made the difference was the question about autotelic personality.

> *ID 02: "I think that, for me, it's not that easy. At work, I get interrupted all the time, and at home, I have small children. I'm constantly holding my antennas up... You should ask this question again after 10 years."*

Finally, the participants of Study II were asked to give their opinions about whether the system was hedonic or utilitarian. All twelve subjects said that they found Onnikka to be more of a utilitarian rather than hedonic system. Surprisingly, only one respondent stated that she would like to experience more fun when using the system. Four respondents underscored the contrary—that implementing more entertaining elements would be a step in the wrong direction.

> *ID 06: It goes more to the utility side. Losing weight is serious business. Joyful things must be thought through thoroughly. Bad humor annoys more than it makes you laugh.*

The results of Study II indicate that, despite its well-designed software features and usability, the Onnikka system did not result in a flow experience for most of the participants. This finding contradicts the study by Venkatesh *et al.* (2012), who argue that, in most non-organizational contexts, hedonic motivation is a critical determinant of behavioral intention, and they found it to be a more important driver of use than performance expectancy. Study II shows quite the opposite, and the findings reveal that the area of consumer health information systems is far more complex than is generally currently assumed. The results resonate with those from Yardley *et al.* (2016), who argue that more engagement will not necessarily lead to more *effective* engagement.

3.3 Study III: Persuasive user experiences of a BCSS

Persuasive system features are assumed to enhance participation and engagement with the interventions (Kelders *et al.* 2012); thus, it is deemed beneficial to examine the perceptions and levels of use of such features. The results of Study III are presented according to the PSD model's categories in the following paragraphs.

The user interviews in Study III were carried out in three different hermeneutic cycles. During the first hermeneutic circle, the *Self-monitoring* feature in the "Primary task support" category was considered to be a key reason for using the system. Weight monitoring and food diaries were mentioned often; however, the user experiences with the different tools varied greatly. A total of nine out of 12 who gave feedback on weight management had positive experiences. Many praised the weight graph for making even the slightest weight loss visible and stated that it gave them greater motivation for behavior change. Nearly all the users interviewed in the first hermeneutic circle complained about the use of Onnikka's food diary, which was often said to require too much effort. The general dichotomy between

the weight tool being the most praised and the food diary the most criticized remained the same throughout all three hermeneutic circles. Typically, if users were dissatisfied with a certain tool, they simply stopped using it. One clear exception was Subject 19, who stopped using Onnikka's tools after a negative experience with the food diary. On the contrary, Subject 42 praised the food diary, and she used it every day for the whole year; as a result, she had more food diary entries than all the others combined. The exercise tool divided opinions, since many had experiences with other commercial exercise systems or mobile applications that made the Onnikka tool seem less appealing. Surprisingly, the mood diary was mentioned only once during the first hermeneutic circle. The other primary task support features with the exception of self-monitoring were hardly mentioned by the interviewees if not specifically asked about. During the second and third hermeneutic circles, when users were on their intervention week 25 or beyond, the subjects were generally not as enthusiastic about self-monitoring as in the beginning. During the long span of the intervention, many participants were faced with a situation in which their weight loss had stalled. There were a few users who seemed to be discouraged by the use of weight monitoring after a setback. For example, Subject 15 stopped using Onnikka altogether because of a relapse.

Regarding the feature of *Tailoring*, everyone was asked whether they perceived the system to be personal enough. After all the interviews were combined, most of the subjects (n=32) thought that the system was more or less personalized for their needs. Surprisingly, of the 11 subjects who perceived the information in the Onnikka system to be too general, five belonged to the tailored group. The result was a surprise, as it has been argued that a successful health behavior change requires receiving tailored and targeted health information (Enwald & Huotari 2010). A potential explanation for the lack of any perceived effect of tailoring by the users in Study III could be that the system was designed with one clear purpose in mind and that the subjects were handpicked to such an extent that the system was perceived to be tailored in any case.

Regarding the "Dialogue support" category, it was assumed that some of the participants would be annoyed by the weekly e-mails; but on the contrary, it was one of the most praised features in Onnikka. Even most participants who had not been active users perceived the reminders as a positive feature. *Reminders* combined with new weekly content that was delivered at a set pace created a sense of continuity for many subjects. The first reminder had a short introduction to that week's theme and a link to the system's web address, which was an effective way to make it easy for individuals to log into the system. The *Tunneling* feature, despite

being part of the "Primary task support" category in the PSD model, was often linked to reminders in subjects' answers. After the experience of the first hermeneutic circle, interviewees were asked deliberately provocatively: *How do you feel about the forced weekly schedule of Onnikka?* Despite using the word "forced," only Subject 27 named tunneling as a reason for not using the system. On the contrary, some subjects defended the system's modular setting. Other features from the dialogue support category did not stimulate much discussion. Neither *suggestions* nor *praise* of the weight tool were mentioned if not specifically requested. Regarding Onnikka, the *liking* feature did not seem to have any meaning whatsoever. The visual appearance did not offend anyone, but it did not appear to bring any added value either. In Study III, the subjects' indifferent perceptions of the liking feature were quite unexpected, as in a study by Lehto *et al.* (2012a), design aesthetics was found to substantially contribute to user perceptions of primary task support, dialogue support, perceived credibility, and perceived persuasiveness.

Onnikka was perceived by almost all participants to be credible. Subject 40 was the only participant who strongly disagreed with the provided content. Some participants had certain doubts relating to official health recommendations, but mostly these doubts were not perceived as issues critical enough to affect system use. Despite the perception of the system as credible by most of the individuals, it was difficult for the users to define the features that made Onnikka so credible. Most subjects mentioned the themes of trustworthiness and expertise of the information providers, as the system was developed by recognized authorities and not promoting any "wonder diet" or commercial products.

According to the findings from the third hermeneutic circle, the need for social support seemed to increase during the intervention's use. Despite the increased need for social support, the comment tool was used very rarely among the participants. The subjects' explanations for low usage varied notably. Many responses related to individual characteristics such as shyness, laziness, or not feeling comfortable using social media types of tools. Some subjects believed that an outside moderator or an active individual is needed as a catalyst for lively discussion. Longing for better social support was the only apparent difference between intervention groups, and the need was more often mentioned among the participants in group C, who received no face-to-face counseling. For example, when subjects were asked about the social facilitation feature on the system's homepage, users in starting groups A and B did not pay much attention to it; however, several subjects in control group C were following how many people had

visited the site to gain a sense of belonging to a group. Many users perceived the lack of social support as one of the key reasons for not using the system throughout the whole intervention period. Subjects who had not used Onnikka for several months did not perceive themselves as needing social support when interviewed (intervention week +18 and/or higher in Table 4). The results of Study III seem to agree with those of Krukowski *et al.* (2008) and Lehto *et al.* (2015b), who indicate that in online communities, peer support gains importance in the maintenance phase. As an explanation, Lehto *et al.* (2015b) suggest that new users have not yet developed affective commitment to the community of users. In Study III, the need for social support appears to decline again after the connection to the virtual community is lost. Social support is acknowledged as a beneficial strategy in behavior change (Oduor *et al.* 2014, van Dam *et al.* 2005, White & Dorman 2001). Kelders *et al.* (2012) did not find evidence that social support would affect adherence, and according to them, reporting a social support feature as part of the intervention does not say anything about whether it is actually being used—meaning that if an intervention contains a discussion board, social support is employed in system design even if there is not a single post on the board (Kelders *et al.* 2012). It is possible that, as in Onnikka case, social support was rarely used in the studied interventions. In hindsight there could have been more social support features implemented in the design. According to Harkin *et al.* (2015) study self-monitoring had larger effects on goal attainment, when the results were made public, than when it was kept private.

The weight results for the 12th month were collected for the last phase of this study (subjects 4 and 16 did not participate). Weight information and system use information presented new dimensions for analysis. Individuals who managed to lose 5% or more of their weight were separated from users who did not lose 5% during one year. Tables 11–12 show the 12th month BMI of interviewed subjects and their percentual weight loss compared to the baseline. The system's use adherence was categorized into three activity levels: high (75% adherence or more); medium (adherence between 25% and 75%); and low (25% adherence or less). Also, use data from the individual Onnikka tools were gathered, which include: following weight via weight graph; mood, exercise and food diaries; submitting weekly tasks; and a commenting tool for submitting responses to Onnikka's discussion column board. Tables 11–12 presents how many times individuals have submitted an entry to a certain tool. As regards the the commenting tool, the table indicates the number of comments an individual has posted, and not how many times this person has simply viewed the discussions.

Table 11. Participants who were able to lose 5% or more of their weight

Act[1]	ID	BMI	W%[2]	We[3]	Mo[4]	Ex[5]	Fo[6]	Ta[7]	Co[8]	Perceived as the best feature	Main reasons for (+) using and (-) not using the system
H	06	26.3	15.4	17	1	0	4	15	0	Information and links to external sources	+ System supports and reminds
	32	23.3	14.3	24	3	16	4	50	0	Self-monitoring tools	+ Being part of research project; support; reminders
	39	26.6	13.0	22	3	4	20	1	0	Weight graph	+ Monitoring weight regularly
	12	26.5	11.5	41	40	67	45	44	2	Weight graph	+ Helps to cope; commitment
	42	27.3	8.8	48	24	254	1677	38	1	Food diary	+ Commitment
	07	29.7	7.3	11	1	39	17	7	0	Exercise diary and weight graph	+ Ability to monitor the outcome of behavior
	01	26.9	7.0	25	2	45	84	3	0	Weight graph	+ Reading weekly content; self-monitoring
	26	31.1	6.0	55	33	16	178	1	4	Weight graph	+ Support; free to use; commitment
	2	31.2	5.1	55	26	67	29	54	0	Self-monitoring tools	+ Ability to follow the progress
M	31	26.6	15.5	15	9	48	2	6	1	Exercise diary and weight graph	- Successful weight loss
	21	26.6	6.4	1	1	1	0	1	0	Weekly information	- E-mails were sufficient
L	36	26.6	16	0	1	3	3	0	0	Content	- Own weight-monitoring tool
	15	28.2	15.6	6	8	17	73	0	0	Self-monitoring tools	- Relapse in weight management
	40	29.6	7.8	6	0	1	0	0	0	[Did not specify]	- No need for the system

[1] Activity: H=high, M=medium, and L=low, [2] Percentual weight loss compared to the baseline, [3] Weight grapgh, [4] Mood diary, [5] Exercise diary, [6] Food diary, [7] Weekly tasks, [8] Commenting tool

From all the interviewed subjects, 41 took part in the physical measurements after one year of intervention. Fourteen of these subjects were able to achieve 5% weight loss in the 12-month period. Most of these subjects (n=10) named one or more self-monitoring tools as the best feature(s) in Onnikka. The use amounts of different tools varied greatly even among the highly active users, as can be seen in Table 11.

Harkin *et al.* (2015) made a systematic literature search to study whether monitoring goal progress have an effect to goal attainment. According to their article, progress monitoring is a crucial element of effective self-regulation, however monitoring is not a unitary process. There are several options in which individuals can evaluate their goal progress, and one of the most interesting findings relate to whether monitoring concerns the behavior itself or outcome. Harkin *et al.* (2015) present that motivating individuals to monitor their behavior impacts significantly on behavior but not on outcomes, whereas monitoring outcomes impacts on outcomes, but not on behavior. In Onnikka case for example weight graph is measuring outcome and food diary helps to monitor behavior. As Harkin *et al.* (2015) argue, a variety of behavioral means can support a person to achieve his/her goal. At the time of conducting the Study III, the distinction between self-monitoring behaviors and outcomes were not made, and therefore this differentiation is not in the scope of that study.

Nearly all subjects in this group who were not active users perceived at the time of the interview that they had either already succeeded in their weight loss or that they had sufficient self-regulation skills to manage without the help of the system. According to the interpretation made in Study III, not using the system can also be a sign of success. If a health BCSS actually does what it is designed to do, it should make its use eventually obsolete.

Of the 41 interviewed participants who attended the 12th month measurement, 27 were not able to achieve 5% weight loss. In general among these individuals, self-monitoring was perceived as less meaningful than among the subjects who were able to lose weight, as can be seen in Table 12.

Table 12. Participants who were not able to achieve 5% weight loss

Act[1]	ID	BMI	W%[2]	We[3]	Mo[4]	Ex[5]	Fo[6]	Ta[7]	Co[8]	Perceived as the best feature	Main reasons for using / not using the system
H	22	26.8	4,0	0	0	2	0	36	1	Continuity; weekly content	+ Reminder; system reinforces the change
	30	30.4	3,1	64	13	257	27	44	3	Exercise diary and weight graph	+ Weekly content; self-monitoring
	23	30.0	0.7	0	0	39	0	0	0	System use combined with clinical health checks	+ Weekly content and tasks
	11	30.0	0.1	2	1	0	0	0	0	Reminders and weekly information	- Lack of time to utilize fully
	5	30.6	0.0	4	1	2	4	0	4	Weekly information	- Lack of time to utilize; demands too much effort
	8	30.4	-0,2	5	4	6	11	20	0	Reminders	- Lack of persuasiveness
	37	29.8	-0,3	20	7	65	6	0	0	Information; exercise diary	+ Commitment
	25	29.8	-0.3	3	3	7	13	6	2	Weekly information	- Challenging life situation
	17	30.7	-0.9	22	2	11	9	0	0	Weight graph	+ Commitment; curiosity - Lack of social support
	43	29.3	-2,7	53	90	91	13	50	24	Weekly information; self-monitoring tools	+ Possibility of achieving results with minor changes
	28	29.4	-3,0	1	0	0	3	0	0	Weekly information	+ Reading weekly information is important
M	27	31.5	4.0	8	3	8	9	7	1	Weight graph; weekly information	- Relapse in system use
	19	33.9	2.7	0	1	2	4	0	0	Weekly content	- Bad user experience
	29	30.9	1.9	15	18	57	99	8	5	Food diary; weight graph	- Lack of social support
	24	31.6	1.3	15	14	14	16	22	8	Weekly content; self-monitoring tools	- Lack of time to utilize
	10	31.7	1.1	10	7	124	0	0	1	Exercise diary	- Lack of personal guidance and social support
	13	27.5	1.1	6	0	0	0	0	0	System use combined with counseling visit	+ Continuance; reinforcement
	20	34.4	1.1	0	0	0	0	2	0	regularity; E-mails	- Lack of time to utilize; lack of social support
	3	28.3	-0,1.	16	1	1	8	7	0	None	- Lack of persuasiveness
	33	27.2	-0.2	1	0	0	0	4	0	Weekly information	- Not severe weight problem

Act[1]	ID	BMI	W%[2]	We[3]	Mo[4]	Ex[5]	Fo[6]	Ta[7]	Co[8]	Perceived as the best feature	Main reasons for using / not using the system
	18	28.4	-3.2	8	1	26	50	2	5	Knowledge of healthy living	- Not severe weight problem; lack of persuasiveness
	41	31.4	-3.4	2	0	1	0	1	0	Weekly information	- Lack of time to utilize; lack of persuasiveness; do not use computers
L	9	28.3	0.2	2	0	2	1	1	0	[Did not specify]	- Lack of social support; lack of time to utilize; lack of perceived persuasiveness
	34	28.3	-2.0	8	0	4	0	0	0	Information	- No need to lose weight
	38	31.5	-2.0	0	1	0	3	17	1	Reading comments	+ Commitment
	14	28.3	-3.4	6	1	1	3	12	2	Weight graph; food diary	- Lack of time to utilize
	35	30.6	-3.7	7	6	3	7	11	4	Weekly information	- Challenging life situation; lack of persuasiveness

[1] Activity: H=high, M=medium, and L=low, [2] Percentual weight loss compared to the baseline, [3] Weight grapgh, [4] Mood diary, [5] Exercise diary, [6] Food diary, [7] Weekly tasks, [8] Commenting tool

Regarding reasons for not using the system, five subjects were disappointed about having been assigned to group C and wanted more social support. Another common argument for not using Onnikka was lack of time to fully utilize the system (n=6). Three subjects (ID = 5, 11, and 25 in Table 12) who were highly active in terms of system use adherence felt that they did not have enough time to use the system properly. They felt that their work and life situation was too demanding, and they did not want to do much extra in their limited spare time. One of the reported challenges for not using the system actively or not achieving weight loss was personal health. For some, mere commitment kept them signing into the system regularly.

The results of Study III point in a direction that the people who cannot use the system and those who do not need the system are counterpoints that should be addressed differently. Contrary to the people who felt that they could not utilize the system as much as they would have liked, four users (ID = 18, 22, 33, and 34 in Table 12) felt that they did not have a severe weight problem to begin with and therefore did not have full motivation to pursue a lifestyle change. They had a less serious attitude concerning lifestyle change and viewed the system in more of a supportive role, where the use of the system was often seen as inseparable from counseling visits or clinical health checks.

For four subjects in this group, the lack of persuasiveness was one of the reasons for not using the system. In Study III, the lack of perceived persuasiveness seems to have had an impact on attrition, but this does not mean that the relationship is unambiguous. First, users were surprisingly active despite the lack of perceived persuasiveness. Subject 3, who was the most critical toward Onnikka, still had logins even during the last quarter of the intervention period (weeks 40-52). Second, perceived persuasiveness did not come explicitly from the high adherers' answers. Onnikka was perceived to be more or less persuasive in this group when asked, but most subjects did not pinpoint any specific feature to clarify their reasoning as to why the system felt persuasive. This finding suggests that when an individual is fully engaged in using the system, he/she might not be fully aware of being persuaded and thus merely experiences the system as useful to him/her.

3.4 Study IV: BCSS and habit formation

Study IV set out to investigate participants' use experiences related to Lally and Garder's (2013) habit formation stages. In addition, questions of BCSS use habits and behavior change habits were asked, and the responses are interpreted in the

contexts of system use adherence and individuals' 12th-month weight loss results. Study IV firstly describes how the responses map with Lally and Gardner's (2013) habit formation stages, and secondly it summarizes how the individuals perceived the formation of BCSS use habit and behavior change habit.

Intention formation

Committing to be part of a research project with its baseline measurements was such a threshold for many participants that intention formation was not perceived as a critical BCSS element. For some participants, even the thought of being part of the lifestyle intervention study was a highly affective trigger to carry on behavior change.

Translating intention into action

Typically, the users had strong intentions to lose weight when they started to use Onnikka. However, for three users (ID = 18, 33, 34) the "intention-behavior gap" was caused by a loss of the need to perform the aimed behavior. Several participants perceived themselves as not having the need to use Onnikka after all.

Lally and Gardner (2013) argued that individuals can also fail to act on their intentions simply by forgetting. BCSS users can also be supported in remembering their plans by offering them reminders, and nearly all Onnikka users perceived the reminders as a positive feature. The most effective cues to act on a plan are distinct events in daily life that are hard to miss (Lally & Gardner 2013). For example, Subject 1 measured himself first thing in the morning. According to Lally and Gardner (2013), self-monitoring is useful when translating intention into action, because effective planning requires accurate appraisals of current behavior.

When losing weight, planning how to deal with a social situation where high-calorie foods are offered can be extremely difficult. Somewhat surprisingly, Onnikka users gave only a few concrete examples of coping planning, which involves anticipating difficulties that might hinder healthy behavior (Lally & Gardner 2013).

Repetition

At the early stages of behavior change, actions that give rise to positive emotions can increase effort, whereas those prompting negative affect are most likely

discontinued (Louro *et al.* 2007, Lally *et al.* 2010, Lally & Gardner 2013). As behaviors are repeated and automaticity starts to emerge, the initiation of a behavior becomes less effortful, and therefore participants' satisfaction may be strengthened by focusing on the ease of performance (Lally *et al.* 2011). The system itself was perceived to be easy to use, and not a single interviewed Onnikka user felt that the system was too difficult to use. Positive outcomes can enhance behavior change, but unexpected obstacles can turn into a downward spiral. For example, Subject 39 had a medical issue that prohibited him from exercising, and paradoxically he started to eat more despite the fact that he was consuming less energy; and as he was gaining weight, he stopped self-monitoring.

In the case of facing a setback, Lally and Gardner (2013) suggest switching focus to a different domain. For example, Subject 38 was optimistic despite the fact that she had not lost weight over the year; she had high self-esteem since her waist had gotten smaller, and her cholesterol levels were better than previously.

Lally and Gardner (2013) argue that people engaged in behavior change should be supported to achieve self-directed changes rather than following external instructions. In the current research case, in general, the subjects were aware of the importance of gaining competence and autonomy. Still, data also hold different types of answers, and many perceived that Onnikka enhances compliance. In addition, some users of Onnikka were highly disappointed that their recordings in the system were not monitored by experts.

When helping people to repeat a behavior, planning is important, as it is for initiation, and, according to Lally and Gardner (2013), coping planning may be particularly important for supporting repetition (Scholz *et al.* 2008, Lally & Gardner 2013). As stated earlier, only a few Onnikka participants mentioned a coping plan to prevent cravings. However, many individuals allowed themselves to have some treats in their lives so that it did not feel like a demoralizing slip of action.

After new behavior has been initiated, self-monitoring can better support compliance with behavioral goals. Self-monitoring supports contextual stability to ensure that individuals are performing the behavior in the same way on each occasion (Lally & Gardner 2013). The benefits of self-monitoring can be enhanced by providing feedback on performance, which can keep people motivated during the acquisition phase (Michie *et al.* 2009, Lally & Gardner 2013). The Onnikka system gave positive supportive feedback whenever the individual submitted his/her weight into the system. However this praise feature was hardly ever mentioned by the interviewees if not specifically requested. Positive reinforcement can also be promoted via external feedback by having others comment on

performance (Lally & Gardner 2013). Unfortunately, the commenting tool was used by the participants so scarcely that it did not create a sense of social support among the subjects.

Automaticity

Lally and Gardner (2013) point out that, traditionally in psychology, it was thought that if performance is highly rewarding, the likelihood that behavior would be repeated was high (Skinner 1938), and habits would develop only if rewards were received for each repetition. Conversely, recent studies have shown that providing notable and tangible rewards for behavior can undermine intrinsic motivation and that extrinsic rewards enhance habit formation only when they do not become the goal of the behavior (Deci *et al.* 1999, Lally & Gardner 2013). The individuals in the research project did not receive any rewards for participating. Nearly all the interviewed subjects reported not having any extrinsic rewards of their own to honor their weight loss, and those who did had very moderate and reasonable rewards (e.g., glass of wine, smaller trousers, sports equipment).

Simple activities are easier to make automatic than complex behaviors, and in the flow of everyday routines, behaviors are often linked together in "chunked" sequences so that the completion of one activity cues the next (Graybiel 1998, Lally & Gardner 2013). Several participants were unable to find space for the use of the BCSS in their flow of daily activities. The individuals had the full week to read the weekly content and submit their self-monitoring entries, and therefore the system was not believed to be too time consuming. Surprisingly, lack of time to utilize the system to the full extent was quite a common argument for not using Onnikka, and six subjects named it as their main reason for not using the system. Even some subjects who were highly active in terms of system use adherence perceived that they did not have enough time to use the system properly. Paradoxically, the respondents did not criticize Onnikka's fixed timing, which followed the PSD model's feature tunneling; rather they perceived it as a valuable system feature.

Subjects' answers pointed in a direction where the familiarity of the system and foreseeable schedule served to reduce the cognitive load for many individuals, and for them these elements made it easier to hold onto their desired lifestyle change. Four respondents stated that commitment was their primary reason for using the system.

Lally and Gardner (2013) hypothesize that uninterrupted performance of behavior is a necessary condition for habit formation. However, only Subject 31

named interrupted performance as a reason for discontinuing use of the system. It may also be that uninterrupted performance did not have big impact over such a long intervention period, as in the case of this research. In Onnikka's long 52-week ICT intervention period, there were only a few participants who used the system every week throughout the year, and occasional breaks were not perceived as critical.

Breaking unwanted habits

Vigilant monitoring offers an effective way to inhibit unwanted habits by paying attention to potential slip-ups, which involves thinking "don't do it" (Wood & Neal 2009). Self-monitoring was often perceived as an effective way to inhibit unwanted habits among the participants. Onnikka supported individuals in breaking their old habits by helping individuals to raise awareness of their everyday choices and eventually build healthier habits through repetition.

Lally and Gardner (2013) argue that another appealing solution to breaking old habits is to remove the individual from any environment which cues unwanted habitual responses. Moreover, reminders in the environment are a useful tool for helping people to remember their plans if placed appropriately. Among the users of the Onnikka system, only a few mentioned placing reminders in their environment.

Summary

Larry and Gardner's stages of habit formation and their key elements are listed in Table 13. Also, corresponding concepts from the PSD model (Oinas-Kukkonen & Harjumaa 2009) are added.

Table 13. Stages of habit formation and suggestions for breaking unwanted habits, adapted from Lally and Gardner (2013)

Stages of habit formation, subcategories	A related concept in the PSD model
Intention formation (not emphasized in this study)	
Translation of intention into action[1]	
Remembering intended action	
Action and coping planning	Rehearsal (system feature)
Reminders and cues to the enactment of a plan	Reminders (system feature)
Self-monitoring	Self-monitoring (system feature)
Promotion of repetition	
Satisfaction regarding the experience	

Stages of habit formation, subcategories	A related concept in the PSD model
Positive experience of a new behavior	Ease of use and usefulness (postulate)
Attaining anticipated outcomes	Self-monitoring (system feature)
Different domains of success	Route (Postulate)
Enhancing intrinsic motivation	
Connection with others	Social support (system feature category, multiple system features)
Competence and autonomy	Autogenous technologies (the intent / persuasion context)
Positive feedback	Praise (system feature)
Self-regulatory strategies	
Planning, particularly coping planning	Rehearsal (system feature)
Self-monitoring	Self-monitoring (system feature)
Supporting the development of automaticity	
Enhancing intrinsic rewards	Rewards (system feature)
Consistency	Tunneling (system feature)
Reducing behavioral complexity	Reduction (system feature)
Cues	Route (postulate)
Breaking unwanted habits	
Disrupting the cue-response association	Cognitive consistency (postulate)
Reminders in the environment	Reminders (system feature)
Programming alternative responses	Rehearsal (system feature)
Self-monitoring	Self-monitoring (system feature)

[1]Only volitional / post-intentional categories included in the table

As seen from Lally and Gardner's (2013) habit formation strategies, many features work in multiple different stages. This might be one explanation for why particularly self-monitoring and reminders have been found to be so prominent in empirical studies in changing physical activity and eating behaviors (Michie *et al.* 2009).

Experiences of BCSS use habit and behavior change habit

For the last phase of this study, the weight results for the 12th month were collected, and Onnikka's use data for the entire intervention time were gathered. The possibility of using weight information and system use activity served as new lenses of interpretation. Onnikka users were recommended to log into the system at least once a week to read the provided content. Subjects who had 100% adherence (Figure 8) logged into the system at least once a week throughout the whole 52-week intervention period..

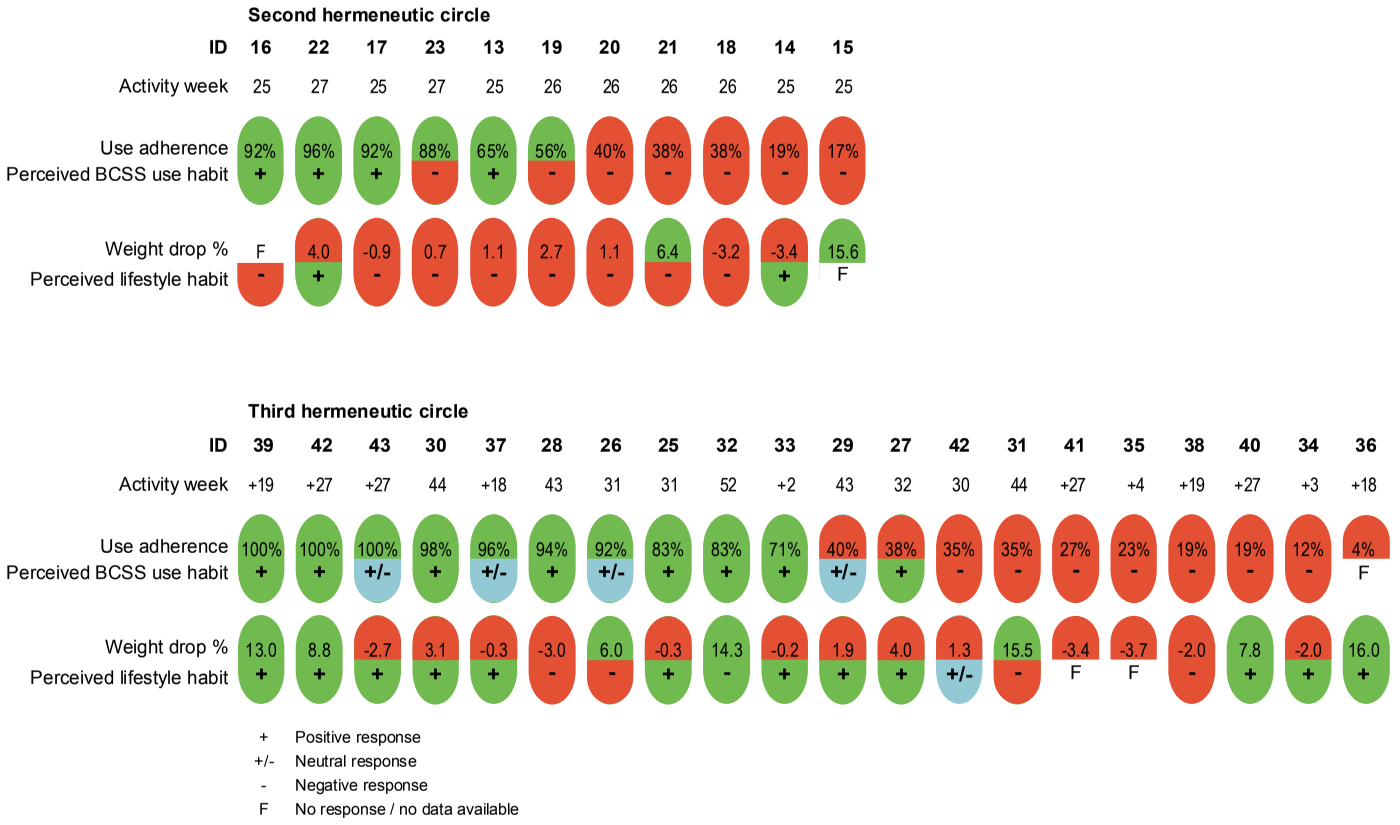

Fig. 8. Responses to habit formation from second and third hermeneutic circles

A total of 15 respondents had less than 50% system use adherence, from which all but one subject said that Onnikka's use never became a habit. Individuals who had over 50% adherence claimed almost the exact opposite: 11 subjects out of 16 claimed that Onnikka's use was more or less a habit for them.

The answers related to behavior change as a new lifestyle habit were surprising. From nine respondents who managed to lose 5% of their weight in a year, only four said their new lifestyle was an automated habit at the time of the interview. Naturally, in these answers, it has to be taken into account that for the most part, the interviews were done in different time periods, and, for example, in intervention weeks 25–27, the subjects seemed in general to still be struggling with their lifestyle change. Based on the interviews there is no possibility to pinpoint a certain time period when new lifestyle had became a habit for most of the subjects. In Lally *et al.*'s (2010) study, the average time for participants to reach automaticity was 66 days, with a range of 18 to 254 days.

Another identified anomaly is that 10 subjects expressed that they had reached automaticity regarding new lifestyles at the time of the interviews, but they had not been able to lose 5% of their weight by their 12th-month measurements. Interviewers' responses do not reveal any apparent differences between the counseling groups regarding habit formation.

The responses as regards subjects' lifestyle habits did not seem to resonate with their actual weight loss. One possible explanation is that the reported automaticity concerned only one area out of many that would have required weight management. For instance, Subject 43 said he selects healthy food ingredients without paying attention to them anymore, Subject 40 reported that exercising has evolved to automaticity, and Subject 33 said his eating habits are now healthy (e.g., regular eating times to avoid binge eating). All these mentioned achievements are highly valuable, but alone they are not enough for sustainable weight management. According to Lally and Gardner (2013), performing multiple behaviors in response to one cue can diminish the possibilities that any response will become habitual (Wood & Neal 2007). If many behaviors can be used to achieve a goal, the association between the goal and any one behavior is reduced (Lally & Gardner 2013). With the Onnikka system, users also had the opposite problem in that one behavior was often not enough to achieve a goal but rather multiple behaviors were required to do so. Harkin *et al.* (2015) offer one explanation why self-monitoring outcomes have been found to be so efficient in behavior change process. Monitoring outcomes can cause a variety of corrective activities, whereas self-monitoring behavior may only influence the performance of that particular behavior.

Harkin *et al.* (2015) argue that people who monitor outcomes are also more committed to the goal and are willing to use alternative means to achieve the outcomes they pursue, than individuals monitoring one particular behavior.

3.5 Study V: Approaches to ethical considerations

Study V concentrates on seven different articles discussing ethical issues in persuasive technology design (Berdichevsky & Neuenschwander 1999, Fogg 2003, Davis 2009, Gram-Hansen *et al.* 2011, Yetim 2011a, Spahn 2011, Smids 2012). In addition, Friedman *et al.*'s (2006) work is discussed in Study V even though the study does not address the persuasive technology field as such.

Study V presents a conceptual ethical framework. Eight articles are divided into three categories, as follows:

i. guideline-based approaches,
ii. stakeholder analysis, and
iii. user involvement.

The guideline-based category includes ethical approaches that provide general ethical precepts but that do not give explicit guidance on the consideration of users' and other stakeholders' moral norms. The stakeholder analysis category targets ethical approaches that evaluate stakeholders without actually involving them in the design or the use process. The user involvement category includes approaches that take stakeholders' voices into account in order to seek ethical solutions with them.

All three ethical approaches have practical implications to the actual BCSS design. To make a system as ethically safe as possible, it seems tempting for designers to involve stakeholders in the design process to build ethical agreement through participation and/or conversation. Ethical approaches in the user involvement category are especially useful when the designed system is targeted at a specific and predefined group, that is, when the goal of conversation can be specific enough, or when building a system jointly with equal partners. However, designers often have only limited resources to do such thorough work in reality.

Davis (2009) and Yetim (2011a) have carried out studies on the suggested framework's user involvement category. Davis (2009) leans on the principles of participatory design and aims to involve direct and indirect stakeholders as contributors of ethical issues and engages stakeholders as equal participants in the design process. The multiple voices of different stakeholders can be also

approached from Jürgen Habermas' (Mingers & Walsham 2010) discourse ethics point of view. In discourse ethics, every stakeholder has to be equal to participate in the discussion, and agreement should be based on the best argument instead of consensus (Mingers & Walsham 2010). Fahri Yetim (2011a) combined argumentation research with discourse ethics and created heuristics for persuasive systems designers and users to guide discussion.

The user involvement category has two handicaps that designers must take into account. Firstly, building consensus on key values does not make the system automatically ethical. Even though moral values should be emphasized, other values cannot be neglected. According to Stahl (2012) something is a value when it is perceived as having worth. For instance, monetary wealth is a value, too, and some stakeholders may be very keen to have it as a primary goal for the system, whereas others may hold the totally opposite view. Secondly, reaching consensus or the best argument itself is often difficult, and in large software development projects this may be an overly optimistic goal. Developers in responsible positions should be prepared to solve stalemates in such a way that the solution remains ethically solid. Mingers and Walsham (2010) argue that even the famous open source development project of Linux kernel cannot meet the ideal conditions of discourse ethics, where the inner core of developers have strong rights to control the implementation of changes. This means that the contributors are not equally participating in the debate and that developers decide in the end which design solution is "the best argument."

Stakeholder analysis aims to consider the values of people who are affected by the system but does not necessarily involve individuals in the actual design process. Similar to the user involvement approach, stakeholder analysis says nothing about the norms stakeholders should follow (Stahl 2008). Nonetheless, the systems are built with some target group in mind. Whether the system design project is vast or small, to design BCSS properly, users should be taken into account on multiple levels. From this viewpoint, it is practical to make ethical considerations along the design process. The Value Sensitive Design (VSD) methodology by Friedman *et al.* (2006) introduces 10 steps for evaluating stakeholders' values in different situations. If the designer has difficulties imagining himself/herself in someone else's shoes, he/she can, for instance, interview stakeholders who will be affected by the system. Kujala and Väänänen-Vainio-Mattila (2009) go further in describing the potential varieties of values, which makes identifying values even easier. Stakeholder analysis can be expected to be a particularly suitable approach for situations in which the use context of the system is clear, as value-based product solutions are

often highly context-dependent (Kujala & Väänänen-Vainio-Mattila 2009). One challenge is that identifying direct and indirect stakeholders can be an extremely difficult task. Local solutions can be considered in a broader context, and they can even be lifted to the global scale when thinking about the consumption of natural resources, for instance. The question is when and where to stop the stakeholder analysis process. Payton *et al.* (2011) name nine different major stakeholders of health IT (healthcare consumers, healthcare providers, health organization administrators and personnel, academic stakeholders, professional associations, private sector vendors, non-profit stakeholders, regulatory stakeholders, and government agency stakeholders), which are all split into more detailed stakeholder categories. The focus area of this dissertation is healthcare consumers, which Payton *et al.* (2011) categorize to four subgroups: patients, user/support groups, caregivers, and individuals seeking to maintain health. This dissertation concentrates on the latter, and evidently even this one small group of stakeholders holds a plethora of different values. Designers should also keep in mind that users in most cases do not explicitly think about their values and can have problems articulating them, especially when the values are unconscious or perhaps socially unacceptable.

Despite high-minded goals, both the user involvement and stakeholder analysis approaches depend greatly on the judgements of persons responsible for system design. It can be argued that user involvement always includes power structures between stakeholders and designers and that the end result of stakeholder analysis always depends on the designer's interpretation. From this perspective, guideline-based approaches may serve as checklists for tackling important ethical issues already recognized in the field; for example, by definition BCSSs should not deceive, manipulate, or coerce its users and BCSSs should also be transparent and enable free choice to engage with the system (Oinas-Kukkonen 2013).

The guideline-based category contains various approaches that suggest general principles for addressing ethical issues. As shown in Table 14, most research interest thus far seems to fall into this category. Berdichevsky and Neuenschwander (1999) suggest eight principles for persuasive technology and design, from which they perceive as the most important guideline the eighth principle: "the Golden Rule of Persuasion." Burri Gram-Hansen (2009) arrived at the same conclusion and states that we must strive toward doing to others as we hope others will do unto us. Jilles Smids (2012) builds his argument on the definitions of persuasive technology and comes to the conclusion that the most important ethical question is related to the person's voluntariness to change. Andreas Spahn (2011) takes the ideas of

discourse ethics and links them to the act of persuasion. He sees persuasion as an act of communication that should always follow the validity claims of speech-acts. The articles presented in this category can be seen to represent all three traditional ethical schools: consequentialism, deontology, and virtue ethics.

Table 14. Framework of ethical approaches in persuasive systems design (V, published by permission of Springer)

Approach	Publication	Primary ethical guidance for BCSS designer
Guideline-based	Berdichevsky & Neuenschwander (1999)	Eight principles for persuasive technology design, from which the golden rule is considered most important: The creators of a persuasive technology should never seek to persuade a person or persons of something they themselves would not consent to be persuaded to do.
	Gram-Hansen (2009)	Ethical reflections are intuitive and personal. Strive to create a product that will have impact on the user in a way which yourself find ethically acceptable.
	Smids (2012)	The most important ethical question regarding persuasive technology is the person's voluntary desire to change. Do not use techniques of coercion, manipulation, or subliminal persuasion.
	Spahn (2011)	Three principles for persuasion: 1) persuasion should be based on prior consent; 2) ideally the aim of persuasion should be the end of the persuasion; 3) persuasion should grant as much autonomy as possible to the user.
Stakeholder analysis	Fogg (2003)	Seven-step stakeholder analysis: 1) list all stakeholders; 2) list what each stakeholder can gain and 3) what they can lose; 4) evaluate which stakeholder has most to gain and 5) most to lose; 6) determine ethics by examining gains and losses in terms of values; 7) acknowledge your own values that you bring to the analysis.
	Friedman *et al.* (2006)	Values are retrieved from stakeholders through analysis that has three different layers: conceptual, empirical, and technical investigations.
User involvement	Davis (2009)	Participation in design. Usage of value-sensitive design to evaluate the values of the direct and indirect stakeholders and participatory design to involve potential users as full participants in the design process.
	Yetim (2011a)	Conversation in use time. A total of 21 critical questions that guide reflections on systems for three discourse types: pragmatic (goal-value, action-goal, action-value); ethical (identifying, checking); and moral (identifying, checking).

According to Goodman (2008), professionals often fail to realize that they encounter ethical issues and challenges in the ordinary course of their work. At times, a designer can face a situation where he/she has no other option but to simply count on his/her own reasoning or perhaps even intuition. Being faithful to one's intuition is not naïve nonsense, because our non-reflected reactions to what is good or bad are shared by the community we belong to (Stahl 2012). This "moral intuition," as Stahl (2012) defines it, simplifies the world by providing a shared view of the world. Understandably relying merely on moral intuition can lead to problems if it is no longer shared with others or collides with other communities. In addition, Goodman (2008) notes that questions of appropriate actions can arise even in situations where nobody has done anything clearly wrong. Thus the designer(s) should be aware of the values that will be implemented into the system design as to whether they are based on moral intuition, predetermined norms, or maximizing overall good or whether the values are gathered from stakeholders or decided together with the users. Values should preferably be explicitly specified and exemplified.

4 Discussion

The objective of this section is to discuss the relevance and applicability of the work, to evaluate the dissertation's reliability and validity, and to give recommendations for future research.

Studies I and III revealed that many subjects evaluated system usefulness in the terms of perceived value for themselves rather than in terms of the system's instrumental value. Studies I, III, and IV underscore that people were less likely to use the systems if they did not fit into their daily routines. Flow experience appeared not to play as fundamental part in the BCSS use experience as was expected in Study II. Study III showed how self-monitoring tools were not used and perceived similarly even among high adherers. According to the results of Study III, self-monitoring, reminders and tunneling can help users to achieve better outcomes. Study IV suggests that those same features help compliance and commitment, which in turn can reduce user's cognitive load, and help individuals to achieve better living habits. Lastly, Study V divides different ethical approaches three distinct categories.

4.1 Theoretical and practical implications

This doctoral thesis contributes to the body of scientific knowledge by evaluating BCSSs and demonstrating their use in an eHealth context. This dissertation studies user perceptions of a BCSS for personal health and wellbeing. It also presents a conceptual framework of how to consider different ethical approaches when designing BCSSs. The results from studies I–IV suggest that there is room for improvement in implementing web-based interventions for health.

BCSS adoption

One of the most common arguments in the eHealth research field is that user attrition and reduced engagement among those participants who continue using the system are significant problems of web-based behavior change interventions (Bennett & Glasgow 2009, Eysenbach 2005, Neve *et al.* 2011). In Or *et al.*'s (2011) study, perceived usefulness accounted for 53.9% of the variability in behavioral intention to use web-based self-management technology. According to Schwarz and Chin (2007), people may perceive usefulness in the development of the self rather than in the instrumental value, and this assumption seems very plausible

based on the findings of this work. Personal traits and capabilities appeared to play an important role in the decision-making process regarding system adoption. People who do not need the system and those who cannot use the system are counterpoints that should be addressed differently. Moreover, not using the system can also be a sign of success. According to Kelders (2012), it seems that there are no universal characteristics of participants that predict adherence but rather that the match between the characteristics of participants and the intervention may predict adherence.

Based on the findings of this dissertation, participants were less likely to use systems if they did not fit seamlessly into their regular daily routines. Unobtrusiveness is one of the postulates behind persuasive systems (Oinas-Kukkonen & Harjumaa 2009), and it reflects whether the system fits with the user's environment and routines in which the system is being used. In Lehto *et al.*'s (2012a) study, unobtrusiveness plays a key role in their research model, where unobtrusiveness has a statistically significant connection to perceptions of primary task features, perceived persuasiveness, actual usage of the system, and intention to continue system use. In their research setting, it was the only construct that significantly decreased over time (Lehto *et al.* 2012b); in other words, obtrusiveness increased over time. This could explain why in Study III some individuals who had used the system for a long time and had high adherence still struggled to find sufficient time to use the system.

In addition to fitting a BCSS to daily routines, other challenges in personal life (e.g., an overwhelming work load, divorce, or the death of a loved one) had a great impact system use. BCSSs should aim to find better means to support users to cope with unexpected changes in life and to help construct space for a healthy lifestyle. When self-regulatory resources are depleted, people cannot easily control their habits (Lally & Gardner 2013). Habits form if a behavior is repeated in unvarying contexts, hence designers should not only focus on repetition but also give tools to settle the context so that a new behavior can eventually translate to a habit. Analyzing the persuasion context is one of the three major elements in the PSD model (Oinas-Kukkonen & Harjumaa 2009, Oinas-Kukkonen 2013).

According to the results of Study I, non-credibility is one of the major reasons for rejecting a BCSS. It is not clear how much perceived non-credibility is actually affected by the system and how much is caused by emotional discomfort. It is possible that the subjects in Study I undermined the BCSS's credibility in order to maintain their cognitive consistency (Oinas-Kukkonen & Harjumaa 2009, Oinas-Kukkonen 2013). Onnikka, on the contrary, was perceived to be trustworthy by

almost all interviewed subjects. It can be speculated whether it was caused by the non-offending tone of Onnikka that was emphasized in the content and system design. For example, during the design process, the competition feature was dropped from the system's implementation based on healthcare professionals' experiences in face-to-face counseling.

These findings resonate strongly with Jimison *et al.* (2008), who studied barriers to the use of health IT. They found three major obstacles: lack of perceived benefit, inability to fit technology interventions into individuals' lifestyles, and not trusting the advice given by the system. Other reasons were, for example, technological malfunctions, overly cumbersome technology, confusion with the technology and content, clinical factors, costs, and age and disabilities (Jimison *et al.* 2008). These findings resonate specifically with Study I's results, where hindrances of the IT artifact played an important role in the non-adoption of the BCSS.

Engaging BCSS users

The participants in studies I–IV were individuals seeking to maintain or enhance their personal health independently with the help of a BCSS. According to Harjumaa (2014), it is challenging for eHealth interventions to compete with the attractiveness of other applications—especially with entertainment applications, which have a central role in the usage of the Internet. Study II aimed to reveal whether hedonic values would stand out from the Onnikka data, since system use was voluntary. The results suggest that flow does not play as fundamental a part in the BCSS user experience as was expected.

As Pöyry *et al.* (2013) highlight, hedonic web usage implies that feelings of enjoyment derive from the experience itself, as opposed to deriving value from accomplishing pre-set goals (Babin *et al.* 1994, Cotte *et al.* 2006, Hartman *et al.* 2006, Holbrook & Hirschman 1982). Since a BCSS aims to help its users to achieve their goals in real life, focus should be on how the system supports individuals to reach flow in the target behavior. When participants described their experiences in a heart-rate monitor related study (Harjumaa *et al.* 2009), one of the primary reasons for exercising was found to be the feeling of enjoyment. Participants knew how they should exercise, but they did not always do it according to their best knowledge.

The flow experience is not a stagnant state, and it can wear off over time, as Magni *et al.*'s (2010) study claims. Flow is a very holistic sensation that does not

easily express its antecedents or consequences. Their results show that, when exploring new technology, the importance of utilitarian values increases while the flow experience decreases over the long run. Onnikka users were interviewed on their 12th intervention week in Study II, and it was found they perceived, in general, utilitarian values to be more important than hedonic values. The rewarding process of the flow is that individuals enhance their competences and skills and achieve higher and higher goals over time, because their skills are constantly adapting to the task's difficulty (Schüler 2012). One of the main challenges can be that many behavior change interventions are still static and passive (Kennedy *et al.* 2012). In addition, based on the findings in Study II, an autotelic personality seems to be an important factor in flow research. If this area is neglected, a researcher might end up searching for answers from the IT artifact when the explanation lies in the user's personality. Study by Ross & Keiser (2014) reveals that personality shares considerable commonality with flow, and also different components of flow seem to be reflected by personality traits. Their research calls attention to individual differences in flow-propensity, which can indicate significant differences how flow is experienced (Ross & Keiser 2014).

Persuasive features and habits

According to Webb *et al.*'s (2010) findings, interventions that employ more behavior change techniques show larger effects than interventions with fewer techniques. Kelders *et al.* (2012) claim that the effect of these interventions is decreased if the exposure to the intervention is not optimal. The PSD model does not argue that there is a relationship between how many features are implemented in the system and the effectiveness of a BCSS (Oinas-Kukkonen & Harjumaa 2009). The results of Study III show that the meaning of a self-monitoring feature alone is not a clear-cut case, as not all the tools offered by Onnikka were used or perceived homogenously, even among high adherers. Persuading an individual to use all the tools that the system offers sounds intuitively like an appealing strategy, but based on the interpretation of Study III, it would in fact more likely increase the dropout rate drastically. Design flaws in one self-monitoring tool can ruin the use experience of the whole system. The results of Study III indicate that offering more self-monitoring tools is an effective design strategy, because it helps individuals to better adjust the system to their personal needs.

The value of reminders in increasing adherence and the effectiveness of web-based health interventions is illustrated in several articles (e.g., Fry & Neff 2009,

Kelders *et al.* 2012, Kuonanoja *et al.* 2015, Lehto & Oinas-Kukkonen 2015b, Webb *et al.* 2010). For example, text messages have been found to relate to increased physical activity when compared to control groups who did not receive reminders (Webb *et al.* 2010). The relationship between different persuasive feature categories has been discussed in several articles (Drozd *et al.* 2012, Lehto *et al.* 2012a, 2012b, Lehto & Oinas-Kukkonen 2015b) that hold important findings regarding the role of dialogue support. According to Lehto and Oinas-Kukkonen (2015b), dialogue support is crucial to a system's effectiveness; however, it does not impact use continuance directly but rather indirectly via multiple proxy constructs. Reminders were a praised feature in Study III even among inactive users and participants who did not achieve the aimed behavior change. Study III's interpretation is that system dialogue alone might not be enough to support individuals' behavior change; a reminder has to lead an individual to pursue his or her intended goals. Similar to reminders, tunneling was perceived almost down the line as an important feature among participants in Study III. Tunneling should not be overlooked when designing BCSSs. Reminders and a foreseeable schedule reduced the cognitive load for many individuals, and for them these elements made it easier to commit to the intervention. Yet, for instance, in Lehto and Oinas-Kukkonen's (2015a) study of six widely used weight-loss websites, tunneling was not implemented in any of those sites. Harkin *et al.* (2015) argue that including other behavior change techniques alongside self-monitoring results in larger effects than interventions supporting solely self-monitoring. They claim, that theoretically supported combinations of techniques have shown to be highly effective (Michie *et al.* 2009, Prestwich & Webb 2015).

According to the findings of Study IV, BCSS use habits appear to have a strong linkage with use adherence, which combined with self-monitoring, reminders, and tunneling can enhance better weight-loss results. Many users of Onnikka perceived that the system supported compliance, and some even considered commitment as the main reason for using the system. However, behavior change habits do not resonate well with actual weight loss. One possible explanation is that the reported automaticity concerned only one area out of many that would have been required for successful behavior change. Change in one behavior was not often enough to achieve the overall goal; rather multiple behaviors were required to do so. This in turn calls for more holistic eHealth interventions in the future. In their study, Dombrowski *et al.* (2014) found no evidence of effectiveness of interventions that focused solely on diet or physical activity. Interventions aiming to change both physical activity and dietary intake were effective in weight management within 12

months, and some evidence suggests that these effects can be sustained further at 24 months (Dombrowski *et al.* 2014).

Kelders *et al.* (2012) argue that persuasiveness has an impact on system use adherence. In their study, persuasiveness was measured by system features used and not by subjects' perceived persuasiveness of the system. In Study III, the lack of perceived persuasiveness seems to have had an impact on attrition, but this does not mean that the relationship is unambiguous. First, users were surprisingly active despite the lack of perceived persuasiveness, as Study III argues. Second, perceived persuasiveness did not come explicitly from the high adherers' answers, which suggests that when an individual is fully engaged in using the system, he/she might not be fully aware of being persuaded and thus merely experiences the system as useful to him/her. Both of these interpretations can explain why in Lehto *et al.*'s (2012b) study the effect of perceived persuasiveness explained nearly one-third (31%) of the variance in the intention to adopt, but in another article by Lehto *et al.* (2012a), the effect of perceived persuasiveness on actual use (at two weeks) was not statistically significant.

Even though Oinas-Kukkonen's (2013) BCSS framework does not include the concept of habit formation explicitly, it promotes a reinforcing outcome (R-outcome) and compliance (C-change), which bolster this type of automaticity. A person "technically" quits their previous behavior only once, but he/she needs support to continue with the new behavior. Reinforcement is vital for supporting and encouraging individuals to keep their feet on the right path. As Oinas-Kukkonen (2013) underscores, BCSSs should aim to activate several change types simultaneously.

Ethics

Stahl (2012) argues that undermining moral views can lead to customer rejection and unwillingness to adopt systems. Overall, BCSSs are deliberately designed to change users' behavior, and, as Berdichevsky and Neuenschwander (1999) stated, designers should take responsibility for the outcomes of a system's use that are reasonably predictable. However, it remains practically impossible for designers to predict all outcomes for all stakeholders. Thus, designers should choose a suitable approach for the task at hand based on an awareness of stakeholders' values and the values that will be brought into the design. Better yet, values should be explicitly specified and exemplified. Study V presented a framework for recognizing and choosing suitable ethical approaches for persuasive systems design tasks at hand

by dividing articles (Berdichevsky & Neuenschwander 1999, Gram-Hansen 2009, Davis 2009, Fogg 2003, Friedman *et al.* 2006, Smids 2012, Spahn 2011, Yetim 2011a) into three categories: guideline-based approaches, stakeholder analysis, and user involvement. The guideline-based category includes ethical approaches that provide general ethical precepts but do not give explicit guidance on the consideration of users' and other stakeholders' moral norms. The stakeholder analysis category targets ethical approaches that evaluate stakeholders without actually involving them in the design or the use process. The user involvement category includes approaches that take stakeholders' voices into account in order to seek ethical solutions with them.

Summary

Table 15 represents the key patterns observed from the studies I-V. It also summarizes main theoretical and practical implications of this dissertation.

Table 15. Patterns observed and theoretical and practical implications based on these findings

Study	Patterns observed	Theoretical implications	Practical implications
I, III	Many individuals regard system usefulness in terms of perceived value for themselves rather than in terms of the system's instrumental value	People who do not need the system and those who cannot use the system are counterpoints that should be addressed differently	User's personal traits and capabilities can be vital elements in the system adoption process
II	Flow experience did not play as fundamental part in the BCSS use experience as expected	Utilitarian values appear to be more important than hedonic values for BCSS users	BCSS should aim to help users to reach flow in their target behavior
III	Self-monitoring tools were not used or perceived homogenously even among high adherers among those with high adherence	Persuading a subject to use all the tools that BCSS offers might not be an optimal behavior change intervention strategy	Offering more self-monitoring tools enables users to better adjust the system to their personal needs
I, III, IV	Participants were less likely to use the system if they did not fit into their daily routines	Studying persuasion context is an important research area	System design should not focus merely on repetition, but also find ways construct space for a healthy lifestyle

Study	Patterns observed	Theoretical implications	Practical implications
IV	BCSS use habits combined with self-monitoring, reminders, and tunneling can help users to achieve better weight-loss results	Enhancing compliance and commitment can reduce user's cognitive load	Tunneling should not be overlooked when designing BCSSs
V	Ethical approaches can be divided to three distinct categories	Framework can guide academia to recognize areas in which deeper ethical research is needed	BCSS developers should preferably explicitly, specify and exemplify the moral values implemented in their design

According to Sarker *et al.* (2013), researchers need to ensure that they offer theoretical abstractions resulting from the interpretation of the data. They adapt Gregor's (2006) classification scheme when analyzing contributions of selected articles in their study. Gregor's (2006) taxonomy presents five types of theory in IS: (I) theory for analyzing, (II) theory for explaining, (III) theory for predicting, (IV) theory for explaining and predicting, and (V) theory for design and action. Reflecting Gregor's (2006) classification scheme, this dissertation resulted in a form of theory that can primarily be characterized as (II) theory for explaining. According to Gregor (2006), this class could also be labeled *theory for understanding*, which aims to explain how and why some phenomena occur but does not concern making testable predictions. According to Gregor (2006), this type of theory corresponds closely to the views of the interpretivist paradigm (Klein & Myers 1999), and she mentions hermeneutics as an approach that can be used to develop this type of theory. Allocating theory to one class is not straightforward, though. For example, Study V would fit best to theory for analyzing (I), but it also offers recommendations for the design of BCSSs (V), which in turn implies that these recommendations are causally connected with successful system development (III).

4.2 Reliability and validity

There are various limitations to the studies introduced in this dissertation. Several other persuasive software features could have been implemented in Onnikka case than the ones introduced. The most important features identified in Study III are somewhat different from the identified features in the two previous studies. Brouwer *et al.* (2011) found that updates to the website providing peer and counselor support, and having phone/e-mail contact with users, result in more log-ins. Morrison *et al.* (2012) on the other hand identified four core design features

that mediate intervention outcomes: self-management, tailoring, contacts with intervention, and social context and support. It is quite likely that in Onnikka case the discussion forum was used so rarely, that it did not create a sense of social support among the subjects.

In Study IV the Onnikka system was not built according to habit formation strategies, which is a clear limitation. It is impossible to say whether some of the habit formation strategies were not mentioned in the interviews because they were not as meaningful as others, or the BCSS enhanced some strategies while neglecting others. It is also possible to debate over whether automaticity levels are even measurable by interviews. Similar problem can be argued to be in Study II, when interviewing individuals' flow experiences. Overall the use of self-reported behaviors in Studies I–IV may bias the results due to the effect of social desirability in the interview situation.

Seeing reality as socially constructed can be thought to be one of the main characteristics of interpretivism (Klein & Myers 1999). Subjects' answers during an interview are interpretations of their initial motives, and researchers' conclusions from the collected material are interpretations as well, which are made in a certain situational context or from a certain standpoint (Walsham 2006, Stahl 2014). Interpretivists are not claiming to report facts; they report their interpretations of subjects' interpretations (Walsham 1995).

What this means is that the findings of this dissertation are ultimately a product that is based on the researcher's subjective understanding of related work and relevant constructs. A set of key background theories was selected for these studies, and it is likely that a different selection of theories would have led to different findings. For example, emphasizing the constructs of the PSD model heavily influenced the semi-structured interview questions and also the analysis of the responses to the questions. Also, the user experiences would be different if explored within other types of IT artifacts and in other social communities. Most likely individuals in the Quantified Self movement (Ploderer *et al.* 2014) would perceive the possibilities of technological highlights of self-tracking and sensor technologies differently than the subjects of this dissertation.

Stahl (2014) asks how, then, can a study that does not claim to describe given reality objectively raise claims to truth? He argues that in interpretive research, the objective of validity is not to verify a correct answer but to convince the reader that a believable story is told. Stahl (2014) emphasizes that one of the main issues when evaluating interpretivist IS research is whether unexpected findings will force

readers to reflect on their assumptions. The studies introduced in this work all aimed to be sensitive to anomalies and other unexpected findings.

The logic of validation within the hermeneutical tradition is best characterized by the hermeneutic circle. The researcher starts with his/her presumptions, and if contradicting evidence is uncovered, the interpretation must be revised. Sarker and Lee (2006) follow the arguments of Smith (1993), who emphasizes that the process of interpretation cannot be reduced to a mechanical process, but rather this absence of rules does not mean that "anything goes." Understanding is constantly subjected to empirical phenomena and data and therefore pressured to evolve. Sarker and Lee (2006) follow the argumentation of Ricoeur (1991: 159–160) "that validation should not be equated with verification: To show that an interpretation is more probable in the light of what is known (i.e., validation) is something other than showing that a conclusion is true (i.e., verification)." Socially constructed reality means that we share overlapping consensus (shared views and perspectives) with other individuals. Since socially constructed entities outlive and transcend the individuals, this also means that we have a measure of independence (Sarker & Lee 2006).

Hermeneutics involves not only making intelligent guesses in formulating an interpretation but also testing the interpretation using the logic of validation. According to Sarker and Lee (2006), such an approach is particularly useful when researchers are attempting to develop a holistic interpretation that is consistent with the parts of a body of evidence. According to Patton (1990: 115) much of these hermeneutic ideas have become commonplace in contemporary social science and are now fundamental in qualitative inquiry.

As Cole and Avison (2007) summarize constructivist hermeneutics does not aim to construct a theory as in grounded theory. Hermeneutics seeks to develop a framework of understanding, which outlines a set of concepts and assumptions that comprise a way of viewing reality. Capability to interpret the meanings of others, requires researchers to acknowledge their own theoretical and personal preconceptions (Cole & Avison 2007). Prejudices are the foundation of the research, since they 1) constitute the structure of meaning by recognizing themes for discussion when interviewing, and 2) direct the data analysis by ciculating themes as codes (Cole & Avison 2007). Constructed prejudices offer the benchmark to interpret anomalous attitudes and behavior, and accoding to Cole and Avison (2007) explication of prejudices can support consistency of judgement and focus. Instead of seeing researcher's role in knowledge creation problematic, researcher bias can be used in a methodical manner (Cole & Avison 2007).

4.3 Recommendations for further research

As a BCSS's core aim is to impact individuals' lives and help them manage lifestyle changes, more studies on the use of BCSSs in their actual contexts are needed to discover how different persuasive strategies can help people achieve healthier lifestyles in practice. BCSSs are not used in isolation from all other technological applications. Thus, further research is warranted to increase our understanding of how and under what circumstances specific persuasive features might lead to better outcomes across different contexts and communities.

Testing theoretical assumptions of behavior change explicitly in user studies can assist researchers building generalizable knowledge about translating behavioral theories into better designs. New methods, such as Michie *et al.*'s (2013) taxonomy of behavior change techniques should be adopted to understand the technological aspects in more detail in the future.

As Hekler *et al.* (2013) point out, the translation of behavioral theory into effective behavior change technologies is by no means a trivial process. They argue that behind each guideline is a set of assumptions about how it should affect users' behavior. According to Harjumaa (2014), the authors of the PSD model also tend to think that users act more or less rationally in the way in which they form and modify their attitudes on the basis of beliefs and values.

Until recent years, the main theoretical paradigm suggested that attitudes were the key point where permanent behavior change would occur. This leaves BCSS designers with a challenging situation, as the premise of cognitive theories has been claimed to fall short empirically (Jeffery *et al.* 2000). According to Schwarzer (2014a), the reasoned action approach (Fishbein & Ajzen 1975) is inadequate, as it does not account for processes involving behavior change. McEachan *et al.* (2011) found that the Theory of Planned Behavior (TPB; Ajzen 1991) is a considerably poor predictor of behavior in a longitudinal study design where the subjects are not students and where the outcomes are measured objectively instead of using self-reported results. Sniehotta *et al.* (2014) even radically demand "retiring" the TPB.

Lally and Gardner (2013) suggest that reaching automaticity may be considered the final stage of behavior change. Despite the critics' claims, intentions do not necessarily need to be thought of as a counterpoint to habits. The current view on automatic behaviors in cognitive psychology emphasizes how goals can arise from outside of conscious awareness but yet habits are fundamentally goal-oriented (Custers & Aarts 2010, Ortiz de Guinea & Markus 2009, Aarts & Dijksterhuis 2000). Specific goals are usually in line with individuals' values and

general goals (Ajzen 2002), which suggests that habits and intentional actions are in fact deeply similar. Although this conclusion is appealing, and it offers an intriguing starting point for further research, it leaves the BCSS designer basically empty handed. This is the reason why frameworks similar to Lally and Gardner's (2013) distinction of four stages of habit formation are also useful conceptualizations from a practical perspective.

Regarding ethical design, the current knowledge base is still limited in the field of persuasive technology. The ethical framework presented in Study III has not been used in practice, and there is a need for more studies regarding the ethical design and development of BCSSs. One important question is what kind of ethical dilemmas designers encounter in real life development settings, and what type of ethical tools should be available for the designers to solve those dilemmas?

To conclude, BCSS researchers need comprehensive behavior change theories. How to perceive behavior change and the means to reach it profoundly impacts how BCSSs should be designed and studied in the future. This dissertation evokes the need for further theoretical discussion about what behavior change-in-full is and how can it be supported by health BCSSs. As Walsham (2012) argues, information systems scholars can learn much from working with other disciplines and vice-versa. The research topics investigated in IS field are multi-disciplinary in nature (Walsham 2012). Variety of different disciplines have something of interest to say on research topics such as eHealth. Also, IS research field does not 'own' the design oriented studies either, as shown by studies made by Yardley *et al.* (2016) and Bradbury *et al.* (2014). The findings of this thesis favor interdisciplinary research in the future.

5 Conclusions

Walsham (2012) underpins the question of the IS field in the future: *Are we making a better world with ICTs?* Health as the main research context of this thesis resonates with the question. Changing people's behavior is at the heart of health promotion. The ability to support wellbeing and maintaining good health independently can truly have a significant impact on preventive healthcare.

The use of technologies to activate and support health behavior change has been an expanding field of research. Use of the Internet as a delivery channel for health behavior change interventions has the potential for high reach and low cost. This dissertation examined the role of BCSSs for users' health and wellbeing purposes. The main research question of this thesis was: *How is user experience with health BCSS related to health behavior change?*

The contribution of this work lies in the multiple perspectives offered in studying about the factors affecting individuals' perceptions and use of a health BCSS. The four studies (I–IV) investigate the phenomenon from slightly different facets: Study I examined the non-adoption of a BCSS; Study II investigated how flow experiences were perceived in the early phase of system adoption; Study III examined perceptions of persuasive features and how they contribute to system use adherence and actual behavior change; and Study IV investigated how stages of habit formation map with BCSS user experiences, the PSD model, and actual behavior change. In addition, Study V builds on the notion that ethical considerations are important to take into account in BCSS research and system design, and it offers a framework that can help developers to elaborate ethical issues in their design.

This dissertation adds to the body of knowledge by demonstrating the important role of the PSD model in health BCSS research. For designers and developers of BCSS, the work implies that building appropriate persuasive features into the system can increase use adherence and lead to better outcomes. Technology may provide the means to aid the individual users in their tasks, but successful engagement may depend on whether users have the opportunity to use the system as a seamless part of their daily routines.

This work took on a qualitative, hermeneutics approach, which is useful when a researcher develops a holistic interpretation that is consistent with the parts of a body of evidence. The understanding itself is realized in language, and the realization of understanding is interpretation. Communicating the process of understanding acts as another stage of interpretation. Conducting this story involved decision making regarding elements of emphasis, words, and tone.

I hope you liked it.

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Appendix A

Table 16. eHealth frameworks introduced in van Gemert-Pijnen et al. (2011) study

Author, year	Definition of technolgoy	Goal
Esser et al, 2009	Telemedicine, own definition; "Information and communication technologies for the exchange of medical information and expertise in the delivery of clinical services to patients, i.e. telemedicine."	The framework aims to improve the design process by helping the design professional to obtain a quick overview of all the aspects within the context that are relevant to the users of a teleconsultation system to obtain improved health, satisfaction, and ultimately acceptance. The authors state that the framework and the checklist are especially set up for, and thus restricted to, the context of patient-provider teleconsultation.
Catwell & Sheikh 2009	eHealth; definition based on Eysenbach (2001): "…an emerging field of medical informatics, referring to the organization and delivery of health services and information using the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a new way of working, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally and worldwide by using information and communication technology."	The overall aim of this model is to maximize the benefits while minimizing any risks associated with the eHealth intervention. This model has the additional advantage of providing a means to understand the implementation process.
Yusof et al. 2008	Health Information Systems (HIS); not defined	The framework aims to assist researchers and practitioners to unfold and understand the perceived complexity of health information system evaluation (on the performance, effectiveness, and impact of HIS).

Author, year	Definition of technolgoy	Goal
Hamid & Sarmad, 2008	eHealth; definition by the WHO/Canada's Health Informatics Association (see Oh et al., 2005): "the leveraging of the information and communication technology to connect provider and patients and governments; to educate and inform healthcare professionals, managers and consumers; to stimulate innovation in care delivery and health system management; and, to improve our healthcare system."	The framework aims to influence users' utilization and satisfaction of eHealth services.
Pagliari 2007	eHealth; own definition: "For the purposes of this paper, the term eHealth is used broadly as a synonym for health informatics or medical informatics and health services research for health technology assessment and health systems research."	The aim of the framework is to improve the quality and effectiveness of eHealth.
Kaufman et al. 2006	Health Information Systems (HIS); not defined	The framework aims: (1) To enhance the potential of eHts to influence the healthcare process positively. (2) To provide coherence and structure to research in informatics. (3) To help researchers focus on the types of evaluation objectives to be accomplished in all phases of system development.
Dansky et al. 2006	eHealth; definition by Eng (2002): "The term „eHealth" has emerged as a central, unifying definition of multiple technologies and modalities; essentially, it refers to: the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care".	The framework aims: (1) To overcome the challenges of implementing eHealth programs. (2) To assist eHealth researchers and others to build and evaluate effective eHealth programs.
Van der Meijden et al. 2003,	Health Information Systems (HIS); own definition: "A patient care information system was defined as a clinical information system in use in inpatient settings, requiring data entry and data retrieval by health care professionals themselves."	The aim of the framework is to foster the success of clinical information systems.
Shaw 2002	Information Communication Technology (ICT); not defined	Not mentioned

Author, year	Definition of technolgoy	Goal
Kazanjian & Green 2002	Health Information Systems (HIS); definition by the Institute of Medicine (2001): “Health information systems can be classified as health technologies, which - together with devices, drugs, and medical or surgical procedures -include the organizational = administrative and support systems within which health care is delivered.”	The aim of the framework is to provide an empirical, evidence based foundation for health technology decisions.
Kushniruk 2002	Health Information Systems (HIS); not defined	Not mentioned
Hebert 2001	Telehealth; definition by Field (1996) and Reid (1996): “The term “telehealth” is used to describe the exchange of health information and provide health care services through electronic information and communication technology (ICT), where participants are separated by geographic, time, social and cultural barriers.”	The framework aims: (1) To develop a body of knowledge around telehealth evaluations and supporting more advanced research efforts. (2) To guide eHealth investments about where telehealth is effective as well as what variables demonstrate telehealth success (eg, quality patient care, user satisfaction).
Eysenbach 2000	eHealth; not defined	Conceptual and methodological framework for describing, comparing, and analyzing the structure and quality of eHealth.
Eng et al. 1999	Interactive Health Communication (IHC) applications; defined by Robinson et al. (1998): “the interaction of an individual (consumer, patient, caregiver, or professional with of through an electronic device or communication technology to access or transmit health information or receive guidance and support on health-related issues”.	The framework aims to improve the quality and effectiveness of eHts..
Jai Ganesh 2004	eHealth; own definition: “eHealth refers to any use of an electronic information and communication technology to promote health or improve health care.”	The framework aims to foster the widespread adoption of eHts and successful deliverance of eHts.
Kukafka et al. 2003	Information Technology (IT) in healthcare; not defined	The framework is intended to guide synthesis of more than one theoretical perspective for the purpose of planning multi-level interventions to enhance IT use.

Appendix B

Table 17. Semi-structured questions are based on the version evolved in the third hermeneutic circle

	Question in Finnish language	English translation
01	Tutkimushankkeen käynnistymisestä on kulunut jo paljon aikaa. Miltä mukanaolo on tuntunut?	It has been a while since the research project started. How has it been so far?
02	Olet mukana ryhmässä, jossa … (viittaus A-, B-, tai C-interventioryhmään). Miten se on vaikuttanut?	You belong to a group, where .. (reference to A, B, or C intervention group). How has it felt?
03	Minkälaista on ollut käyttää Onnikkaa?	How has it been to use Onnikka?
04	Kuinka Onnikan käyttö sopii arkeesi?	How does the use of Onnikka fit to your daily life?
05	Onko sinulla riittävästi aikaa Onnikan käyttöä varten?	Do you have enough time to use Onnikka?
06	Vaatiiko Onnikan käyttö tietoista sitoutumista? Onko se jo osa rutiineja?	Does the use of Onnikka still demand conscious commitment? Is it part of your everyday routine?
07	Missä yleensä käytät Onnikkaa? Käytätkö älypuhelimen tai tabletin kautta?	Where do you normally use Onnikka? Do you use it with smartphone or a tablet?
08	Onko sinulla muita vastaavia sovelluksia tai järjestelmiä käytössä?	Do you have any other similar apps or systems in use?
09	(Jos kyllä) Oletko käyttänyt ohjelmia ennen Onnikkaa, vai kannustiko tämä hanke sinua etsimään niitä?	(If yes) Have you used these type of systems before Onnikka, or did this project inspire you to search them?
10	Oletko muihin verrattuna taitava nettisovellusten käyttäjä?	Do you think you are skilled web-systems' user if compared to others?
11	Onko sinulla riittävät taidot Onnikan käyttöön?	Do you have sufficient skills to use Onnikka?
12	Tuntuuko Onnikan käyttö helpolta?	Is it easy to use of Onnikka?
13	Tuntuuko olo koskaan epävarmalta, kun käytät Onnikkaa?	Have you ever felt insecure when you have used Onnikka?
14	Onko Onnikka sinulle hyödyllinen?	Has Onnikka been useful to you?
15	Saako Onnikka sinut pysymään ohjelmassa?	Has Onnikka helped you to stay in the program?
16	Onko Onnikka muuttanut käyttäytymistäsi?	Has Onnikka changed your behaviour?
17	Onko Onnikka vaikuttanut asenteisiisi?	Has Onnikka affected to your attitudes?
18	Auttaako Onnikan käyttö houkutusten kohtaamisessa?	Is Onnikka able to help you to resist temptations?
19	Opitko Onnikan avulla uusia asioita?	Have you learnt new things by using Onnikka?
20	Onko sen hahmottaminen, mitä informaatiota Onnikka tarjoaa, helppoa?	Is it easy to perceive what information Onnikka offers?

	Question in Finnish language	English translation
21	Onko Onnikan informaatiossa liikkuminen jouhevaa?	Is it easy to navigate whitin Onnikka's information?
22	Tuntuuko informaatio riittävän omakohtaiselta?	Do you feel that the the information has been personal enough?
23	Antaako Onnikka sinulle sopivasti haasteita?	Does Onnikka challenge you enough?
24	Oletko täysin keskittynyt tekemiseesi, kun käytät Onnikkaa?	When using Onnikka, are you completely focused on what you are doing?
25	Oletko päässyt Onnikan käytössä flow-tilaan? (Flow-käsite selitettiin tarvittaessa)	Have you reached flow when you have used Onnikka? (The term flow was described by the interviewer when needed.)
26	Oletko kokenut Flow-kokemuksia painonhallintaan tai elämäntapamuutokseen liittyen Onnikan ulkopuolella?	Have you experienced flow regarding weight maintenance and lifestyle change outside of Onnikka?
27	(Jos kyllä) Onko Onnikasta ollut apua flow'n saavuttamisessa?	(If yes) Has Onnikka helped to reach flow?
28	On yksilöllistä, kuinka helposti kukin pääseen flow-tilaan. Onko se sinulle kuinka helppoa tai vaikeaa?	There are differences between individuals for how easy it is to reach flow. Is it easy or hard for you?
29	Oliko flown kokemisella, tai sillä ettei sitä ole saavuttanut, ollut merkitystä Onnikan käyttöön?	Has experiencing flow or not experiencing it affected the use of Onnikka?
30	Onko Onnikka onnistunut viihdyttämään sinua, vai onko se sinulle yksinomaan hyötysovellus?	Has Onnikka been able to entertain you, or is it for utility purpose only?
31	Mitä jos vaakakuppia käännettäisiin enemmän viihdyttävämpään suuntaan?	What if the balance could be tilted to be more entertaining?
32	Kuinka uskottava Onnikka on sun mielestä?	How credible Onnikka is in your opinion?
33	Mitkä asiat siihen vaikuttaa eniten?	What issues influence credibility the most?
34	Onnikka edustaa ns. perinteistä näkemystä painonhallinnasta. Mitä mieltä olet käynnissä olevasta rasvakeskustelusta tai paastodieetistä?	Onnikka represents so called traditional view of weight management. Does the currently on-going debate on fats or fasting diet bother you?
35	Kun mietit Onnikan käyttöä, niin mitkä ominaisuudet ovat tukeneet parhaiten elämäntavan muutoksessa?	When you evaluate your Onnikka use, what features have supported you on your lifestyle change?
36	Miltä viikoittainen sähköposti Onnikasta on tuntunut?	How has it felt to receive weekly e-mails from Onnikka?
37	Mikä merkitys muutaman päivän päästä tulevalla muistutuksella on?	What is the significance of the reminder message you receive after few days?
38	Tulevatko sähköpostit sinulle kännykkään?	Do you get your e-mails to your smartphone?
39	Kuinka usein haluaisit saada Onnikan lähettämää palautetta?	How often would you like to receive feedback from Onnikka?
40	Haluaisitko määrittää ne hetket, jolloin Onnikka sinulle palautteen lähettää?	Would you want to be able to choose the moments when Onnikka sends you feedback?

	Question in Finnish language	English translation
41	Miltä Onnikan pakkotahtisuus tuntuu?	How do you feel about the forced weekly schedule of Onnikka?
42	Onko viikoittain tulevalla uudella sisällöllä vaikutusta Onnikan käyttöön?	Does receiving new, weekly content affect your Onnikka use?
43	Oletko tehnyt viikkotehtäviä Onnikkaan? Mitä mieltä olet niistä?	Have you done weekly tasks in Onnikka? What do you think of them?
44	Onnikan etusivulta näkee, kuinka moni on käyttänyt järjestelmää sillä viikolla. Oletko huomannut tätä ominaisuutta? Mitä mieltä olet siitä?	On Onnikka's front page you can see how many persons have used the system during that week. Have you noticed this feature? What do you think about it?
45	Etusivulla näkyy myös, kuinka paljon matkaa on seuraavaan pysäkkiin. Oletko huomannut tätä ominaisuutta? Mitä mieltä olet siitä?	On Onnikka's front page you can also see how much time there is till next bus stop. Have you noticed this feature? What do you think about it?
46	Onnikkaan on mahdollista tallentaa tietoja omasta painosta. Miten painokäyrä vaikutti?	There is a possibility to track weight in Onnikka. How has the weight graph affected you?
47	Oletko huomannut, että saat aina painon syöttämisen jälkeen palautetta järjestelmältä? Miltä se tuntuu?	Have you noticed that after every time you submit your weight, you get feedback? How has it felt?
48	Oletko merkinnyt motivaatiotasi Onnikkaan? Mitä mieltä olet siitä?	Have you ever marked your motivation in Onnikka? What do you think of it?
49	Oletko täyttänyt liikuntapäiväkirjaa? Mitä mieltä olet siitä?	Have you used exercise diary? What do you think of it?
50	Oletko käyttänyt ruokapäiväkirjaa? Mitä mieltä olet siitä? Onko vaikuttanut haitallisesti Onnikan käyttöön?	Have you used food diary? Has it affected your Onnikka use negatively?
51	Onnikassa on mahdollista jakaa kokemuksia toisten kanssa. Käytätkö ja seuraatko sitä?	In Onnikka there has been a possibility to share experiences with one another. Have you used or followed it?
52	Käytetty melko vähän. Mistä luulet, että se johtuu?	It has been used quite seldomly. What do you think are the reasons behind it?
53	Käytätkö sosiaalista mediaa, kuten Facebookia?	Do you use social media such as Facebook?
54	Onnikassa on kysy-vastaa-palsta. Oletko huomannut sitä?	Onnikka has frequently asked questions section. Have you noticed it?
55	Kuinka vakuuttava Onnikka-järjestelmä on kokonaisuutena sinun mielestä? Suostutteleeko se sinua? Saako se sinut tekemään tavoittelemiasi asioita?	How persuasive is Onnikka system in your opinion? Does it convince you? Does it make you pursue your goals?
56	Mitä vaatisi, että järjestelmä olisi mukaansatempaavampi?	What would it require from a system to be more engaging?

	Question in Finnish language	English translation
57	Mikä saa sinut käyttämään Onnikkaa? / Mikä sai sinut luopumaan Onnikan käytöstä?	What issues make you use Onnikka? / What made you stop using Onnikka?
58	Onko sinulla mielestäsi riittävät painonhallintataidot?	Do you think you have sufficient weight management skills?
59	Onko taidoissasi tapahtunut muutosta tämän hankkeen aikana?	Have your skills changed during this research project?
60	Minkälainen rooli Onnikalla on ollut siinä?	Does Onnikka have any role in it?
61	Seuraatko painoa, motivaatiota, liikuntaa tai syömistä Onnikan ulkopuolella?	Do you monitor your weight, exercise or diet with other means than Onnikka?
62	Minkälaisen tavoitteen itsellesi asetit hankkeen alussa?	What kind of goal did you set originally?
63	Ovatko muutokset näkyneet myös painon tippumisena?	Have the changes shown also as actual weight loss?
64	Ootko muutoin tuntenut onnistumisia hankkeen aikana?	Have you experienced other successes during this project?
65	Minkälainen tavoite sinulla on hankkeen loppuajaksi? Onko se sama vai muuttunut?	What kind of goal do you have for the remaining project period? Is it same or has it changed?
66	Kuinka aktiivisesti oot pitänyt tätä tavoitetta mielessä?	How actively you have kept this goal in mind?
67	Onko uusista elämäntavoista tullut tapa?	Have new lifestyle choices become a habit?
68	Onko arki muuttunut tämän tutkimushankkeen myötä?	Has your everyday life changed because of this research project?
69	Teetkö eteen tulevat valinnat jo automaattisesti?	Are you making any foreseeable choices in an automated manner now?
70	Mikä on ollut se kaikkein vaikein muutettava asia, johon on pitänyt eniten keskittyä?	What has been the one most challenging thing that you have had to focus on the most?
71	Kuinka hyvin sulla on riittänyt itsekuria?	How have you been doing with self discipline?
72	Suunnitteletko jo etukäteen, kuinka selvitä hankalista hetkistä?	Do you plan ahead how to cope with tough situations?
73	Onko tapahtunut repsahduksia?	Have you had relapses?
74	Kuinka selvisit niistä?	How did you cope from them?
75	Kuinka hyvin sulla on riittänyt motivaatiota?	How has your motivation been?
76	Onko sulla ollut keinoja palkita itseä, vai ootko halunnut sen lähtevän sinusta itsestä?	Do you have means to reward yourself, or do you believe in intrinsic motivation?
77	Uskotko, että tulet saavuttamaan tavoitteesi?	Do you believe that you will achieve your goals?
78	Onko mielessäsi vielä jotain, mitä haluaisit sanoa?	Is there anything more that you would like to say?
79	Oliko jotain, joka jäi kysymättä haastattelun aikana?	Was there something that I forgot to ask during this interviews?

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I Karppinen P, Lehto T, Oinas-Kukkonen H, Pätiälä T & Saarelma O (2014) Using hermeneutics to uncover anomalies for non-adoption of behavior change support systems. PACIS 2014 Proceedings. Chengdu, China: 110.

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