Michael Oduor

PERSUASIVE SOFTWARE DESIGN PATTERNS AND USER PERCEPTIONS OF BEHAVIOUR CHANGE SUPPORT SYSTEMS
MICHAEL ODUOR

PERSUASIVE SOFTWARE DESIGN PATTERNS AND USER PERCEPTIONS OF BEHAVIOUR CHANGE SUPPORT SYSTEMS

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**Abstract**

Modern life has increasingly become intertwined with technology, and recent years have witnessed a growth in technologies that support people in, for instance, leading healthier and more sustainable lifestyles. At the centre of this growth has been persuasive systems design, which has been shown to have a positive effect on individuals’ behaviour and their use of systems.

This dissertation consists of five studies, encompassing a literature review, two quantitative studies with a total of 227 respondents, and two constructive studies that address the central research question of the dissertation: *How can integrating judgment and decision-making processes and persuasive software design patterns enhance the development of behaviour change support systems?*

The primary theoretical framework for the research is the Persuasive Systems Design model. This is a model that outlines the key requirements for developing persuasive systems, consisting of the theoretical underpinnings, persuasion context analysis, and four feature categories. In recent years, improving the design of persuasive systems to better achieve their intended objectives has been an important topic. This dissertation, in addition to examining the role of persuasive software features in influencing behaviour, also integrates behavioural economics and software design patterns into the design of persuasive systems. Additionally, the interplay between the categories and other constructs such as perceived competence is investigated through statistical analyses.

Overall, results reveal that persuasive system features have an impact on the efficacy of behaviour change support systems. Additionally, integrating behavioural economics concepts that explain the reasons why individuals deviate from expected behaviour and software design patterns can help improve the development of persuasive systems and further enhance their efficacy.

**Keywords:** behaviour change, behaviour change support systems, behavioural economics, commitment devices, persuasive systems design, software design patterns
Oduor, Michael, Suostuttelevat ohjelmistosuunnittelumallit ja käyttäjien koke- 
mukset käyttäytymisen muutosta tukevissa järjestelmissä. 
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Tiivistelmä

Teknologia on yhä tiukemmin osa nykyelämää. Viime vuosina on tapahtunut kasvua ja kehitystä 
teknologiassa, jotka tukevat ihmisiä esimerkiksi elämään terveellisemmin ja ympäristöä säätä-
en. Tämän kasvun keskiössä on ollut vakuuttavien järjestelmiän suunnittelu, jonka on osoitettu 
vaikuttavan positiivisesti sekä ihmisten käyttäytymiseen että järjestelmien käyttöön.

Tämä väitöskirja käsittää viisi tutkimusta, sisältäen kirjallisuuskatsauksen, kaksi kvantitatii-
vista tutkimusta yhteensä 227 vastaajalla, ja kaksi konstruktiiivista tutkimusta, jotka yhdessä vas-
taavat väitöskirjan päätutkimuskysymykseen: Kuinka arviointi- ja pääöksentekoprosessit sekä 
vakuuttavien järjestelmien suunnittelumallit yhdistämällä voidaan edistää käyttäytymisen muu-
tosta tukevien järjestelmien kehitystä?

Ensisijainen teoreettinen viitekehys tutkimukselle on vakuuttavien järjestelmien suunnittel-
malli (Persuasive Systems Design model). Kyseinen malli määrittää keskeiset vaatimukset 
vakuuttavien järjestelmien kehittämiselle. Tärkeänä aiheena on ollut vakuuttavien järjestelmien 
suunnitelmisen edistäminen, jotta niillä voitaisiin paremmin saavuttaa aiotut päämäärät. Tämä 
väitöskirja tutki vakuuttavien järjestelmien ohjelmisto-ominaisuuksien vaikutusta käyttäytymi-
seen yhdistäen siihen myös käyttäytymistaloustieteen sekä ohjelmistosuunnittelumallit. Ohjel-
misto-ominaisuksien kategorioiden ja muiden tärkeiden käsitteiden, kuten koetun pätevyyden, 
keskinäisiä suhteita ja vuorovaikutusta on tutkittu tilastollisen analyysin keinoin.

Kaiken kaikkiaan tulokset paljastavat vakuuttavien järjestelmien ominaisuuksilla olevan vai-
kutusta käyttäytymisen muutosta tukevien järjestelmien vaikuttavuuteen. Yhdistämällä näiden 
suunnittelun ja erityisesti niitä koskeviin ohjelmistosuunnittelumalleihin käyttäytymistaloustie-
teen konsepteja voidaan selittää syitä, joiden vuoksi yksilöt joissakin tilanteissa saattavat käyt-
täytyä odotetusta poikkeavasti. Tällä voidaan edistää vakuuttavien järjestelmien kehittämistä ja 
eteitä parantaa niiden vaikuttavuutta.

Asiakset: käyttäytymisen muutos, käyttäytymisen muutosta tukevat tietojärjestelmät, 
käyttäytymistaloustiede, ohjelmistosuunnittelumallit, sitoumuskienot, vakuuttavien 
jarjestelmien suunnittelu
To my family
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While going through various stages of studies and even till my Master's degree, getting a PhD always seemed like something to pursue much later in life when I had seen more of the world, had a family, old age cropping up with warnings of unmet goals, and life has a semblance of normalcy (if it ever does). Although just a tiny part of the overall journey is complete, looking back, it has been among the most fulfilling journeys ever for me. There is still plenty to learn, but the intervening period has been full of growth both personally and as a researcher. Plus, there has been an opportunity to see more of the world too, not so bad!

There is plenty of freedom when doing research, but this can be double-edged sword. Especially, for someone like me who finds it difficult to get started without having key issues lining up as I believe they should. A habit I am slowly learning to shed the more I develop as a researcher. Doing a PhD is fun... at times. The fun moments, of course, do not include rushing to meet deadlines, going through rejection after rejection and prolonged periods of self-doubt. Self-doubt of your abilities and the usefulness of your own research which can, at times, be destructive to the mind and spirit. This is, of course, momentarily forgotten when a submission is accepted, you receive a favourable response or certain plans work out, but then the cycle begins again and you do learn!

This thesis would not be possible without the support of my family, friends, and colleagues who made the journey a pleasurable experience. But before getting to these individuals, it would be very remiss of me not to acknowledge the support and belief that my supervisor Harri Oinas-Kukkonen has shown in me. Who would have thought that participating in an elective course during my Master's studies could lead to a research career? Certainly, not me but that is how it started (sort of). The supervisor-student relationship has been punctuated with open and regular communication, freedom and sincere criticism which has created a favourable environment for research. Throughout the process, we have had interesting discussions and debates which have resulted in mostly positive outcomes. Harri's guidance and constant encouragement to develop as a researcher has been invaluable. He opened the door and provided a map for a journey that, until my Master's thesis under his supervision, I had not considered or did not think was possible. Yet, here we are now. Thank you for taking a chance on, believing in, guiding and helping to sharpen a semi-confused mind!
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to especially thank my eldest sister, Alice, who I will forever be grateful to for her
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Lastly, this doctoral thesis is dedicated to my parents. To my late Dad, I know
you are up in heaven jumping with joy looking down wondering how this happened
so soon... well, you and me both. While we are in awe, Mama is here saying I told
you so! A superhuman whose unshakable belief in her son always drives me to
become a better version of myself. All praise to the Almighty!

Date: 12.3. 2018, Michael Oduor
Abbreviations

BCSS  Behaviour change support system
ELM   Elaboration likelihood model
HCI   Human-computer-interaction
IS    Information systems
PSD   Persuasive systems design
TAM   Technology adoption model
UTAUT Unified theory of acceptance and use of technology
Original publications

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


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1 Introduction

Technological changes have impacted upon the ways in which we communicate, and recent years have seen a growth in systems aimed at motivating people to change their attitudes and behaviour (Chatterjee & Price, 2009). Digital interventions have transformed the sustainability, healthcare and well-being sectors by encouraging active user participation and facilitating user interaction in digital environments. Interpersonal interactions with technology are essential for persuading individuals to adopt the desired behaviour. As persuasion can enable continuous change in individuals’ attitudes, it has the capacity to lead to behaviour change. Factors that lead to attitude change have been prevalent in social psychology since its inception. The fundamental premise of attitude change is the success of presented messages in moving recipients’ attitudes towards an advocated position after they have been processed. The revised attitude may, in turn, influence subsequent behaviour (Chatterjee & Price, 2009).

There are many kinds of digital interventions sharing similar features that have been developed with persuasion in mind. An important consideration for these interventions is to maintain high levels of user engagement and to encourage and keep users motivated (Oinas-Kukkonen & Oinas-Kukkonen, 2013). This has been a major challenge that is often approached through persuasive systems design (Oinas-Kukkonen & Harjumaa, 2009; Schneider, Moser, Butz, & Alt, 2016). This is because a persuasive communication’s appeal is more likely to be effective to the extent that the reason for holding the position outlined in the appeal matches the recipients’ dispositions (Wood, 2000).

The Web and handheld devices have the ability to provide efficient, interactive, and tailored content to the user and digital interventions have induced significant changes in smoking, diet, and physical activity (Langrial & Oinas-Kukkonen, 2012; Lehto & Oinas-Kukkonen, 2011; Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007; Womble et al., 2004). Digital interventions also have the potential to provide personalised behaviour change information to many individuals (Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009).

The wellness-related sectors are prime candidates for the application of key behavioural science theories and principles for promoting healthier behaviour, and generate new insights for healthcare that encourage sustainable and healthier living (Langrial, Lehto, Oinas-Kukkonen, Harjumaa, & Karppinen, 2012; Lehto & Oinas-Kukkonen, 2011). There is extensive research showing that computer-based health interventions can be efficacious and, as computing has migrated to the Web, so
have the plethora of behaviour change support systems (BCSSs) (Lenert, Munoz, Perez, & Bansod, 2004; Oinas-Kukkonen, 2013).

A BCSS was introduced as an object of persuasive systems, and is defined by Oinas-Kukkonen (2013) as follows:

*A BCSS is a sociotechnical information system with psychological and behavioural outcomes designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception.*

BCSSs are inherently transformative and highlight voluntary approaches in which people use technology to change their own behaviour by relying upon their personal motivation or goals (Oinas-Kukkonen, 2013). These systems and technology are, in general, more effective in persuasion and offer a potential path to long-term behaviour change as they leverage technology’s capabilities (Fogg, 2003) to influence users.

Technical design decisions and choices related to software features determine how content is presented, the mode of user interaction with the content, the content’s visibility span, and the links between users. These design decisions, in turn, influence the level of user engagement and the social interactions that can occur within systems (Hansen, Shneiderman, & Smith, 2010).

The underlying principle behind persuasive systems is studying and understanding users and integrating this knowledge into developing systems that help users to meet their various sustainability and/or health-related goals. This could be through design strategies that help people to change their everyday behaviour (Consolvo, McDonald, & Landay, 2009), or investigating how the design of persuasive systems and an intervention’s characteristics influence users’ adoption, continuance intention, and adherence to these systems (Kelders et al., 2012; Lehto & Oinas-Kukkonen, 2015; Lehto, Oinas-Kukkonen, Pätiälä, & Saarelma, 2012), among others.

Technology, although often seen as a tool to accomplish goals, is never neutral, and people are constantly being influenced, whether intentionally or as an unintentional side effect of the design (Oinas-Kukkonen, 2013). Research has shown that persuasive systems design matters (Kelders et al., 2012), but there is not yet a common understanding of when or how different persuasive strategies work and why certain strategies might only work in some cases (Schneider et al., 2016). A comprehensive system that meets each individual’s needs has yet to be developed and no single solution can solve all our problems (Drozd, Lehto, & Oinas-Kukkonen, 2012).
In most persuasive systems research, the context and its effect on decision making is seldom addressed. Success is defined in terms of changing behaviour in ways predetermined by the developers or providers of a system without due consideration to the sustainability effects of the design (Brynjarsdottir et al., 2012; DiSalvo, Sengers, & Brynjarsdóttir, 2010). The main design strategies have involved providing information about the extent to which users’ behaviour is or is not desirable and presenting information related to consumption habits or other behaviours implicitly contextualised within the topic of study (DiSalvo et al., 2010). However, research has shown that information-centric approaches, which rest on the assumption of people being rational actors striving to improve based on their knowledge and the available information, can be disadvantageous (Brynjarsdottir et al., 2012; M. K. Lee, Kiesler, & Forlizzi, 2011).

Furthermore, there has been a tendency to describe the software systems and the persuasion context at a generic level. This is primarily because of a lack of guidance for developers of persuasive systems on how to apply the underlying theories (Oinas-Kukkonen, 2013), with few works placing the emphasis on describing the actual software system clearly (cf. Pribik & Felfernig, 2012). In addition, the theoretical frameworks upon which the research relies fail to provide guidance for the implementation of systems that support the behaviour change process, thus leading to a passive adoption of these theories in systems implementation and into a mismatch between the intended outcome of persuasive communication (Chapter 2 discusses the persuasion intent) and the selected persuasive strategy (Oinas-Kukkonen, 2013; Wiafe, Nakata, & Gulliver, 2014).

Overall, the aim is to: 1) Understand how users’ limited information-processing capabilities influence their decision making and interaction with IS by using persuasion context analysis from the PSD model (Oinas-Kukkonen & Harjumaa, 2009) to review behavioural economics studies in information systems (IS) research, 2) examine and understand how users perceive the persuasive software features, and their potential effect on users’ behaviour, 3) highlight the persuasive software features used to influence users’ behaviour in social web platforms, and propose generalizable and reusable techniques for the development of persuasive systems.

Understanding how limited information-processing capabilities affects decisions can help improve the development and presentation of different persuasive techniques by simplifying selection criteria to help users make better choices, reducing the cognitive costs associated with decision making, and facilitating user commitment. Based on this understanding, the dissertation
investigates the effects of persuasive software features on an online commitment device’s efficacy. Following this, the features used to influence user interactions and the importance users attach to these features are examined. After examining the persuasive software features, the dissertation proposes the use of persuasive software design patterns to develop BCSSs.

Therefore, this dissertation aims to address the abovementioned shortcomings of persuasive systems by investigating how different features are used for persuasion and which of these features are more or less effective in influencing user interactions and facilitating behaviour change. This is achieved by reviewing behavioural economics studies to examine how its insights can be applied to improve the design of persuasive systems, investigating the effectiveness of persuasive software features in an online commitment device and in social web platforms, and, based on the results of these two studies, instantiating dialogue support and social support persuasive features categories from Oinas-Kukkonen and Harjumaa’s (2009) PSD model.

The structure of this dissertation is as follows. Section 2 presents the key background literature relevant to this dissertation. Section 3 presents the research methodology, comprising the research objectives, approach, and research analysis methods. A summary of the studies included in the dissertation and their findings is presented in Section 4. A discussion of the results, their importance and relation to previous work is presented in Section 5. After this, the limitations and future research directions are presented and the dissertation is concluded.
2 Theoretical background

The theoretical background for the studies in this dissertation is presented in this section. Related research on persuasive technology, the persuasive systems design model, and its application are presented. This is followed by a review of studies related to judgement and decision making and information systems-related research. The section concludes by reviewing studies on software design patterns.

2.1 Positioning the background literature

There are many different models and approaches for the development of persuasive systems. In this doctoral dissertation, the PSD model (Oinas-Kukkonen & Harjumaa, 2009) is the main framework guiding the work.

The background presents the underlying concepts behind the use and development of persuasive systems, the issues to be considered, and how a system’s features can contribute to its success. The characteristics of persuasive technology, what PSD entails, and how web platforms provide persuasive user experiences are discussed in sub-section 2.2.

Judgement and decision (2.3) aims to describe individuals’ limited information-processing capabilities, their thought process when making a decision or valuing between different options, and how this affects their decision making – decision making that may not always be based on facts and deviates from the expected responses. The literature on judgement and decision making aims to provide research guidelines for guiding users to make improved decisions and how the principles can be applied in systems that facilitate user commitment to their goals such as those described in 2.3.2.

Section 2.4 considers a dominant theory in the IS discipline, the technology acceptance model, its iterations, and the improvements that have been made to the theory in order to better explain the adoption, use, and post-adoption behaviours of IS users.

Section 2.5 presents a more software engineering-oriented perspective by describing software design patterns and how these patterns can be used to improve the development process of systems. The core idea behind patterns is reusability, and the section explores the overall background and how different patterns have been used, for example, in the various stages of systems development.
2.2 Persuasive technology

The use of technologies to persuade and facilitate behaviour change has been an active domain for research in the recent past (Chatterjee & Price, 2009). Persuasion as a consideration for information technology is often concerned with how behaviour change can be enabled by intervening in moments of local decision making and by acknowledging, rewarding and enhancing motivation for desirable behaviours (Dourish, 2010). Persuasive technology research, in the sustainable HCI literature, often comes from a psychology or computer-mediated communication (CMC) orientation, although some are more design-oriented (DiSalvo et al., 2010). Within the genre, the standard approach has been to design systems that try to motivate users to behave in a more desirable way by providing information or giving them feedback (Brynjarsdottir et al., 2012; DiSalvo et al., 2010; Lee, Kiesler, & Forlizzi, 2011).

In terms of persuasive technology, computers are viewed as interactive technologies that can motivate and influence the user. Oinas-Kukkonen & Harjumaa (2009) define a persuasive system as “a computerized software or information system designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception”. Technology does not, in itself, seek to influence, but, through services that can be built on top of the technology, it facilitates behaviour change (Lockton, 2012). Therefore, designing systems that aim at behaviour change requires a thorough understanding of the problem domain and the underpinning theories and strategies of persuasive systems design (Lehto & Oinas-Kukkonen, 2011).

Persuasion is a situation whereby a recipient receives an intervention (e.g., a persuasive message) that refers to something outside the message itself (the context) (Briñol & Petty, 2009). Persuasion techniques are most effective when they are interactive and when persuaders adjust their influencing tactics as the situation evolves. Computers are particularly effective in persuasion because: 1) they can be more persistent, 2) they offer greater anonymity, 3) they can manage huge volumes of data, 4) they can present information in numerous modes (data and graphic, rich audio and video, animation) which humans cannot match, 5) they can scale according to demand, and finally, 6) they are ubiquitous – can be accessed from almost anywhere (Fogg, 2003, p. 7-11). These different properties enable persuasive systems to adopt to different roles according to the aims of a particular intervention.
The multi-modality and high interactivity of web technologies enables the creation of self-regulatory skills and provides various options for engaging, educating, and equipping individuals (Lustria, Cortese, Noar, & Glueckauf, 2009). Persuasive technology combines context and cognition, external factors and the individual, as well as taking into account personal factors such as motivation alongside environmental ones such as triggers (Lockton, 2012).

Humans often rely on intuition to achieve target behaviours, something upon which computers cannot yet rely to create persuasive experiences. For efficiency, these experiences must be pre-coded in the systems and thought must be given to the target behaviours desired and how to achieve them (Fogg & Hreha, 2010). From a user’s perspective, computers can operate as tools that increase capability, as mediums that provide interactive experiences, and as social actors that create and enhance relationships (Fogg, 2003).

Fogg’s work builds on Nass, Steuer, and Tauber's (1994) proposition of computers as social actors and that individuals’ interactions with computers are primarily social. Through experiments where social norms and notions of “self” and “other” were applied to computers, it was deduced that people’s responses to computers are not the result of conscious beliefs that computers are human or possess human-like features, of ignorance, psychological dysfunction or the belief that the computers were acting as mediators. In contrast, it is because it was common and relatively easy to produce social responses to computers (Nass & Moon, 2000; Nass et al., 1994). This not only shows that users view their interactions with technology as social and interpersonal, but that they also attribute human-like behaviours and personalities to technology (Al-Natour & Benbasat, 2009).

Extending Fogg’s (2003) studies on persuasive technology is Oinas-Kukkonen and Harjumaa’s (2009) PSD model discussed in the following section.

### 2.2.1 Persuasive systems design model

The PSD model (Oinas-Kukkonen and Harjumaa, 2009) (summarised in Figure 1) for designing and evaluating persuasive systems is intended to solve real-world problems in the design and development of persuasive systems. The model integrates studies of human behaviour based on prior knowledge of social psychological theories and information systems (IS) development to develop behaviour change interventions (Harjumaa, 2014). The model has been used to investigate, for example, adherence in the use of health BCSSs (Kelders et al.,
2012), persuasive user experiences of a health BCSS for the prevention of metabolic syndrome (Karppinen et al., 2016), and the factors explaining perceived effectiveness and use continuance of a BCSS for weight loss (Lehto & Oinas-Kukkonen, 2015).

In the PSD model, persuasive software features are categorised according to: (1) Primary task support – features that support the carrying out of a user’s real-world activity and comprise reduction, tunnelling, tailoring, personalisation, self-monitoring, simulation, and rehearsal. (2) Computer-human dialogue support (henceforth dialogue support) – deals with degree of feedback and features which
support interaction between the users and the system. Dialogue support comprises praise, rewards, reminders, suggestion, similarity, liking, and social role. (3) System credibility support – deals with designing more credible and subsequently more persuasive systems. Credibility support comprises trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. (4) Social support features motivate users by leveraging social influence. This includes social facilitation, social comparison, normative influence, social learning, cooperation, competition and recognition (Oinas-Kukkonen & Harjumaa, 2009).

However, before being able to implement any of the abovementioned persuasive software features, the PSD model presents seven essential postulates behind persuasive systems that relate to the neutrality of technology, accessibility and reach, ease of use, making and enforcing of commitments, attitudes and persuasion strategies, the sequential nature of persuasion, and the ideal moments for initiating persuasive features and openness (Oinas-Kukkonen & Harjumaa, 2009). Inherent in the above postulates are social psychological theories on attitude and behaviour change, social influence, learning, and so forth that help to explain human behaviour in different situations.

When developing persuasive systems, the applicable theories should be taken into account. These include: the elaboration likelihood model (ELM) (Petty & Cacioppo, 1986), a theory on attitude change that describes the central and peripheral routes to information processing and persuasion; Bandura's (1989) social learning theory, which provides a framework for understanding, predicting and changing human behaviour and states that people learn new behaviours by studying, observing and then replicating the actions of others; and Cialdini’s (2007) studies on influence, which show how formulating requests in certain ways triggers automatic compliance response from individuals.

After acknowledging the persuasion postulates, the context for persuasion should be included when developing persuasive systems. Persuasion context analysis calls for a thorough understanding of what takes place in the information processing event, namely understanding the roles of persuader, persuadee, message, channel, and the wider context (Oinas-Kukkonen and Harjumaa, 2009). A thorough analysis of the persuasion context helps to recognise inconsistencies in a user’s thinking, discern opportune and/or inopportune moments for delivering messages, and persuade effectively.

Persuasion context analysis includes the intent of persuasion, the persuasion event, and the strategies in use (Oinas-Kukkonen & Harjumaa, 2009).
The persuasion intent involves determining who the actual persuader is, as intentionality is a salient part of persuasive communication (Harjumaa, 2014). Since computers do not have any intentions of their own, the source of persuasion in a system is always one of those who creates the interactive technology (endogenous), distributes the interactive technology (exogenous), or adopts the interactive technology (autogenous) (Fogg, 1998). Analysing the intent also covers defining the type of change (Oinas-Kukkonen & Harjumaa, 2009). The outcome/change design matrix (Oinas-Kukkonen, 2013) defines three potential outcomes for a persuasive system as: 1) reinforcement – making current attitudes resistant to change, 2) changing outcome – relating to one’s response to an issue, and 3) shaping outcome – formulating a pattern for a situation where one did not previously exist (Oinas-Kukkonen, 2013; Oinas-Kukkonen & Harjumaa, 2008).

As for understanding the persuasion event, the use, the user, and the technology contexts should be considered (Oinas-Kukkonen & Harjumaa, 2009). The use context covers the characteristics of the problem domain in question, the user context considers the differences and characteristics of users, and the technology context details the technical specifications of a system or the type of technology used in a study. Finally, identifying the persuasion strategies includes analysing the persuasive message that is conveyed and the route, whether direct or indirect, that is used to reach the persuadee (Oinas-Kukkonen & Harjumaa, 2009).

2.2.2 Persuasive user experiences

Social web platforms focus on the consumers’ user experience and expand their media choices so as to capture and reach intimacy and engagement (Hanna, Rohm, & Crittenden, 2011). As a platform that provides tools and extensive documentation to interact with and extend application programming interfaces (APIs) capabilities (boyd & Ellison, 2007; Hanna et al., 2011; Hansen et al., 2010; Kaplan & Haenlein, 2010), the social web has availed radical and innovative ways to interact. It has also presented unforeseen opportunities for networking (Hansen, Shneiderman, & Smith, 2010; Oinas-Kukkonen & Oinas-Kukkonen, 2013).

Online interaction depends on the medium used that defines and frames the message. Communication media differ according to the state of social presence. That is, the state of being present between two communicators using a social medium (Lowenthal, 2010). Some communication media have a higher degree of social presence, for example, characters in virtual environments, whereas others have a lower degree of social presence, for example, e-mails and audio. The higher
the degree of social presence, the more sociable a communication is viewed –
warmly and personally, and the larger the social influence that communicators have
on one another (Kaplan & Haenlein, 2010; Lowenthal, 2010).

An important consideration for the future of the web is providing persuasive
user experiences for different user groups who would otherwise not have a reason
to contribute to the content. Persuasive user experiences can be used to motivate,
encourage, and persuade them to participate (Oinas-Kukkonen & Oinas-Kukkonen,
2013) by providing symbolic strategies that trigger users’ cognition and or emotions
and often try to convince them to take action (Oinas-Kukkonen & Harjumaa, 2009).
From a persuasive system’s point of view, this is referred to as a system’s self-
referential persuasion – the persuasive intent being to refer to itself so that users
stay within the ecosystem and are persuaded to frequently use it.

The phases of the behaviour chain related to this are discovery, superficial
involvement and (true) commitment (Fogg & Eckles, 2007). Discovery and
superficial involvement concern the initial introduction to a web service and the
process of learning about it and first-time use, for example, setting up a user
account. This first encounter between a user and a system is crucial, as it is likely
to influence the later decision to continue using the same system (Ruth, 2012).
However, when analysing already well-known social web platforms, investigating
the persuasive strategies for user commitment can be more revealing. The success
witnessed by the major social web platforms such as Facebook is based on
encouraging and persuading social interaction and engagement among users. The
true commitment phase (see Figure 2) includes creating value and content that
others can consume, staying active and loyal through repeated visits and
contributions to a service, and encouraging others to use the service through friend
invitations, commenting on their posts or tweets, and sharing information and links
(Fogg & Eckles, 2007).

The design of software components can explain how technology creates a
persuasive experience to change users’ attitudes and/or behaviour, which makes the
development and delivery of target behaviours and their persuasive goals easier and
significantly faster (Fogg, 2008). There are many uses and goals for social web
platforms, but the main ones can be broken down to: (1) encouraging users to create
a personal profile (cf. creating value and content); (2) inviting and connecting with
friends (cf. involving others); (3) responding to others’ contributions (cf. creating
value and content); and (4) regularly accessing the site (cf. staying active and loyal)
(Fogg & Iizawa, 2008).
2.3 Judgement and decision making

The science of judgement and decision making is based on studying how people actually behave instead of how they should behave. People are far less rational in their decision making than is assumed in standard economic theories. This simple idea forms the basis of behavioural economics and related concepts such as commitment devices discussed below, focus on the idea that people do not always behave rationally and often make mistakes in their decisions (Ariely, 2008).

Vassileva, (2012), analysed the development of web-based social applications and the approaches used to motivate user engagement. She found that most of the web-based applications employ simple approaches that have successfully managed to enhance interactivity. However, these approaches only ensure that users follow stipulated instructions, but are unable to guide them toward prolonged desirable and sustainable healthy behaviours. For this reason, several future trends related to the application of social psychology, behavioural economics and their convergence with other disciplines are suggested in the design of reward and incentive mechanisms for particular types of research domains (Vassileva, 2012).

2.3.1 Behavioural economics

Behavioural economics examines conditions that influence the consumption of commodities and combines psychology and economics to investigate how individuals actually behave as opposed to how they would behave if they were being perfectly rational (as in the sense of maximising their utility) (Prince, Carey,
Behavioural economics is organised around experimental findings that suggest inadequacies of standard economic theory and is focused on individual choice, the motives underlying that choice, and knowing more about a subject’s situation at the time of making a choice (Pesendorfer, 2006).

Behavioural economics departs from the standard economic model (that markets and incentives play a key role in shaping people’s behaviour) in acknowledging three human behavioural traits: 1) bounded rationality – human beings have limited information-processing capabilities and, because of this, they adopt rules of thumb to aid in the problem-solving process. 2) bounded willpower – accounts for the fact that people do not always make choices that are in their best long-term interests, due to a lack of self-control, and 3) bounded selfishness – relaxes the assumption that people are motivated by pure self-interest and their actions also include altruistic and spiteful behaviours (Thorgeirsson & Kawachi, 2013).

The majority of the literature on behavioural economics relates to interventions for healthier living, strategies for reducing unwanted behaviours (for example, alcohol dependence) – at both the communal and individual level – environmental sustainability, and improving governmental and institutional policies that benefit society.

For example, Prince et al. (2013) in their review aiming to improve assessment instruments for reducing alcohol involvement among college students, propose improvements to better understand the role of protective behavioural strategies in reducing the use of alcohol and explain why there have been inconsistencies in previous studies and what can be done to enhance future studies. Michie and Williams (2003) discuss the factors that lead to work-related psychological ill health, comparing between different professions and proposing solutions to these problems, primarily involving training and more involvement in decision making.

Mehrotra, Sorbero, and Damberg (2010) apply lessons in behavioural economics to improve pay-for-performance programmes. They address the reasons why the pay-for-performance programmes are flawed, how people respond to incentives, and how to mitigate the unintended consequences of such programmes (Mehrotra et al., 2010). Lunze and Paasche-Orlow (2013), investigate the advantages and disadvantages and ethical concerns of using incentives in behavioural economics to promote healthy behaviour and to reduce health costs. Their findings reveal a need for safeguards in the programmes to monitor the associated risks (such as contribution to inequities, promoting dependence, and
decrease in social solidarity) and promote fairness in offering the incentives for them to be beneficial (Lunze & Paasche-Orlow 2013).

Adams (2010) highlights the issues to consider when discussing the health impact of patient education especially on their health literacy – the capacity to seek, understand, and act on health information. The article places emphasis on how behavioural economics takes the context, setting and physical environment into account when developing behaviour change interventions and how adherence to medication can be enhanced by adoption of incentives from behavioural economics (Adams, 2010).

Avineri (2012), on the other hand, investigates how behavioural economic principles, such as financial (dis)incentives, default choices, and salience, can be applied in transport and economic change based on travel demand modelling and design of behaviour change measures. The study applies psychological theories, for example, theory of planned behaviour and norm-activation theory, links these theories to travel behaviour, and shows how individuals’ choices in different contexts deviate from the predictions of rational behaviour (Avineri, 2012).

In Buttenheim and Asch (2013), behavioural economic principles such as present bias, framing and zero price effects, are applied in improving maternal, newborn, and child health in pursuit of the Millennium Development Goals (MDGs) 4 and 5. In their study, they state that behavioural economics as a field is not new; rather, the application of its principles in helping people to make better health-related choices and to do what is in their best interests through offering new approaches such as strategically deployed financial incentives and decisions is what is new (Buttenheim & Asch, 2013). Additionally, individuals allocate their limited resources (time, money) to gain access to goods (commodities or reinforcers) within a system of variable constraints which are conceptualised as monetary value, cost, effort or behavioural response. These constraints can be controlled in regulating the price, effort or amount of work required to gain access to the commodity (Epstein, Salvy, Carr, Dearing, & Bickel, 2010).

Crowley, Heitz, Matta, Mori, and Banerjee (2011) apply behavioural economics principles in developing sensor-based interactive systems to initiate change in residential energy consumption. They argue that even though the success of most of the sensor-based power meters and other related residential monitoring devices depends on users responding to the data they generate with appropriate changes in their consumption behaviour, most of these devices have not been developed with the end user in mind. Therefore, they propose a more human-centred process that integrates insights to determine the effectiveness of sensor-
based interactive systems and of interfaces based on cognitive, social and affective frames (Crowley et al., 2011).

Behavioural economics provides valuable insights into human behaviour that show promise for behavioural interventions, on either an individual or societal basis (Thorgeirsson & Kawachi, 2013). Behavioural economics departs from the traditional economics’ premise of people being rational actors, showing that people’s decision-making processes are biased by various contextual factors, such as the presentation of different options, the timing of choices, and their emotional state at the time of choice (Lee et al., 2011). It provides numerous practical examples of how decision making is influenced by factors beyond people’s control and ways to encourage people to make better choices.

2.3.2 Commitment devices

There are numerous examples of suboptimal health behaviour, for example, unwillingness to think about problems when risks are known or data are ambiguous, in which people do not follow through on their (behaviour change) goals or make self-beneficial decisions (Mogler et al., 2013). Unhealthy behaviours are also responsible for a large proportion of healthcare costs and poor health outcomes (Rogers, Milkman, & Volpp, 2014). Therefore, people require self-commitment devices as research has demonstrated their effectiveness in helping people to commit to goals (Beshears, Choi, Laibson, Madrian, & Sakong, 2011; Reeves, 2011; Rogers et al., 2014). As people often set goals with varying degrees of formality that in most cases they fail to meet, commitment devices can be used to, for example, help people purchase unhealthy food in small portions to reduce intake (see Table 1 for examples of commitment devices) (Rogers et al., 2014).

Commitment devices create accountability for completing the goals that people commit to (Bryan, Karlan, & Nelson, 2010). According to Munson et al. (2015), commitment devices relate to restricting the occurrence of future behaviour with the awareness of what your preferences will be at the time the behaviour is to take place – a request in the present that a future request be denied.

There is a strategic interaction between the self who creates the commitment device and the future self who is influenced by it. Indeed, it involves a three-stage interaction among the selves at three different times: when one makes a commitment (time 1), when one chooses to engage in an activity such as
deciding between walking and watching TV (time 2), and when rewards or punishments are meted out (time 3).

Table 1. Examples of commitment devices (adapted from Rogers et al., 2014).

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Health Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Put money in a deposit contract</td>
<td>Forfeit money by failure to achieve a goal by a given date (e.g., losing five pounds within 2 months)</td>
<td>Any</td>
</tr>
<tr>
<td>Engage in temptation bundling</td>
<td>Restrict access to instantly gratifying experiences (e.g., watching TV) only to occasions when engaging in goal-consistent behaviours (e.g., exercising).</td>
<td>Any</td>
</tr>
<tr>
<td>Purchase vices in small packages</td>
<td>Limit portion sizes for unhealthy items (e.g., cigarettes, junk food, alcohol)</td>
<td>Reduce consumption</td>
</tr>
<tr>
<td>Order groceries online</td>
<td>Avoid purchasing unhealthy foods on impulse</td>
<td>Improve diet</td>
</tr>
<tr>
<td>Check into rehabilitation</td>
<td>Ensure no access to addictive substances (e.g., alcohol, drugs) until professionals deem a patient ready</td>
<td>Treat addiction</td>
</tr>
<tr>
<td>Purchase annual gym membership</td>
<td>Ensure future gym visits will not require out-of-pocket payment</td>
<td>Increase exercise</td>
</tr>
</tbody>
</table>

In many cases, the factors leading to unhealthy behaviours are an integral part of people’s lifestyles and this is where intervention programmes should be targeted. However, radical and long-term change is difficult to implement and, often, almost impossible to sustain (Fletcher, Pine, & Page, 2007). Many people intend to improve their health, well-being and other behaviours (exercise, maintain a diet, quit smoking) in the future, but when the time comes to act on their intentions, they do not (Rogers et al., 2014). People are often aware of the changes they need to make in their behaviour but usually have a problem following through on their intentions, primarily due to a lack of self-control or willpower which weakens the more it is called upon (Beshears et al., 2011; Fletcher et al., 2007; Reeves, 2011). That is to say, people intend to make choices that carefully consider short-term and long-term cost and benefits, “but at the decision-making moment, they place disproportionate weight on immediate costs and benefits” (Beshears et al., 2011).

Furthermore, some of the solutions people choose to help them change a behaviour or form habits are often easy and do not result in any significant change because they are not accompanied by hard commitments. A solution to this problem is the use of commitment devices: “a way of changing one’s incentives to make an otherwise empty threat or promise credible” (Reeves, 2011). This involves entering
into an arrangement that restricts people’s future choice set by making some choices more expensive or making a present intention for a future action more substantial (Bryan et al., 2010; Moraveji, Akasaka, Pea, & Fogg, 2011).

2.4 Information systems adoption, acceptance, and use continuance

Moody, Iacob, and Amrit (2010) conducted a review to determine the most influential native theories in IS, and in their view, these were Davis's (1989) technology acceptance model (TAM) and Delone and McLean's (2003) IS success models, with TAM and its variations, TAM2 (Venkatesh & Davis, 2000) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), being the most influential and commonly employed theory in IS.

TAM was originally developed because there were no valid measurement scales for predicting user acceptance of technology and the available subjective measures were not validated and their relationship to system usage was not clear. TAM posits that perceived usefulness (the extent to which users believe that using a particular information technology (IT) enhances job performance) and perceived ease of use (the extent to which users believe that learning how to use an IT and actual use will be relatively free of effort) are primarily relevant for computer acceptance behaviours. The theory led to testable propositions that could be empirically investigated (Davis, 1989).

TAM has, however, been criticised for being solely focused on studying a particular technology in a specific context (the utilitarian benefits that users accrue from their interactions with IT artefacts), its belief in the rational user, and its deterministic nature not supporting the investigation of individuals’ actual choices in various everyday use contexts (Al-Natour & Benbasat, 2009; Benbasat & Barki, 2007; Blechar, Constantiou, & Damsgaard, 2006; Constantiou, Lehrer, & Hess, 2014). TAM has also ignored the role of emotions and habits and their importance in continuing IT use as the theoretical constructs found in TAM may not be appropriate for the study of IT use continuance and how users’ interactions with IT artefacts change over time as the user-artefact relationship develops (Al-Natour & Benbasat, 2009; de Guinea & Markus, 2009; Li & Ku, 2011).

Following these criticisms, there has been increased attention to IT post-adoption/IT continuance (Bhattacherjee, 2001). The IS Continuance model investigates the driving factors for continued use and links satisfaction and
perceived usefulness (from TAM) to a user’s intention to continue using a system (Constantiou et al., 2014). Continuance intention refers to the intention to continue using a system after initial acceptance and better explains the success of a system because the psychological motivations that affect users’ continuance intention decisions emerge only after starting to use a system (Bhattacherjee, 2001; Bhattacherjee & Barfar, 2011). The goal of IT continuance research has been to predict actual behaviours and not intentions of the same and it has been recommended for future research to operationalise and measure IT usage behaviour rather than end at intention (Bhattacherjee & Barfar, 2011).

Emotions and habits have been incorporated into UTAUT (Venkatesh, Thong, & Xu (2012) to study acceptance in consumer technologies or individual IS, as Baskerville (2011) termed them and their use context. These factors were found to have important roles in influencing technology use. In a related study investigating continuance in social networking services, Yoon and Rolland (2015) found emotions play an important role in use continuance and user behaviour arises from automatic as well as from reasoned actions, and enjoyment drives the automatic behaviour (Yoon & Rolland, 2015).

2.5 Software design patterns

Patterns reflect factual and experience knowledge that can be applied in different situations to solve tangible engineering problems (Wentzlaff & Specker, 2006). This, in particular, is a result of idea generation and problem solving being based on the premise that there are no truly new inventions and that the process of recognising problem situations is similar to those faced previously (Dan Lockton, Harrison, & Stanton, 2010). Patterns have primarily been used to preserve common problem-solving knowledge, as they describe recurring problems together with their solutions; they have been tailored to suit the needs of various disciplines and, over time, have evolved to dealing with specific problems (Kruschitz & Hitz, 2010a; Wentzlaff & Specker, 2006).

Patterns are reusable solutions applied to commonly occurring problems in software design and enable the building of systems with good object-oriented design qualities. Patterns are not the source of programmable code, but rather provide solutions to general design problems, to be applied when developing specific applications. They serve as templates to be modified in different ways to solve various design problems (Gamma, Helm, Johnson, & Vlissides, 1994).
Patterns guide development, are enhanced with the progress of the developmental process, and they primarily address issues concerning changes in software. Most patterns allow some part of a system to vary independently of all other parts, and these varying parts are often encapsulated (Gamma et al., 1994). Furthermore, they aid in avoiding design alternatives that compromise reusability and can also help improve the documentation and maintenance of existing systems by providing explicit specifications of class and object interactions and their underlying intent (Gamma et al., 1994; Zemin, 2009).

Patterns depict the static and dynamic structures and collaborations of successful solutions to problems that arise when developing applications within a particular context and have four essential characteristics:

1. The **pattern name** – a common term that eases the communication amongst stakeholders and enables design at a higher level of abstraction while simplifying thoughts on designs and communicating these and their trade-off to others.

2. The **problem** describes when a pattern should be applied and its context.

3. The **solution** provides an abstract description of a design problem and how a general arrangement of elements (classes and objects) solves it.

4. The **consequences** are the results and trade-offs of applying the pattern (Gamma et al., 1994).

Patterns can further be classified according to what they do (purpose) and whether they primarily apply to classes or objects (scope) (Gamma et al., 1994). Gamma et al., (1994) further describe the classification of patterns and their functions including the initialising of classes and objects, their relationships, and the distribution of responsibility.

Most of the studies on software design patterns have focused on different phases and aspects of systems development such as reuse and the challenges involved in evaluation of architectures. For example, Zemin (2009) and Peña-Mora and Vadhavkar (1997) detail the application of patterns in software reuse, where an effective method of software development based on pattern reuse is proposed. Both papers provide a framework with valuable insights on the use of patterns for development and analysis of reusable software systems. Gestwicki and Sun (2008) using game development as an example, show how design patterns could be taught with an emphasis on object orientation and patterns integration. The study provides relevant examples of how patterns could be used to implement various features of a system’s architecture (Gestwicki & Sun, 2008).
Others have focused on the challenges involved in software architecture evaluation; formalisation and unification of human computer interaction (HCI) patterns to aid different groups including software engineers in their work with patterns; and visualisation of software systems as a set of design patterns and possible solutions through use of UML class diagrams to document a system’s static structure (Kruschitz & Hitz, 2010b; Trese & Tilley, 2007; Zhu, Babar, & Jeffery, 2004).

Another stream of research (Leff & Rayfield, 2001; Ning, Liming, Yanzhang, Yi-bing, & Jing, 2008; Thung et al., 2010) principally concentrates on architectural features which detail the use of the Model-View-Controller (MVC) in Web information system development. In Leff and Rayfield (2001), a model of flexible web application partitioning that can be implemented using the constructs of MVC is proposed.

Taleb et al. (2007) and Diaz et al. (2008) provide a classification of different web design patterns, discuss how they can be combined in the development process, and show how the patterns have been used in the redesign of a website. Diaz et al. (2008), for example, visually represent web design patterns by integrating them with goal-oriented design to assist both end users and casual developers in selecting the right patterns needed for specific design projects, determining the complexity of the project, and the relationships and trade-offs of each (Diaz et al., 2008).

Others (Franch, 2013; Aversano, Canfora, Cerulo, Del Grosso, & Di Penta, 2007; Kobayashi & Saeki, 1999; Peña-Mora & Vadhavkar, 1997) have focused on the changes of patterns in the software development process, where each of the stages have their own styles that could be reused in other development processes. Franch (2013), for example, has, in particular, concentrated on patterns in the requirements phase of systems development. Initially, Franch (2013) notes, a suitable pattern has to be chosen then instantiated to make it adaptable to the problem in order to be able to get an artefact. However, according to Aversano et al. (2007), pattern change frequency and amount of co-change does not depend on the pattern type, but rather on the role played by the pattern to support the application features. The use of patterns provides a shared language that maximises the value of communication amongst developers, thus reducing the time spent on making design decisions related to feature changes (Gamma et al., 1994).

Even though there is a certain set of well-known patterns, choosing the one to use can be a problem, especially for inexperienced developers (Kruschitz & Hitz, 2010a, 2010b; Wentzlaff & Specker, 2006). Therefore, when thinking of future developments, patterns could be more domain-specific and tailored to particular
focus areas such as software-oriented architecture (SOA), mobile systems, and Web 2.0, that are yet to be properly covered by the pattern languages (Buschmann et al. 2007).

Moreover, as software design patterns address all aspects of interactivity in online systems (Buschmann et al. 2007), there lies an opportunity for the development of persuasive patterns that can streamline the development of BCSSs and enhance the presentation of persuasive communication strategies within these systems.
3 Research objectives, approach, and methods

In this section, the research questions, aims, and approach are discussed. The research objectives, including the research questions and positioning of the dissertation within the IS discipline, are presented in 3.1. Following this, 3.2 presents the research approach, including a summary of the studies and the role of the PSD model in each of the studies. Next, 3.3 presents the research methods used in the dissertation. In 3.4, the data analysis methods are discussed. Finally, 3.5 presents the theoretical foundation for the constructs and the measurement instrument’s validation and concludes with a discussion on ethical issues.

3.1 Research objectives

3.1.1 Research questions

This dissertation’s objective is to provide an in-depth analysis of persuasive systems design. The dissertation integrates literature from behavioural economics, persuasive systems design, and software design patterns in order to analyse and study the feasibility of persuasive software features in facilitating and enhancing users’ engagement with persuasive systems and behaviour change. Furthermore, the dissertation proposes persuasive design patterns as a potential avenue for the development of persuasive systems.

A key proposition of this dissertation is that applying behavioural economic principles in persuasive systems design, studying the feasibility of the persuasive software features, and developing persuasive software design patterns, can help to better examine users’ engagement with persuasive systems and enhance the development of these systems.

There is need for an enhanced understanding of how social-psychological and behavioural decision-making theories are applied in developing persuasive systems, and how this, in turn, enhances user engagement with these systems and facilitates behaviour change as their successful adoption will depend on the grounded understanding of the theories (Chatterjee & Price, 2009). Therefore, the main research question for this dissertation is:

How can integrating judgment and decision-making processes and persuasive software design patterns enhance the development of behaviour change support systems?
“Cognition and emotion are tightly intertwined, which means that the designers must design with both in mind” (Norman, 2013: 11). Acknowledging that users have cognitive limitations that may affect how they use persuasive systems, and factoring this into their design, can enhance their overall efficacy by guiding users to make self-beneficial decisions. This takes place through presenting choices in a way that leverages the users’ decision-making processes (Lee, Kiesler, & Forlizzi, 2011). A way to facilitate this is by understanding users’ perceptions of these systems and how they interact with them. Following this, suitable software features can be implemented. A suggestion is to use software design patterns and object-oriented design practices to develop persuasive systems. These patterns would be based on well-known social psychological and cognitive theories that form the basis of the PSD model’s (Oinas-Kukkonen & Harjumaa, 2009) software feature categories.

By applying the aforementioned theories, the dissertation breaks down the main question into the following three sub-questions to investigate cognitive processes involved in decision making, users’ perceptions, how they use the systems, and how their development can be improved (Figure 3).

1. How can behavioural economics enhance understanding of users and their interactions with IS?
2. How do persuasive software features in persuasive systems influence user engagement and facilitate behaviour change?
3. How can persuasive software design patterns provide generalizable design techniques for developing behaviour change support systems?

Fig. 3. Research questions.
3.1.2 Positioning the work within the information systems discipline

From the turn of the century, there have been many studies conducted on the contribution of IS (R. L. Baskerville & Myers, 2002), what form of science it is (Avgerou, 2000), its lack of a defining identity (Benbasat & Zmud, 2003; Orlikowski & Iacono, 2001), and its nature (Gregor, 2006). These studies have primarily been aimed at establishing the core of the IS discipline and its main contribution compared to other fields.

In his rebuttal on the “no native theories” in IS assertion, Straub (2012), suggests a reframing of the discussion to whether issues relevant to practice in academic research are addressed (topic usefulness) and whether knowledge is disseminated to a wide variety of channels (knowledge transfer). Straub (2012), then goes on to review the native theories (a native theory is described as an IS-specific theory that includes the IS/IT artefact and fits the IT phenomenon in different ways) and comes to the conclusion that the IS discipline does, indeed, have a healthy number of native theories. Oinas-Kukkonen (2015) categorises these into: 1) theories explaining individual user behaviours, such as UTAUT, 2) theories explaining social behaviours (of both individual users and groups of users), such as the IS success model, and 3) theories explaining organisational behaviours, such as the soft systems methodology.

Gregor (2006) presents the multiple views of theories in IS by giving examples of different ontological types of theories (Gregor, 2006, p. 613):

Theory as statements that say how something should be done in practice: provides guidelines to be followed in practice that are expected to be better than the alternatives.

Theory as statements providing a lens for viewing or explaining the world: such theory is seen as a useful outcome and does not involve formal testing.

Theory as statements of relationships among constructs that can be tested: these are testable propositions that can be empirically investigated.

Straub (2012) goes on to assert that, instead of questioning whether the IS field has theories, a secondary note to consider is whether these theories are being tested, as this could highlight how the field is evolving.

Orlikowski and Iacono (2001) and Benbasat and Zmud (2003) further highlight the need to investigate phenomena directly related to IT. Benbasat & Zmud (2003) express their concern about the ambiguous identity of the IS discipline caused by
the research community’s focus on issues distantly associated with IT-based systems. Benbasat and Zmud (2003) further argue that the core of IS research should focus on the IT artefact and how IT enables or supports tasks embedded within structures that are themselves embedded with different contexts. It is the focus on IT that differentiates IS from other disciplines (Benbasat & Zmud, 2003; Orlikowski & Iacono, 2001).

Beyond studying the IT artefact, IS research also strives to increase an understanding of: 1) how the artefacts are conceived, developed and implemented, and 2) how they are used and their impact on the wider contexts within which they are embedded (Benbasat & Zmud, 2003). The IS field concerns the use of artefacts in human-machine systems and not only investigates social or technological systems, but also the phenomena that emerge when the two interact (Gregor, 2006).

While agreeing with many of their observations, Agarwal and Lucas (2005) argue that solely focusing on the IT artefact, as proposed by Benbasat and Zmud (2003), will result in a micro focus. IS scholarship should, instead, focus on macro and transformational issues of technology and their importance. That is to say, the impact of the IT artefact rather than on the artefact itself as IS draws upon many disciplines to understand the nature and construction of the artefact (Agarwal & Lucas, 2005).

Going a step further, Sidorova, Evangelopoulos, Valacich, and Ramakrishnan (2008) focus on facilitating identity construction within the discipline by seeking the intellectual core of IS research in the major IS journals. Sidorova et al. (2008) highlight that the differences in opinions regarding the core of IS research result from the level at which research is analysed. Furthermore, scientific knowledge advances incrementally and many individual research efforts have a narrow focus, thus leading to a perception of insignificance or only marginal relation to the core problems addressed by a scientific field (Sidorova et al., 2008).

Their analysis identified core research areas that combine earlier efforts in addressing the identity crisis in IS and the need to maintain a strong identity. These include: 1) IT and organisations; 2) IS development; 3) IT and individuals; 4) IT and markets; and 5) IT and groups, which can be said to be a combination of the micro and macro focus highlighted in earlier research. These core areas share similarities with the five thematic areas (applications of information technology to support the functioning of an organisation; the process of systems development; information systems management; the organisational value of information systems and the societal impact of information systems) earlier identified in IS research by Avgerou (2000).
Sidorova et al. (2008, p. 475), summarise the intellectual core of IS discipline as:

*The Information Systems academic discipline focuses on how IT systems are developed and how individuals, groups, organizations, and markets interact with IT.*

The IS field has primarily been concerned with the development, use, and implications of IS in organisations and the wider context within which organisations are embedded (Avgerou, 2000). However, recent technological developments have enabled increasingly complex socially constructed individual IS that cross the boundary between work and home which warrants IS researchers’ attention (Baskerville, 2011).

The focus of this dissertation is primarily on IT and individuals and IS development, examining both psychological aspects of human-computer interaction (HCI) and the IT (artefact) itself and how it is developed (Sidorova et al., 2008). Based on the discussion above, the dissertation fits well within the IS research discipline. As the dissertation is also limited to the individual use of IS and examining of the persuasive software features, it is at the micro level (Agarwal & Lucas, 2005).

### 3.2 Research approach

The research approach is a way of conducting research, it embodies a specific style and may apply different methods or techniques (Galliers, 1990). According to Gregor (2006), the research approach adopted could vary with different types of theory in IS. The four primary goals of theory are *analysis and description* of the phenomena of interest, *explanation* for the occurrence of events, *prediction* of future events if certain preconditions hold, and *prescription* for the construction of an artefact (Gregor, 2006, p. 619). Furthermore, Gregor’s (2006) classification of theories includes: (I) theory for analysing, (II) theory for explaining, (III) theory for predicting, (IV) theory for explaining and predicting, (V) theory for design and action. These five types of theory are interrelated and some works could include aspects from all of them (Gregor 2006).

An understanding of how and why systems work or do not work is required if significant progress is to be made in IS research (March & Smith, 1995). The study of IS is fundamentally an interdisciplinary pursuit with a variety of multifaceted questions regarding the development, use and implications of information and
communication technologies in organisations (Agarwal & Lucas, 2005; Avgerou, 2000). IS also draws upon different research traditions, multiple disciplines and perhaps computer science to understand the nature and construction of IT (artefacts), its operation, use, evolution, evaluation, and impact (Agarwal & Lucas, 2005; Iivari, Hirschheim, & Klein, 1998).

IS, a discipline at the intersection of knowledge of the properties of technology and knowledge of human behaviour (Gregor, 2006), can broadly be categorised into natural and design science (March & Smith, 1995). Natural science includes traditional and behavioural research and is aimed at understanding how things are (realities), whereas design science is more technology-oriented and attempts to create things that serve human purposes (March & Smith, 1995). Consequently, IS should not only be confined to the practical implications of descriptive theories (Benbasat & Zmud, 2003), but also the rigour of constructing IT artefacts, as this is what distinguishes IS as design science (Iivari, 2007).

This dissertation has approaches that are both theory testing and prescriptive in nature. In addition to a literature review exploring the persuasion context of behavioural economics-related IS studies (Study I), the dissertation includes both quantitative (in the form of field studies (Studies II and III)) and constructive design-oriented approaches (Studies IV and V). The approach is summarised in Figure 4. The dissertation investigates the use and persuasive effects of an online commitment device and social web platforms through questionnaires of the respective users and, based on the PSD model’s categorisation of persuasive software features (Oinas-Kukkonen & Harjumaa, 2009), proposes a software design pattern-based approach for developing BCSSs.

The theory type in this dissertation, therefore, follows Moody et al.’s (2010) definition of a native theory as “a theory specifically developed to describe, explain, predict, or design IS phenomena”. Such a theory must be IS-specific and should include the IS artefact among its key variables (Straub, 2012). The dissertation considers the wider context of behaviour change and persuasive systems (not just characteristics of a specific technology) and how this informs the design of systems. Accordingly, it encompasses both theory types IV and V in Gregor’s (2006) classification, as these two theory types are strongly interrelated.
3.2.1 The main studies in the dissertation

The dissertation describes five studies where the PSD model was applied and evaluated through both field studies and a constructive approach. The studies are briefly summarised in Table 2 and more details and their contributions are presented in Chapter 5.

Study I focused on analysing behavioural economics in IS research by using persuasion context analysis, as described in Oinas-Kukkonen and Harjumaa (2009). Applying behavioural economics in studying technology use and adoption can provide a potential strategy for better understanding users and the factors that lead to the non-adoption or intended use of IS. Behavioural economic principles can also aid in developing techniques for the improved presentation, delivery, and organisation of information or services. As noted in Goes (2013), there has not been extensive research in the IS field utilising behavioural economics methods. Therefore, the objective of Study I was to examine behavioural economics research in IS that addresses how cognitive limitations influence decision making.

Study II investigated users’ perceptions of an online commitment device. The study examined the effect of the PSD model’s principles (Oinas-Kukkonen & Harjumaa, 2009) on users’ perceived competence and how this, in turn, predicted their intention to continue using the commitment device. As previous research (Karppinen et al., 2016; Kelders et al., 2012; Lehto & Oinas-Kukkonen, 2015; Stibe
& Oinas-Kukkonen, 2014) has shown that persuasive design principles and the corresponding software features have a positive effect on individuals’ behaviour and systems use, Study II continued along the same lines by analysing the effects of these principles on an online commitment device.

Study III focused on how social web platforms, such as Facebook and Twitter, influence user interactions. The influence was explained from the perspective of the PSD model’s persuasion context analysis and the provision of persuasive user experiences. Additionally, Study III introduced the concept of a system’s self-referential persuasion and illustrated its application through the discussion and analysis of preliminary results of a survey (N=57) on the use of the social web. Overall, Study III examined user interaction via social web platforms and shed light on the inherent features of these platforms that purposefully aim at influencing user behaviours.

Based on the findings of Studies II and III, the following two studies proposed the development of persuasive software design patterns. Study IV focused on developing software design patterns for social influence by examining how users’ thoughts and actions are influenced by the actions of others and applying this knowledge to propose how the social support features can be implemented in a BCSS. Since there have also been inconsistencies in the classification of social influence constructs in IS research (Zeal, Smith, & Scheepers, 2012), and as these features have been categorised in Oinas-Kukkonen and Harjumaa’s (2009) PSD model, developing patterns based on the categorisation was seen as a potential solution to addressing the issue. Therefore, the patterns are instantiations of the social support features in the PSD model that extend the principles from design and evaluation into actual software implementation, which has been requested by, for example, (Wiafe et al., 2014).

Study V focused on the conceptualisation of software design patterns for providing persuasive computer-human dialogue in BCSSs. Specifically, this relates to instantiating features for facilitating interaction between the user and the system. The conceptualisation is based on the dialogue support software features in the PSD model (Oinas-Kukkonen & Harjumaa, 2009). Although a prominent research area, BCSSs have, in prior studies, been described at a generally undetailed technical level (cf. Bennett & Glasgow, 2009; Lehto & Oinas-Kukkonen, 2011). This is partly due to a lack of understanding of how to apply the knowledge from the relevant theories and a lack of guidance for software developers of persuasive systems on the principles to apply (Oduor, Alahäivälä, & Oinas-Kukkonen, 2014;
Oinas-Kukkonen, 2013). As in the previous study, this extends the principles from design and evaluation into actual software implementation.

### Table 2. Studies and methods.

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Aim</th>
<th>Scope, background, and study requirements</th>
<th>Method/Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studies IV and V</td>
<td>To develop design patterns based on the PSD model’s software features categories.</td>
<td>Design considerations for persuasive systems Persuasive design principles and Software design pattern literature</td>
<td>Constructive (conceptual development – proof-of-concept, GUI-based prototype and pseudocode)</td>
</tr>
<tr>
<td>Study III</td>
<td>Examine and understand factors affecting user interaction in the social web and shed light on the features that aim to influence users’ behaviours.</td>
<td>User engagement in the Social Web Active users with accounts in at least two different social platforms</td>
<td>Quantitative Survey – online questionnaire (N=57)</td>
</tr>
<tr>
<td>Study II</td>
<td>To investigate the persuasive software features in an online commitment device and how they affect users’ perceived competence and continuance intention.</td>
<td>Analysis of the persuasive features in the system and users’ perceptions of these features An online commitment device</td>
<td>Quantitative Survey – online questionnaire (N=173)</td>
</tr>
<tr>
<td>Study I</td>
<td>Explore the application of behavioural economics principles in the top IS journals. Importance of considering the persuasion context in the development of persuasive systems.</td>
<td>Behavioural economics in IS research Persuasion context analysis</td>
<td>Literature review</td>
</tr>
</tbody>
</table>

### 3.2.2 The role of the PSD model in the studies

The PSD model (Oinas-Kukkonen & Harjumaa, 2009) is a conceptual framework for the design and evaluation of persuasive features for digital interventions across
a range of domains. The aforementioned four feature categories of the PSD model enable the analysis of a system’s persuasive quality. The model’s context analysis, comprising the persuasion intent, use, user, technology and delivery of persuasive communication, enables the transparent evaluation of the techniques used to persuade users of the digital interventions (Lehto, 2013). The features and components of the PSD model investigated in each study are presented in Table 3.

Table 3. Persuasive systems design categories and features investigated in each study.

<table>
<thead>
<tr>
<th>Study</th>
<th>Categories and elements investigated</th>
<th>Features investigated</th>
<th>Other variables investigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Use, user and technology contexts</td>
<td>----</td>
<td>-----</td>
</tr>
<tr>
<td>II</td>
<td>Primary task support, dialogue support, credibility support, social support</td>
<td>Category-level analysis</td>
<td>Continuance intention and perceived competence</td>
</tr>
<tr>
<td>III</td>
<td>Use, user, and technology contexts</td>
<td>Primarily dialogue support and social support features</td>
<td>-----</td>
</tr>
<tr>
<td>IV</td>
<td>Social support</td>
<td>Social learning, social facilitation, competition, cooperation and recognition</td>
<td>-----</td>
</tr>
<tr>
<td>V</td>
<td>Dialogue support</td>
<td>Rewards, praise, suggestion, reminders</td>
<td>-----</td>
</tr>
</tbody>
</table>

3.3 Research methods

The following sub-chapters present the research methods used in this dissertation. The main questions in Studies II and III are addressed in two quantitative studies, with a total of 230 subjects using field studies. Both studies had a single point of measurement. Studies IV and V adapted a constructive design-oriented approach where software design pattern knowledge was applied to develop conceptual BCSS prototypes based on the social support and dialogue support software features of the PSD model.

3.3.1 Quantitative methods

Analysing web-based data through unobtrusive research methods, such as field studies, holds promise for gaining a deeper understanding of user behaviour (Ruth, 2012). Boudreau, Gefen, & Straub (2001) define a field study as “non-experimental inquiries occurring in natural settings”. The researcher does not manipulate the
independent variable(s) or control the influence of confounding variables, while the dependent variables are systematically measured. The primary data gathering techniques are questionnaires, administered either in person, by mail, or over the Web (Boudreau et al., 2001; Jenkins, 1985).

IS research is not based on a single overarching theoretical perspective, but quantitative methods, which have a positivist epistemological stance, have been the most common (Avgerou, 2000; Chen & Hirschheim, 2004; Myers & Liu, 2009; Orlikowski & Baroudi, 1991). Quantitative positivist studies, from which inferences can be made, primarily serve to test theory. They are used to analyse data with the aim of identifying significant results in an attempt to increase the predictive understanding of phenomena by measuring, quantifying or finding the phenomena’s extent (Galliers, 1990; Mukherji & Albon, 2014; Orlikowski & Baroudi, 1991). This differs from qualitative methods, which are usually more concerned with describing experiences, emphasising meaning, and exploring the nature of a phenomenon. Among the objectives is to understand phenomena through accessing the meanings participants assign to them (Mukherji & Albon, 2014; Orlikowski & Baroudi, 1991). To quote Iivari (1991, p. 257):

“\textit{Positivism seeks 'to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements', whereas anti-positivism maintains that the social world 'can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied... Positivism regards scientific knowledge as consisting of regularities, causal laws and explanations.'}”

For positivists, reality exists objectively and independently from human experiences and the role of the researcher is to craft precise measures to discover this objective physical and social reality. Positivism is concerned with the hypothetic-deductive testability of theories – whether this requires theories to be verified or falsified (Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991). Positivist studies are premised on the existence of a priori fixed relationships within phenomena. These studies are primarily theory testing in attempting to increase the predictive understanding of phenomena (Orlikowski & Baroudi, 1991, p. 5). They generally require: 1) formulating hypotheses, models, or causal relationships among constructs; 2) using quantitative methods, although not always necessary, to test theories or hypotheses; and 3) objective, value-free interpretation (Chen & Hirschheim, 2004, p. 201).
3.3.2 Constructive methods

The aim of Studies IV and V was on how to improve the development of persuasive systems and the studies principally focused on system functionality and designing/implementing different types of persuasive features.

Benbasat (2010) has argued that, for HCI research to be relevant, there should be a design component combined with the evaluation of the design. This design component can either be a particular IS or an IT (artefact) (Benbasat, 2010). Taking into account the special nature of IS and computer science as applied sciences, constructive, in addition to nomothetic and idiographic methods noted in earlier research, have been identified as suitable techniques for knowing, understanding and studying reality (Iivari, 1991; Iivari, Hirschheim, & Klein, 1998). Earlier work in IS (e.g., Nunamaker & Chen, 1990) focused on system development approaches. This consisted of constructing artefacts and represented a form of design science research (Iivari, 2007). Constructive research is suggested as being the specific research method for constructing IT artefacts as it allows the development of artefacts as outcomes of design science research (Iivari, 1991; Iivari, 2007). Constructive research methods include both conceptual and technical development. Conceptual development does not necessarily need to have a ‘physical realisation’ and includes the development of new models and frameworks. Technical development produces physical artefacts which could include executable software (Iivari, 1991).

Design science research applies knowledge of tasks or situations in order to create effective artefacts (March & Smith, 1995). Building and applying a designed artefact signifies the achievement of knowledge and understanding of a problem domain. Whereas the behavioural science paradigm seeks to develop and verify theories that explain or predict human or organisational behaviour, the design science paradigm seeks to understand, execute, and evaluate research that aims to create novel artefacts to solve identified organisational problems (Hevner, March, Park, & Ram, 2004).

Design is both a process (set of activities) and product (artefact) and the IT artefact is often the object of study in IS behavioural science research (Hevner et al., 2004). March and Smith (1995) identified four design artefacts and two processes or activities included in design science. The artefacts are constructs, models, methods, and implementations (or instantiations). The two activities are build and evaluate (March & Smith, 1995). Instantiations are the operationalisation of constructs, models and methods. They demonstrate the viability and
effectiveness of the models and methods they contain and enable the concrete assessment of an artefact’s suitability to its intended purpose (Hevner et al., 2004; March & Smith, 1995).

Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) presented a methodology for conducting research consisting of a six-step process and a model for presenting and evaluating design science research. The six steps entail: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication. These steps have four research entry points: problem-centred initiation (starts with problem identification), objective-centred initiation (starts with definition of objectives), design and development-centred initiation (starts with design and development), and client/context-initiated (starts with demonstration) (Peffers et al., 2007).

For Studies IV and V we used a problem-centred approach, where the problem stemmed from the need to more effectively design systems that support individuals’ behaviour change. The six-step process above was used as follows: The problem identification and motivation came from the persuasive systems and BCSSs research agenda, which stated that there is a need for finding generalizable tools for BCSSs development (Oinas-Kukkonen, 2013). The objectives for a solution to the problem included outlining design patterns for BCSSs. The design and development phase consisted of developing these patterns. As a demonstration, a proof-of-concept graphical user interface-based prototype was developed. For the evaluation phase, we provided user scenarios and pseudo-code to demonstrate their utility. Finally, the results of the two studies were published (Figure 5).

The constructive approach emphasises the prescriptive nature of scientific knowledge that is constructed by researchers with the help of theoretical and cognitive tools. This is in contrast to the positivist approach, which views scientific knowledge as being discovered in the world – a world based on unchanging, universal laws where facts are discovered through a systematic, scientific approach to research. Constructivism is interested in the creation of artefacts (models, constructs, methods, and instantiations) while positivism describes the state of theory, where a dominant framework has been established among competing approaches (Crnkovic, 2010; Mukherji & Albon, 2014).
Fig. 5. Persuasive pattern development process in Studies IV and V.

- **Objectives of a solution**
  - Develop a pattern-based BCSS

- **Design & Development**
  - A set of persuasive design patterns

- **Demonstration**
  - Proof-of-concept – a GUI-based prototype

- **Evaluation**
  - Scenarios & pseudocode to show utility

- **Disciplinary knowledge**
  - Metrics, analysis, knowledge

- **Inference**
  - Theory

- **Problem-centered initiation**

- **Communication**
  - Scholarly publications
3.4 Data analysis methods

3.4.1 First-generation techniques

First-generation techniques are statistical methods that have commonly been used by social scientists and include regression-based approaches such as multiple and logistic regression and analysis of variance. The techniques can either be confirmatory when testing the hypotheses of existing theories and concepts or exploratory when they search for latent patterns in the data in case there is no or little prior knowledge on how variables are related (Hair Jr., Hult, Ringle, & Sarstedt, 2013: 3).

The analysis methods for Study III were the independent samples t-test and one-way analysis of variance (ANOVA). IBM SPSS version 21 was used for the data analysis.

A t-test tests the hypothesis that two samples have the same mean and it compares sample means by calculating the Student’s t-test and displays the two-tailed probability of the difference between the means. The independent samples t-test compares two means, when those means have come from different groups of entities (Field, 2009). For example, calculating the difference between males’ and females’ ratings in a survey.

ANOVA compares the ratio of systematic variance to unsystematic variance in a study. The one-way ANOVA procedure produces a one-way analysis of variance for a quantitative dependent variable by a single factor (independent) variable. ANOVA is used to test the hypothesis that several means are equal, so it tests the null hypothesis that all group means are the same (Field, 2009).

3.4.2 Second-generation techniques

The research model for Study II was analysed using partial least squares (PLS), a structural equation modelling (SEM) approach, which is a technique for simultaneously estimating relations among multiple constructs. PLS-SEM is used to develop theories in exploratory research by focusing on explaining the variance in the dependent variables when examining a research model. The primary objective is the prediction and explanation of target constructs (Hair Jr. et al., 2013). SmartPLS software (Ringle, Wende, & Becker, 2015) was used for the data analysis.

PLS-SEM analysis is composed of two steps: The first step, the measurement model, analyses the relation of each indicator in a research model with its
corresponding constructs. The second step, the structural model, evaluates the hypothesised relations between the constructs. The evaluation of the predictive capabilities of the structural model is based on the significance of the path coefficients and the relations between the constructs (Hair Jr. et al., 2013).

The measurement model represents the relation between constructs and their corresponding measures. Constructs’ properties are assessed in terms of their validity and reliability, and measurement items that are not at acceptable levels are removed. Evaluating the measurement model addresses internal consistency (the composite reliability), indicator reliability, convergent validity, and discriminant validity. Reliability and consistency are measured using Cronbach’s alpha and composite reliability with values ranging between 0 and 1. High values indicate higher levels of reliability, and values higher than the typically applied threshold of 0.7 are acceptable (Fornell & Larcker, 1981). For composite reliability, values from 0.6 to 0.7 are acceptable in exploratory research, while in more advanced stages of research, values between 0.7 and 0.9 are considered satisfactory. A value of 0.95, however, indicates unnecessary redundancy in the construct items (Hair Jr. et al., 2013).

The inter-construct correlations and the square root of the average variance extracted (AVE) and the indicators’ factor loadings, are a good measure of convergent validity – the extent to which two or more items measure the same construct (Bagozzi & Phillips, 1982). High loadings indicate that the measurement items correctly measure the same phenomenon and share a high proportion of variance (Hair Jr. et al., 2013).

Assessing the structural model determines how well the empirical data support the theory, showing the relations between different constructs and specifying how the constructs are related (Hair Jr. et al., 2013). The key results are the path coefficients and the $R^2$ values, which represent the hypothesised relations among the constructs and the percentage of the total variance of the dependent variable explained by the independent variables. The complete bootstrapping method with 5,000 resamples and parallel processing with no sign changes was used. Two-tailed bias-corrected and accelerated (Bca) bootstrap was the confidence interval method used in Study II.
3.5 Other considerations

3.5.1 Theoretical foundations for the constructs and measurement instrument validation

Developing improved measures for key theoretical constructs has been a research priority for the IS field. Better measures for predicting and explaining system use have both theoretical and practical value for researchers and the wider community (Davis, 1989). The IS field has gone through many changes but the problems of rigour have persisted. Without solid validation of instruments used to gather data, upon which findings and interpretations are based and that are important in the positivist quantitative field, the scientific basis of IS research is threatened. In positivist research, there is a need to ensure that data gathering is as objective as possible and an accurate representation of the underlying phenomenon is provided (Boudreau et al., 2001; Detmar Straub, Boudreau, & Gefen, 2004).

The use of previously validated research instruments is efficient, but does not necessarily lead to improved constructs for the field (Boudreau et al., 2001). Previously validated instruments are primarily used because they allow researchers to accumulate knowledge and maintain comparability between studies. Another reason for their use is time savings, but this can be disadvantageous because of the reduced efficiency and space limitations in articles when they need to be explicated (Boudreau et al., 2001).

Prior to publishing the surveys for Studies II and III online, pre-tests were performed to ensure that the survey items were valid. Any issues regarding language and ambiguity were also rectified. The survey questions for Study III were adapted from previous studies (e.g., boyd & Ellison, 2007; Hanna, Rohm, & Crittenden, 2011; Kaplan & Haenlein, 2010; Sleeper et al., 2015) on the use of social web platforms. The constructs for Study II and their descriptions are summarised in Table 4.
Table 4. Summary of the constructs used in the research model for Study III.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary task support</td>
<td>The way in which a system helps users to carry out the real-world activity that they would like to complete by enhancing their self-efficacy and reducing the cognitive burden associated with using systems.</td>
<td>(Lehto &amp; Oinas-Kukkonen, 2015; Lehto et al., 2012; Oinas-Kukkonen &amp; Harjumaa, 2009)</td>
</tr>
<tr>
<td>Dialogue support</td>
<td>These features facilitate and improve communication between a system and its users, especially in terms of feedback for better guiding users toward their intended goals.</td>
<td>(Lehto et al., 2012; Nass &amp; Moon, 2000; Oinas-Kukkonen &amp; Harjumaa, 2009)</td>
</tr>
<tr>
<td>Perceived credibility</td>
<td>Designing credible, trustworthy systems and subsequently more persuasive systems.</td>
<td>(Lehto &amp; Oinas-Kukkonen, 2015; Lehto et al., 2012; Oinas-Kukkonen &amp; Harjumaa, 2009)</td>
</tr>
<tr>
<td>Social support</td>
<td>Features that motivate users by leveraging social influence.</td>
<td>(Anderson, Winett, Wojcik, &amp; Williams, 2010; M.-C. Chiu et al., 2009; Oinas-Kukkonen &amp; Harjumaa, 2009; Stibe &amp; Oinas-Kukkonen, 2014)</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>The desire to feel a sense of satisfaction and effectiveness in attaining important results when using technology</td>
<td>(Deci &amp; Ryan, 2000)</td>
</tr>
<tr>
<td>Continuance intention</td>
<td>Users’ intention to continue using a system after initial acceptance</td>
<td>(Bhattacherjee, 2001; Lehto et al., 2012)</td>
</tr>
</tbody>
</table>

3.5.2 Ethical issues

The ethical guidelines for the University of Oulu were followed for the studies involving human subjects. Participation in Studies II and III was voluntary and no one was coerced into participating. All participants were adults who, prior to their participation, were presented with an information sheet notifying them of the requirements they were to fulfil. Participating in the two studies was not a risk (either physically or psychologically) to the participants. The participants’ privacy and anonymity were handled confidentially and securely. One of the studies was completely anonymous and, in the other study, where they optionally provided their contact details for follow up questions, participants were guaranteed that any identifying information would not be provided to anyone who was not directly involved in the study.
4 Research contribution

This chapter presents a summary of the key findings of Studies I – V. The main research question addressed by the following studies is:

*How can integrating judgement and decision-making processes and persuasive software design patterns enhance the development of behaviour change support systems?*

4.1 Behavioural economics in information systems research

Study I (Oduor & Oinas-kukkonen, 2017) is a literature review examining behavioural economics studies in information systems (IS) research. The objective of Study I was to examine behavioural economics research in IS that addresses how people’s cognitive limitations influences decision making and the implications this has for PSD. The main research question for Study I was:

*How can persuasive design patterns be applied to develop behaviour change support systems?*

Webster and Watson's (2002) and Kitchenham's (2004) guidelines were used to conduct the review. The following keywords were used in the electronic search: 1) behavio(u)ral economics, prospect theory, mental accounting, cognitive bias, choice architecture, nudge, and 2) persuasive systems design, persuasive technology, behavio(u)r change, attitudes, persuasion. The keywords were used to search for the metadata related to the top eight IS journals – MIS Quarterly, European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Information Systems Research (ISRe), Journal of Information Technology (JIT), Journal of Management Information Systems (JMIS), Journal of Strategic Information Systems (JSIS), and the Journal of the Association for Information Systems (JAIS). The search for the years between 2006 and 2014 was carried out in Wiley, INFORMS PubsOnline, EBSCOhost, ScienceDirect, Taylor Francis Online, and ProQuest ABI/INFORM.

Articles were included if they: 1) had behavioural economics in the abstract, 2) were full research papers (and not editorials/commentaries), 3) described the persuasive/cognitive stimuli applied, and 4) investigated the relation between the stimuli and (behavioural) outcome. Articles were excluded if they did not investigate either a persuasive or cognitive stimuli, were primarily about systems...
implementation or benefits, and related to research methodologies. The study identification process is presented in Figure 6.

Context analysis as defined in the PSD model (Oinas-Kukkonen & Harjumaa, 2009) was used to categorise the articles. The categorisation was suitable because of the level of abstraction it enabled in identifying the effects of the measures used in the presented studies. However, as not all the studies fell within the realm of persuasive systems, it was challenging to categorise them and there is a potential for bias in the grouping of the studies.

The majority of the selected articles were from EJIS and ISRe, with all but one of the journals producing original results with data, and only two articles (Adomavicius, Bockstedt, Curley, & Zhang, 2013; Goh & Bockstedt, 2012) from ISRe had behavioural economics as a keyword in the metadata. Certain articles (for
Some articles explicitly focused on users’ valuations of presented options and investigated goals and design aspects that may not be classified as behavioural economics (Angst & Agarwal, 2009; Blanco et al., 2010; Lankton & Luft, 2008). Therefore, the categorisation of the articles as investigating a behavioural economic principle should be considered with this caution in mind, especially since behavioural economics is not a homogenous field that can straightforwardly be defined and there have been opposing views as to what counts as behavioural economics (Avineri, 2012).

Most of the studies were either experiments or surveys carried out on the Web or on mobile devices investigating decision making in various circumstances such as risk and the reasons people buy in online stores. For example, Chiu et al. (2014) used prospect theory (Kahneman & Tversky, 1979) to explain decision making from a value maximisation perspective and why people do not consider how their consumption behaviour is affected by their decisions.

The use, user and technology contexts were not discussed in detail because the studies focused more heavily on investigating users’ responses to different persuasive or cognitive stimuli. As the studies were not related to a particular technology, it was not possible to discern the actual interactions mediated by the systems, the processes under investigation, and/or the potential outcomes resulting from their use.

The studies were categorised according to the behavioural or cognitive stimuli used to investigate users’ actions or valuation of options in different settings, for example, how anchoring, loss aversion, framing, and confirmation bias affect decision making (e.g., in Adomavicius et al., 2013; Chiu et al., 2014; Goh & Bockstedt, 2012; Park et al., 2013). Those investigating issues related to framing, which were the majority, considered: how the presentation of information affects users’ perception and recall; how framing affects consumers’ valuation of online stores’ products; whether the salience of information influences online purchase decision; and, how persuasively framed messages can change users’ attitudes and their intentions to join electronic health records (Angst & Agarwal, 2009; Blanco et al., 2010; Goh & Bockstedt, 2012; Tsai et al., 2010). The findings of these studies
addressed the importance of product presentation in online settings and how digital environments significantly influence consumers’ choices.

Other studies investigated risk aversion. For example, how users’ risk preferences and perceived risk affect their purchase intentions, what this means for sellers, and the possible mitigating factors (Chiu et al., 2014; Wu & Gaytán, 2013).

In summary, the 15 studies highlighted how contextual factors affect decision making and why it is important to understand how people are influenced by those with whom they interact and their actions, how people’s reactions are shaped by predictable mental cues, and how people’s actions are often influenced subconsciously (Dolan, Hallsworth, Halpern, King, & Vlaev, 2010; Thaler & Sunstein, 2008; Thorgeirsson & Kawachi, 2013).

Behavioural economics and related concepts study the valuation of options and how this affects decision making. The field helps us to understand user behaviour or their thought process in different contexts and provides debiasing techniques that enable people to make self-beneficial decisions (Lee et al., 2011). People have been shown to be predictably irrational (Ariely, 2008) and, in order to develop effective interventions, it is important to also consider factors that may lead to the non-adoption or unintended use of well-developed IS.

Study I explored behavioural economics in IS and categorised articles describing its application in relation to decision making and, in general, cognitive processes. The categorisation enabled analysis of the use of the principles in different contexts and their effects on users’ actions. Based on these insights, the review contributes to research on user behaviour. This has implications for the design of persuasive systems as it provides techniques for studying the value users attach to provided options or content and their subsequent choices. Therefore, Study I set the ground for investigating how persuasive software features facilitate engagement with an online commitment device that helps people to define and stick to their intended goals by adding real consequences for failure to meet them.

4.2 Users’ perceptions of and engagement with persuasive systems

4.2.1 Commitment devices as behaviour change support systems

Study II (Oduor & Oinas-Kukkonen, 2017) analysed the effects of the PSD feature categories; primary task support, dialogue support, perceived credibility, and social
support on users’ perceived competence and intention to continuing using an online commitment device. The results showed that 37% of users’ continuance intention is explained by the persuasive software feature categories.

The online commitment device (Beeminder) is a Web-based Quantified Self (self-tracking data collection and visualisation) system (Figure 7). Beeminder is a motivational tool where you pledge money to stay on track toward a goal and, if you go off track, you pay. An individual creates a contract to spend either more or less time on a particular activity. The commitment contract is linked to a graph of their progress which is either entered manually or automatically reported from synced devices. The commitment is to keep all of your data points on a yellow brick road drawn on a graph that is accessible from one’s account either through mobile devices or on the Web.

**Fig. 7. The study context.**

Between March and May 2016, an online survey of the system users was conducted. Data were collected using an online software tool (Webropol) over a 7-week period. Participants were recruited through a public link that was sent to their email addresses. The survey had two main parts. The first consisted of demographic

1 https://www.beeminder.com/.
questions and questions related to the main goal tracked, use history, and use frequency. A total of 173 responses without missing data were collected. Overall, around 76% (131) of the respondents were male, 50% (87) were 30 years old or younger, 43% (75) were from 31 to 50 years, around 70% (120) were either married or in a relationship, and 86% (149) had at least an undergraduate degree.

The second part was the main survey instrument (Appendix 1) consisting of seven-point Likert scale items (ranging from strongly disagree to strongly agree).

In Study II, a model was constructed predicting the continuance intention of an online commitment device. In addition to the persuasive features, Study II investigated the effect of users’ perceived competence on continuance intention. Overall, the results moderately supported the hypotheses (Table 5) concerning factors that affect users’ continuance intention of the commitment device (see Figure 8).

Table 5. Hypotheses.

<table>
<thead>
<tr>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a: Dialogue support positively affects primary task support.</td>
</tr>
<tr>
<td>H1b: Dialogue support positively affects social support.</td>
</tr>
<tr>
<td>H1c: Dialogue support positively affects perceived credibility.</td>
</tr>
<tr>
<td>H2a: Primary task support positively affects perceived competence.</td>
</tr>
<tr>
<td>H2b: Primary task support positively affects continuance intention.</td>
</tr>
<tr>
<td>H3: Social support positively affects perceived competence.</td>
</tr>
<tr>
<td>H4: Perceived credibility positively affects continuance intention.</td>
</tr>
<tr>
<td>H5: Perceived competence positively affects continuance intention.</td>
</tr>
</tbody>
</table>

Five (H1a, H1b, H1c, H2a, H2b) of the eight hypotheses (Figure 8) were supported at p < .001, and primary task support and social support explained 12% of the variance in perceived competence. Dialogue support had a key role in the proposed research model as it had significant effects (varying from medium to small) (Table 6) on the other persuasive software feature categories. Primary task support had the highest total effect on perceived competence (a medium effect size) and continuance intention (a large effect size). Dialogue supports, facilitates and improves communication between a system and its users, especially in terms of receiving appropriate feedback which keeps them motivated in their endeavours (Langrial et al., 2012; Lehto & Oinas-Kukkonen, 2011). Primary task support aids users in carrying out the real-world activity that they would like to complete (Oinas-Kukkonen & Harjumaa, 2009).
Perceived credibility deals with designing credible and subsequently more persuasive systems. Perceived credibility comprises trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability (Oinas-Kukkonen & Harjumaa, 2009). Perceived credibility had a surprisingly negative relation with continuance intention, which warrants further attention. The relation between perceived competence and continuance intention, although positive, was statistically insignificant, which also warrants further investigation.

Table 6 shows the total effects (direct and indirect effects) and the effect sizes of each construct on the corresponding dependent variables’ variance. Effect sizes determine whether the effects shown by path coefficients are small (.02), medium (0.15), or large (.35) (Cohen, 1988). Effect sizes below .02 are considered too weak to be relevant, which is the case for three hypotheses. Dialogue support has the highest total effect (with a medium effect size) on primary task support, whereas primary task support has the highest total effect on perceived competence (a medium effect size) and continuance intention (a large effect size). Dialogue support also has an indirect positive effect on perceived competence and continuance intention.
Table 6. Total effects and effect sizes (Cohen’s $f^2$ in parentheses) (Oduor & Oinas-Kukkonen, 2017).

<table>
<thead>
<tr>
<th>COMP</th>
<th>CONT</th>
<th>CRED</th>
<th>DIAL</th>
<th>PRIM</th>
<th>SOCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP</td>
<td>0.085 (0.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRED</td>
<td>-0.023 (0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIAL</td>
<td>0.134</td>
<td>0.224</td>
<td>0.266 (0.076)</td>
<td>0.377 (0.166)</td>
<td>0.301 (0.100)</td>
</tr>
<tr>
<td>PTS</td>
<td>0.346 (0.132)</td>
<td>0.609 (0.436)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOCI</td>
<td>0.012</td>
<td></td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contrary to previous research (e.g., Lehto & Oinas-Kukkonen, 2015), not all constructs included in the model had a practically relevant impact on the continuance intention of the system which warrants further research. Nevertheless, Study II provided evidence that persuasive system design features are, to varying degrees, associated with users’ perceived competence and continuance intention of a commitment device. Furthermore, as in several previous studies, dialogue support was found to have a crucial role in the effectiveness of the system, as this feature strongly supports users’ interactions with the system and facilitates the completion of the primary tasks. Primary task support also strongly predicts users’ confidence in their ability to carry out tasks and their intention to continue using a system.

4.2.2 A system’s self-referential persuasion

Study III (Oduor & Oinas-Kukkonen, 2015) examined how users interact through social web platforms and aimed to shed light on the inherent features of these platforms that influence users’ behaviours.

Social web platforms provide ecosystems of related elements comprising both digital and traditional media that leverage the personal relationships embodied in real-life social networks (Gupta, Li, Yin, & Han, 2010; Oinas-Kukkonen, Lyytinen, & Yoo, 2010). Consequently, they can be seen to be re-transforming the Web to the purpose for which it was initially created: “a platform to facilitate information exchange between users” (Kaplan & Haenlein, 2010).

There are numerous socially based platforms which share similar features, such as the creation of user profiles that disclose whom the user is in contact with, setting up and customising user profiles, private messaging, discussion forums, uploading media files, integration with other applications (boyd & Ellison, 2007; Fogg & Iizawa, 2008), amongst others. In these platforms, among the major challenges is that of how to engage and motivate different stakeholders, particularly end users.
to keep contributing back to the operational environment (Oinas-Kukkonen & Oinas-Kukkonen, 2013). This is particularly true, given that users are no longer passive recipients of information and are increasingly taking part in all aspects of value creation (Hanna et al., 2011). We refer to this as an information system’s self-referential persuasion, where users not only participate in the co-creation of value, but also leave their own identity into the system (Porter, 2008) and are persuaded to continue using it.

Study III’s focus, a system’s self-referential persuasion, was illustrated through the analysis of a survey (N=57) on the use of the social web. The survey covered topics such as the reasons for joining a particular platform, the types of platform used, use history and the kind of information primarily shared in these social websites. Our analysis also examined whether there were any differences between demographic variables, such as gender and age, along with use history and certain categories.

Prior to publishing the survey online, a pilot test was conducted with eight (two senior scholars and six doctoral students) participants. Based on the results of the pilot test, some questions and Likert scale options were modified. The online survey of social web users was conducted between December 2 and 23, 2014. Data were collected using an online survey and analysis tool called Webropol. According to the statistics given by the tool, the total number of visitors was 110, of which 57 responded; thus, the effective survey response rate was 52% (57/110) – albeit a small sample size. All these were valid for further analysis.

Male respondents represented 61% (35) of the total, 86% (49) of the respondents had at least an undergraduate university degree, and 56% (32) were in the age range of 25–34 years. The survey also asked users which social web platforms they generally used from a given list with an open text option to add extra choices. The data provided valuable insights on the features users consider important and the information they primarily shared, which could somewhat be linked to their reasons for registering with, or frequently using, any of the investigated social web platforms.

The reasons people gave for joining or using the various social platforms were examined. The most popular reasons for joining any platforms were networking, entertainment, and suggestion from a friend or family. All these involve a social aspect, where users were primarily interested in interacting with those they already knew (Fogg, 2008; Fogg & Iizawa, 2008) and to also meet new people.

These also corresponded to most responses given to the question "What do you primarily use social web sites for?" which consisted of communication and connecting with old friends. Additionally, most of the information shared on the
various platforms (primarily social networking sites) were of a personal nature or links related to the respondents' personal interests.

In the survey, there was a question measuring 'user satisfaction' (from 1, very dissatisfied, to 5 very satisfied) which consisted of 12 features found in the social platforms. The features with the highest ratings included: inviting and connecting with friends, responding to posts and updates, uploading content, private communication, creating and editing profile, and forming groups. Gender, age, and level of education did not have a significant effect on level of satisfaction.

Features were also ranked in order of importance, and aside from newsfeed, the rankings were similar to the satisfaction ratings, although the order differed slightly. There were also no significant differences between gender and use history on the feature rankings. It is possible that a larger sample size might reveal different results with greater variance in the rankings between groups.

Overall, the results support the claim by Fogg and Eckles (2007) that users creating value and content as well as involving others led to their staying active and loyal. As most of previous research (e.g., Hanna et al., 2011; Kaplan & Haenlein, 2010) emphasised the collective, interactive, and interconnected nature of the social web, person-to-person push communication akin to email is also considered to be important by users (especially in social networks such as Facebook).

Study III presented the features which aim to commit users so that they regularly keep accessing the social web platforms. The key is to provide persuasive user experiences, which are able to capture and maintain users’ interest on the content provided, thus ensuring their engagement and repeated visits. We referred to this as a system’s self-referential persuasion where the system’s persuasive intent is to refer to itself so that users stay as part of its ecosystem and are persuaded to frequently use it.

These results help to further explain the findings in Study II which examined specific persuasive features contribution in committing users’ and contributing to their intention to continue using an online commitment device. The persuasive software features in the investigated systems supported users’ various objectives for using the systems. The findings in both studies suggest that users’ goals and their reasons for using persuasive systems affect how they perceive different persuasive features. Depending on the reasons or goals for using a particular system, some features appear to be more important than others and the effectiveness of the systems may rest on how these features provide different forms of support across genders and/or user goals.
Inherent in the systems and research investigated in Studies I – III are psychological theories that form the basis for crafting persuasive interactions and how people interpret the technological experience with regards to the functions of a particular system. Studies II and III both highlighted the importance of dialogue and social support persuasive features as these features facilitate the achievement of users’ main goals and provide opportunities for social interaction. Therefore, the results of Studies IV and V, which focused on instantiating the persuasive software features for facilitating interaction between users and systems and those that provide social support to users, are presented below. As indicated in Studies II and III, users consider these features important in most of their digital interactions.

4.3.1 Software design patterns for social support

Study IV (Oduor et al., 2014) is a conceptual study that describes the development of persuasive software design patterns based on the social support category of the PSD model (Oinas-Kukkonen & Harjumaa, 2009). Study IV proposes generalizable techniques based on software design patterns to develop social support features in BCSSs.

For social support features to be effectively applied in persuasive systems, an understanding of the fundamental aspects of human behaviour is required. Additionally, mediums for channelling this understanding to enhance positive user experiences and interaction via the persuasive systems are needed. Therefore, Study IV presented an overview of PSD and social psychological principles. Following this, software design patterns were discussed, which formed the basis for the development of the persuasive design patterns based on the social support features in the PSD model (Oinas-Kukkonen & Harjumaa, 2009).

Social influence is defined as a change in one’s beliefs, behaviour, or attitudes caused by external pressures that may be real or imagined (Guadagno & Cialdini, 2010). Social influence is common in our daily activities as we either try to influence or are influenced by the actions of others. The influence arises from social situations, for example, in relatively trivial issues such as the choice of a diner or more significant ones such as raising money for humanitarian aid (Smith et al., 2011). When computers are perceived as social actors, they can leverage the social principles to motivate and persuade (Fogg, 2003).
New problem situations are often similar to those faced previously, as emphasised by approaches to idea generation and problem solving (Lockton, 2013). Software design patterns solve design problems by defining appropriate objects, putting reuse mechanisms to work and designing for change (Gamma et al., 1994).

The software feature categories of social support in Oinas-Kukkonen and Harjumaa's (2009) PSD model present ways to induce social influence. As instantiations of these constructs, Study IV presented four patterns that could be used in developing social support features in persuasive systems. These included: Social Learning and Facilitation (SLF), Competition (COM), Cooperation (COO) and Recognition (REC), with SLF pattern being the underlying layer. The categories of normative influence and social comparison are partially implicit in the other features. For example, competition and recognition features, to some extent, use social comparison and normative influence through showing numeric figures or displaying the results of other people's performance.

The diagram (see Figure 9) presents an example of the use of the patterns. Figure 9 is a class diagram representing the static view of a system and describes the social support features in the persuasive system. The user and the SLF pattern are the two main elements in the system with a one-to-many relationship, because the user can perform multiple tasks. The SLF is an abstract class, which has the three sub-classes (COM, COO, and REC) with an inheritance relationship, indicating that they have similar attributes, and some additional operations. These patterns provide the structure whereas the theories they are based on, are used to provide the content.
In order to demonstrate the applicability of the software design patterns for social support, they were used to develop a non-functional software prototype for a conceptual BCS. A system supporting the motivational method called “don’t break the chain”\(^2\) was developed. The method is based on the idea that, in order to change behaviour, one should choose a habit and start performing it on a daily basis. Each day the habit is successfully maintained is tracked in order to keep count of the number of consecutive days the target behaviour has been followed. The longer the “chain”, the more resilient the user is in maintaining the behaviour. The concept serves as a motivational technique to enhance commitment. The basic functionality of the conceptualised system would be for the user to choose habits to develop and then record each day they perform them.

The persuasive potential of the patterns was then inspected in the implemented system. An example of the implementation of the competition pattern and its composition is presented in Table 7 and Figure 10.

In the PSD model (Oinas-Kukkonen & Harjumaa, 2009), competition is presented as a principle to motivate users by leveraging their natural drive to compete. The proposed pattern therefore applied competitive elements such as ranks, scores, and levels to enable the comparison of performance with others and allow users to adjust their goals based on these (Figure 11). It should, however, be

\[^2\]http://lifehacker.com/2012/05/jerry-seinfelds-productivity-secret-all
noted that individuals may have different views about openly competing. Some could, for example, be wary of other people’s reactions to their bad performance or failure to meet goals, thereby leading to an unintended effect.

Table 7. The competition pattern (Oduor et al., 2014).

<table>
<thead>
<tr>
<th>Pattern name</th>
<th>Competition (COM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>To define features that function as motivational factors and result in competitive interactions among users.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Enabling of competitive elements such as ranks, scores and levels that allow users to compare their performance with others and adjust their target goals based on these. These competitive elements may function as additional motivation for users.</td>
</tr>
<tr>
<td>Applicability</td>
<td>A practical implementation of the Competition pattern would be the ranking of users based on their performances, such as levels and points received for engaging in a target behaviour. This enables users to follow their natural competitive tendencies to reach a higher rank among their peers while pursuing their target behaviours.</td>
</tr>
<tr>
<td>Structure</td>
<td>The COM is represented by the features of User, Chain, Goal and Story entities. The COM feature is implemented by encouraging users to gather points. Maintaining Chains that consist of Stories created on subsequent days adds to the points attributed to a User. A Chain comprises records of a user’s subsequent Stories, and a Story always relates to a certain Goal (Figure 10).</td>
</tr>
<tr>
<td>Implementation</td>
<td>The high scores feature (see Figure 11) demonstrates the implementation of the COM pattern. In our conceptual design, the users gain points each time they record a consecutive day of performing the habit. The points gained for each action are shown alongside it in the newsfeed. The High score list then shows the users' rankings based on the points accumulated. This allows users to compare their performance with others.</td>
</tr>
<tr>
<td>Known uses</td>
<td>Endomondo(^3), for example, allows users to meet like-minded friends, be inspired and challenge one another in, in general, outdoor sports.</td>
</tr>
</tbody>
</table>

\(^3\)https://www.endomondo.com/.

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The other patterns were also based on the same format. Simplified scenarios of potential user interactions with a BCSS that represent the implementation segment of the patterns were then presented (Table 8).
Table 8. Scenarios for social support-related user actions (Oduor et al., 2014).

<table>
<thead>
<tr>
<th>User action</th>
<th>Question(s) to consider</th>
<th>System response</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>User navigates to the site</td>
<td>Is the system device or platform agnostic?</td>
<td>Optimise according to device.</td>
<td>Is the user aware of the various layouts they could use?</td>
</tr>
<tr>
<td>SLF Browses other users’ shared information</td>
<td>What information about other users should be displayed?</td>
<td>User numbers and their actions displayed in a suitable manner</td>
<td>Show the most popular content of only those in the users close circle in the news feed</td>
</tr>
<tr>
<td>COM Reviews the tasks and compares completed tasks to those of others</td>
<td>Information to be displayed so as to both encourage and motivate the user?</td>
<td>Tasks completed and level attained by others displayed in the ranking lists</td>
<td>Send encouraging messages about the target behaviour</td>
</tr>
<tr>
<td>COO Checks own and the group’s progress</td>
<td>What kind of information is the user likely to be presented with? How to encourage users to work together towards a common goal?</td>
<td>The tasks that other users are working on are clearly visible. System shows suitable groups with similar goals to join</td>
<td>Provide information on how to reach similar others or those the users may like to interact with</td>
</tr>
<tr>
<td>REC Update completed targets and duration of next task</td>
<td>Should the rewards automatically be visible to other users?</td>
<td>User obtains new rewards because s/he got to a certain level.</td>
<td>Display action steps and what is needed to attain a set target to get the next reward.</td>
</tr>
</tbody>
</table>

There is limited research on persuasive software design patterns and of the few available, such as Lockton (2013), the focus has not been on actual system development. Therefore, Study IV proposed software design patterns as a new direction for persuasive systems design and development. In Study IV, the social support features in the PSD model were instantiated as persuasive patterns. Software patterns provide structure and standardised reusable frameworks that can enhance the development of persuasive systems. Although the presented implementation of the software patterns in a conceptual prototype suggested their usefulness, there is still a need for further research to ascertain their feasibility in systems development.
4.3.2 Software design patterns for dialogue support

Study V (Oduor et al., 2017), based on the dialogue support features of the PSD model (Oinas-Kukkonen & Harjumaa, 2009) conceptualises software design patterns for providing persuasive dialogue support in persuasive systems. Study V aimed to provide a more detailed and technical description of PSD by investigating the patterns from both an object-oriented modelling approach and a coding level. This was to ensure that the results would be applicable to both researchers and practitioners investigating and developing persuasive systems.

There are numerous principles drawn from cognitive and social psychological theories that have been developed for overall PSD; these principles provide ideas for system feature considerations. However, detailed descriptions and guidelines for their software level implementation are still lacking and, in current persuasive systems research, there seems to be a tendency towards describing the software systems and the persuasion context at too general a level (Oinas-Kukkonen, 2013). The reference theories, although important, do not provide guidance on the implementation of systems that support behaviour change, thus easily leading to a passive adoption of these theories in systems development and into a mismatch between the persuasive message and the selected strategy (Oduor et al., 2014). Black-box thinking of the software systems, with no actual description of what is implemented and how, may make the research results obsolete (Oinas-Kukkonen, 2013). Accordingly, persuasive software design patterns were suggested as a new avenue of research in PSD to tackle this problem (Oduor et al., 2014).

Kelders et al. (2012) in their review on persuasive systems, found, although not conclusively, that dialogue support features such as reminders can significantly predict better adherence in subjects and the effectiveness of web-based interventions. Dialogue support is the design principle concerning the interaction between a system and its users. These features improve communication between users and the system, especially in terms of system’s feedback to better guide the user through the intended behaviour change process. Dialogue support features should be included in persuasive systems to keep users involved and motivated in continued interaction with the system towards achieving their behavioural goal(s) (Langrial & Oinas-Kukkonen, 2012; Lehto & Oinas-Kukkonen, 2011; Oinas-Kukkonen & Harjumaa, 2009). The features include praise, rewards, reminders, suggestion, similarity, liking, and social role.
Similarity, liking and social role primarily relate to systems design at the user experience level, and these features of the dialogue support cannot be easily operationalised as software design patterns. For this reason, Study V focused on praise, suggestion, reminders and rewards. Reminder and Reward patterns are implemented as is, but because both Praise and Suggestion provide feedback based on users’ actions, they were combined into the Instant Feedback pattern (Figure 12).

Fig. 12. Dialogue support patterns (Oduor, Alahäivälä, & Oinas-Kukkonen, 2017).

The dialogue support patterns were designed for a BCSS developed using the model/view/controller (MVC) and Representational state transfer (REST) (Fielding & Taylor, 2002; Krasner & Pope, 1988; Leff & Rayfield, 2001) approaches. MVC is a common design pattern to distribute the software functionalities into distinct components for the sake of maintainability and separation of applications’ concerns (Krasner & Pope, 1988; Leff & Rayfield, 2001). Building on these two approaches, it was assumed that the application’s resources are implemented as their corresponding Models, Views, and Controllers with create, read, update and delete (CRUD) actions. A REST application usually provides an interface for performing CRUD actions on its resources (Fielding & Taylor, 2002).

At least two generalizable resource entities necessary for a BCSS are the User resource and the Entry resource. The User resource represents the users of the systems, their account information and possible behavioural profiles. The Entry resource is an abstraction of the data that the user submits to the system to monitor their behavioural habits, for example, weight measures in a weight-monitoring
application. Table 9 presents a summary of the Instant Feedback pattern and provides a structured presentation of the problem and solution. The other patterns had a similar structure to the one presented in Table 9. As in Study IV, the patterns were used to develop a prototype for a conceptual BCSS. The basic functionality was for a user to choose a habit to follow and then note each day they successfully perform the habit.

The features suggested in the patterns were applied in a system implemented using the Ruby programming language with the Ruby on Rails web framework (see Appendix II for the pseudocode). Ellipses in the code indicate omitted implementation details.

Table 9. Instant feedback pattern (Oduor et al., 2017).

<table>
<thead>
<tr>
<th>Pattern name</th>
<th>Instant Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
<td>The system should give real-time comments on the user’s performance, so they can</td>
</tr>
<tr>
<td></td>
<td>receive immediate feedback on their progress. Good performance should be praised</td>
</tr>
<tr>
<td></td>
<td>and relapses should be met with appropriate suggestions for the next action to be</td>
</tr>
<tr>
<td></td>
<td>taken.</td>
</tr>
<tr>
<td><strong>Components</strong></td>
<td>User, Entry (Controller).</td>
</tr>
<tr>
<td><strong>Solution</strong></td>
<td>Upon creation of an Entry to a BCSS system, it should be analysed in the Create</td>
</tr>
<tr>
<td></td>
<td>action of its Controller, and an appropriate feedback message should be passed on</td>
</tr>
<tr>
<td></td>
<td>the View that is shown to the user, containing (1) a praising message for good</td>
</tr>
<tr>
<td></td>
<td>performance or (2) a suggestion how to correct their behaviour.</td>
</tr>
<tr>
<td><strong>Consequences</strong></td>
<td>The user always receives appropriate feedback when submitting an entry of a</td>
</tr>
<tr>
<td></td>
<td>behavioural action. Based on the feedback the users can re-examine the progress</td>
</tr>
<tr>
<td></td>
<td>made and possibly make adjusting moves to their habits.</td>
</tr>
</tbody>
</table>

Both Studies IV and V present a new approach for the future development of BCSSs. The studies present the process for developing persuasive software design patterns based on the social and dialogue support features of the PSD model. The studies aim to address the black box approach to the development of persuasive systems and the current ad-hoc approach of developing each persuasive system from scratch without a set of well-defined guidelines. The studies clearly articulate the development process of a BCSS and describe the system’s persuasiveness as being derived from the technological context. In both studies, relevant background literature related to providing social support and facilitating HCI are considered and these are integrated with object-oriented development practices in order to develop the persuasive patterns.
5 Discussion

Technological advancements have availed numerous opportunities to encourage user participation and active engagement with computer-tailored interventions that attempt to persuade users to choose courses of action that are often beneficial to them (Benbasat, 2010; Chatterjee & Price, 2009; DiSalvo et al., 2010; Oinas-Kukkonen, 2013). These interventions also provide a fertile source of data for research, as user contributions are, in most cases, explicit and available for mining and analysis, especially in the case of social web platforms. Analysing the data from web-based systems, such as those investigated in Studies II and III in this dissertation, provides opportunities for gaining a deeper understanding of user behaviour (Ruth, 2012) and the features with which they principally engage.

Since customer retention and attrition in web-based social platforms, eHealth and/or self-help systems is often a challenge because of the easy availability of alternatives or low switching costs (Eysenbach, 2005; Ruth, 2012), in this dissertation the effect PSD has on the use of these systems in influencing user behaviour, and how the principles can be used in systems development, was studied.

Study I, a literature review, examined behavioural economics studies in IS research related to how users’ cognitive limitations affect their decision making. Study II examined the use of commitment devices as BCSSs by analysing the effect PSD’s design principles have on users’ perceived competence and intention to continue using the system. Study III, also a feature-level analysis, investigated user interaction in social web platforms and the features they primarily used. Studies IV and V integrated relevant theoretical background (social support, dialogue support and software design patterns) to demonstrate how the development of persuasive systems could be improved.

The key issues arising from the review in Study I of behavioural economics in IS included: 1) an understanding of how the technology-driven context of a decision has significant effects on consumers’ choices; 2) new insights into consumers’ valuations of personal data and how this relates to their online decisions; 3) an understanding of how users’ preferences in online settings are malleable and how this can be performed more effectively; and 4) techniques to limit unwanted effects of bias in decision making. The results also revealed that in most studies, the use, user, and technology contexts were not clearly outlined.

The results of Study II revealed that the persuasive software feature categories of the PSD model and perceived competence explained a considerable amount (37%) of users’ continuance intention. Post-adoption behaviours better explain
technology’s success, because the motivations affecting users’ willingness to continue using a system only emerge after using the system (Bhattacherjee, 2001; Bhattacherjee & Barfar, 2011).

Commitment devices aim to deliberately limit future choices while attempting to enforce people’s voluntarily placed restrictions until they accomplish their goals. Mutable commitment devices, for example, purchasing only small plates for home use to limit portion sizes, allow people the future latitude to mitigate consequences (Rogers et al., 2014). For online commitment devices, the technology-driven context, focus on small achievable goals, and its incremental goal setting, enables users to better keep track of their progress. Additionally, the system investigated in Study II rewards users with buffer days after a continuous period of meeting or surpassing their goals, which allows users not to worry about the consequences of not meeting their goals on some days.

Study III revealed the main uses of social web platforms such as Facebook, Twitter, and LinkedIn. This included the reasons users joined these platforms, their satisfaction with them, and their rankings of the features present in the platforms. The results also revealed the information users’ primarily shared on these platforms and the importance of some of the features to users. This information could be linked to users’ reason(s) for joining or frequently using a particular platform.

Features that enable users to create and edit their profiles allow them to portray a favourable image of themselves and to leave their own identities within these systems, thus representing a form of self-presentation (Gupta et al., 2010). Most of the features facilitate social connection, communication, and encourage regular access. Because the possibility to interact with friends or other like-minded individuals is made salient, users find it easier to express themselves.

Studies IV and V, which described how dialogue support and social support features outlined in the PSD model (Oinas-Kukkonen & Harjumaa, 2009) could be implemented in BCSSs using software design patterns, revealed how to apply relevant background theories and software design patterns to develop BCSSs. In Study IV, in addition to presenting GUI-based prototypes for the different social support features, also outlined scenarios for users’ actions that could be implemented based on the social support features. Study V presented pseudo-code for handling user management and submission of completed activities based on the Ruby on Rails web framework for a non-functional software prototype.

Design patterns emphasise the rarity of entirely new problems; solutions, even those applied earlier and in different environments, could be used to solve current problems (Lockton et al., 2010). Patterns, as presented in Studies IV and V, can
provide reusable frameworks and strategies to improve the development of BCSSs and have previously been suggested as a potential avenue for research in persuasive design (Oinas-Kukkonen, 2013). Patterns are an important tool for sharing knowledge, as they help to identify and document best practice solutions. Furthermore, it is also important not to reinvent the wheel whenever a system is to be developed in order to save time and avoid making erroneous implementation interpretations (Kruschitz & Hitz, 2010b; Wentzlaff & Specker, 2006).

5.1 Implications

5.1.1 Implications for research

Simple approaches such as informing users of their behaviour and providing feedback have been among the most common ways to, for instance, convince people to adopt healthy or sustainable lifestyles in web-based social applications and studies related to persuasion (DiSalvo et al., 2010; Dourish, 2010; Golman, Hagmann, & Loewenstein, 2017; Lee et al., 2011; Vassileva, 2012). The success of these approaches – or the basis of their evaluation – is behaviour change that aligns with predetermined behaviours defined by the systems’ providers or designers. The emphasis upon which the educational approach rests is the assumption of people being rational and striving to maximise their utility (similar to the criticisms of TAM (e.g., Benbasat & Barki, 2007) in IS-related research) (Brynjarsdottir et al., 2012; DiSalvo et al., 2010). These approaches, however, only ensure that users follow instructions but are unable to guide them towards maintaining long-term desirable behaviour (Vassileva, 2012).

Consequently, there have been calls to integrate behavioural economics in IS and other research fields (Goes, 2013; Lee et al., 2011; Vassileva, 2012). This is because behavioural economists have shown how people’s decision-making processes are biased by various contextual and situational factors and the state of a person when weighing between different options or making a choice (Ariely, 2008; Lee et al., 2011). Additionally, studies have shown how problems often arise when people must make decisions that test their self-control; how they give in to their impulses because emotions overcome them and make them view the world from a different perspective (Ariely, 2008; Thaler & Sunstein, 2008).

In order to better understand behaviour in different contexts, it is therefore important to consider both cognitive and emotional (or utilitarian and hedonic)
factors. The results of Study I highlighted how these factors influence decision making, the use of systems, and the importance of considering them when developing systems. These findings are also supported by previous literature (e.g., de Guinea & Markus, 2009; Lee et al., 2011; Moraveji et al., 2011; Thorgeirsson & Kawachi, 2013; Venkatesh et al., 2012).

Behavioural economics helps us to understand why people sometimes do not follow through on their intentions. It provides techniques to develop strategies (nudges) that act as enablers towards the future achievement of intended behaviour. By understanding various cognitive biases that are not initially acknowledged when people set goals, various behaviour change interventions can be better designed for long-term benefits. For example, the formation (starting a healthier regime), alteration (in case of bad or unwanted habits such as smoking), and reinforcement (in case one goes off track) of behaviour and/or attitudes (Oinas-Kukkonen, 2013). Behavioural economics can be especially important in devising incentive-oriented behaviour change programs where individuals are rewarded or fined for either fulfilling or not fulfilling set objectives, similar to how commitment devices work.

As in several previous studies (Chiu et al., 2009; Lehto et al., 2012; Nass & Moon, 2000), the results of Study II indicate that the dialogue support features have a crucial role in the perceived effectiveness of the system, as these features strongly support users’ interactions with the system and facilitate the completion of users’ main goals. Interactive computer-based interventions are more effective and can be more persuasive <(Fogg 2003). A key to facilitating computer-human dialogue is the multi-modality of technology, which provides various options for social interaction, engagement and learning even anonymously that could also encourage individuals who prefer privacy to be active (Lustria et al., 2009; Womble et al., 2004). Kelders et al. (2012) when reviewing the efficacy of persuasive systems noted that extensive employment of dialogue support features such as reminders, significantly predicts improved adherence in subjects and web-based interventions’ effectiveness.

The findings of Study II further extend the literature on use continuance intentions of persuasive systems (Ebermann & Brauer, 2016; Lehto & Oinas-Kukkonen, 2015; Stibe & Oinas-Kukkonen, 2014) by identifying primary task support as a key predictor of perceived competence and continuance intention. This indicates that supporting a user’s main goal is likely to lead to him or her feeling more competent and increases the likelihood of their continued use. The finding is consistent with Lehto and Oinas-Kukkonen’s (2015) post-hoc analysis of simpler path models in the studies’ research model that tested the effect of the PSD features
in continuance intention. Wu and Du (2012) state that in order to better understand system-use behaviour, researchers need to enhance their conceptualisation and measures of system usage which factor in the quality of information and the complexity of the IS environment. Therefore, to enhance this understanding, Study II integrated the perceived competence construct, one of the three basic psychological needs described in the self-determination theory (Deci & Ryan, 2000) and not a commonly investigated construct in persuasive systems research.

Persuasion can also be considered as a process and the design principles provide techniques to further learn about users and their changing goals, which is important in systems such as the one investigated in Study II, where users can pursue different goals with the system. PSD directs attention to the characteristics or features of technology that may restrict or guide users’ actions. Therefore, it is important to consider how users interact with different features of persuasive systems and how a system can, in isolation, act as an environmental cue by triggering automatic action (de Guinea & Markus, 2009).

On a practical note, the study also highlights the importance of considering a system’s primary intent and how this can be translated to software features that help users to achieve their main goals, as not all users have uniform backgrounds. The enhancement of systems’ persuasiveness will depend on the implementation of features that align either a system’s (or the designers’) intent to those of users. This is important because a reason for discontinued use could be the lack of “feature-function fit” (Markus & Tanis 2000) between users’ needs and the system’s features.

The research is also useful in enhancing further dialogue within the research (especially persuasive) community regarding the technical details of developing persuasive systems.

5.1.2 Implications for practice

The research suggests that users have different preferences and perceptions on systems use and because of other factors beyond their conscious control, they might not use systems as originally intended. In order to develop appropriate recommendations and guidance for users, developers need to understand how different persuasive strategies facilitate user engagement and social interaction and how the strategies can help to counterbalance factors that lead to the failure of digital interventions.

For practitioners, it is also important to understand the cognitive biases that could prevent desired behaviours and incorporate this knowledge into the
The results in Study III provide support for the claim by Fogg and Eckles (2007) that creating valuable content encourages user involvement leading to their staying active and loyal. The features in social web platforms that enable this include: creating and editing user profiles, inviting and connecting with friends, responding to posts and updates, uploading content, newsfeed, and a result not previously considered is that users value the possibility to privately communicate within these social platforms. As most of previous research (e.g., Fogg, 2008; Hanna et al., 2011; Kaplan & Haenlein, 2010) emphasises the collective, interactive, and interconnected nature of these social web platforms, person-to-person push communication similar to email was also considered important by users (especially in social networks such as Facebook). This point emphasises the importance of carefully considering the value of the features implemented in systems and always studying how users engage with them, as it is the use of an IT artefact in a particular interaction that forms the basis for how the artefact is perceived and evaluated by users. An artefact’s features provide options on how it can be used, but it is users’ choices in terms of how to use the artefact that determines the perceptions they form about the artefact during their interaction (Al-Natour & Benbasat, 2009). The results may also help designers to understand people’s priorities and the possibilities persuasive systems provide for (or in) social interactions.

Studies IV and V shed light on how application developers and designers can apply theoretical concepts and develop relevant actionable scenarios to assist in the development of persuasive systems.

There has not been extensive research conducted on persuasive software design patterns and those with a persuasive focus (e.g., Lockton, 2013) have not focused on actual system development. The current practice in developing persuasive systems, while based on well-developed and researched psychological principles, lacks the support of clear, well-defined, flexible and generalizable software development practices that provide generalizable solutions for enhancing the development process (Oinas-Kukkonen, 2013). Persuasive software design patterns have, therefore, been suggested as a solution.

Studies IV and V’s implications for practice are in providing an implementation-level view of the software development process of BCSSs. The examples provided in the studies are intended to break out from the black box approach in persuasive systems design. The studies present practitioners with techniques to guide both researchers and normal users on how to inspect the
software components for developing persuasive applications. Therefore, this serves as the initial steps in providing evidence for why patterns could be an important component in enhancing the persuasive intent of BCSSs’ development.

Practitioner-wise, the use of persuasive design patterns will assist in creating conventions to bootstrap future BCSSs development. Study V, by also considering the model-view-controller (MVC) architectural pattern and the representational state transfer (REST) approach, shows the patterns can be applied to both local and distributed architectures. Thus, they are of interest to software developers.

5.2 Limitations of this research

Naturally, the dissertation has several limitations. The use of interpretive categorisation in the analysis for Study I might be subjective, leading to disagreements regarding the grouping of articles. The study also concentrated only on articles from the major IS journals and, as comprehensive as these are, they may not present most of the relevant research conducted. Considering that behavioural economics is a relatively new field, and IS research is itself multidisciplinary, there may be other applicable studies outside the major IS journals. For example, examining articles from well-known conference and workshop proceedings.

Surveys can provide a reasonably accurate description of real world situations from a variety of viewpoints (Galliers, 1990), but as surveys rely on self-report, selection bias is a major factor limiting the generalizability of results (Eysenbach & Wyatt, 2002). Self-report techniques are also not well-suited to obtain valid individual-level processes that take place outside of people’s awareness (de Guinea & Markus, 2009). With surveys, only limited insight is generally gained regarding the causes behind the phenomena being studied (Galliers, 1990). People are more likely to respond to questionnaires if there are items of interest to them, for example because they are affected by the topics in question, or because they are attracted by the incentives offered for participating (Eysenbach & Wyatt, 2002). There were no incentives in either Study II or III; therefore, it is likely that those responding to the surveys were affected by, or interested in, the items in question.

Given large sample sizes, generalization of the results of a survey may be less of a concern (Galliers, 1990). Nonetheless, Study III had only 57 respondents, which could have had an effect on the significance of some of the results. It is possible that a larger sample could have led to different findings. The respondents were also predominately highly-educated, therefore not representative of all the users of social web platforms. Additionally, the study primarily focused on the
features in general without considering the specifics of the platform. This said, we did ask users to rank the features based on the one they used most frequently. This information could be used to compare the differences in rankings and the level of satisfaction with the features between users of different platforms, which was not performed in the study.

Two of the positive relations and the one negative relation (in contrast to Lehto and Oinas-Kukkonen (2015) and Cheung et al. (2009)) in Study II had low path coefficient values, meaning the practical significance of their associations is limited, which warrants further research on the insignificant values. The research model in Study II was only investigated in the one system, thus necessitating an element of caution about the generalizability of the findings to other contexts. Nonetheless, the results should be applicable to other systems with a similar design and/or objectives to the one investigated. Neither Studies II and III considered demographic attributes and use characteristics in the analysis, which calls for further research on the effects of PSD on gender and other demographic variables.

The patterns presented in Studies IV and V suggest they could be useful in developing BCSSs. However, as the patterns are only conceptual instantiations of two software feature categories from the PSD model, there is still need for further research and additional testing on a fully-fledged BCSS. The proposed patterns are therefore limited, as they are only used to develop a demonstrative system prototype. Consequently, further proof of their usefulness by comparing to alternative or related patterns if available is required.

### 5.3 Further research

The literature review, Study I, found articles which were very diverse in nature. Some studies focused on behavioural IS and others on the economics of IS. Future research could examine whether there are any differences in adopting behavioural economics depending on the research community and the implications this has for the findings between different communities. Most of the research analysed in Study I focused on examining behavioural economics in already existing systems. Future work could concentrate on implementing the principles in the actual development of systems and investigate their effects on user behaviour. For example, it could be explored how varying the allocation and rate of rewards combined with social support in incentive schemes could influence goal achievement in technology-mediated environments.
Persuasive technologies and BCSSs aim to change behaviour by informing users of desirable outcomes and guiding them to make more effective choices. Behavioural economics research has shown that this is not always the best option and might even lead to information avoidance because of users’ deeply entrenched beliefs. Information avoidance is when people intentionally avoid information that contradicts their beliefs even though it might be helpful (Golman et al., 2017). Future research could address this by investigating how self-regulatory performance could be enhanced through increased digital self-monitoring, as demonstrated in Soror, Hammer, Steelman, Davis, and Limayem, (2015) who applied the dual-process theory to investigate mobile use.

Additionally, future work related to Studies II and III could investigate using PSD to unveil how user intentions are affected that past studies on continuance with non-persuasive systems do not and to further explain how the reasons for using a particular platform ties to users’ satisfaction and engagement. Another avenue for further research that is especially important for persuasive systems design is exploring the unintended consequences for supposedly helpful technologies, such as the negative consequences (the extent to which the use of handheld phones is perceived to create problems in managing oneself) associated with mobile phone use (Soror et al., 2015).

Both Studies II and III were cross sectional, therefore, future work should collect longitudinal data using more objective measures such as log data, field experiments, experience sampling, and/or interviews to explore certain findings in greater detail in addition to surveys.

Future work related to Studies IV and V should investigate the development of more complex applications applying the patterns. More rigorous evaluations of a richer set of patterns should be conducted to help researchers think about and identify different aspects of designing persuasive systems. Rather than merely focusing on the software feature categories of the PSD model, the patterns could, for example, be applied in systems for making recommendations based on externally generated information from sensors. The application of the patterns in different programming environments, languages, and frameworks should also be studied. For example, it could be explored whether (or how) the patterns apply in the development of native mobile applications as well as the development of web-based BCSSs. These should include further concrete examples of the code and GUI features that serve as a source for the patterns, showing how they could be extended by connecting them with other patterns. Furthermore, an evaluation based on
analyses of reports of key works showing how the patterns systematise the ways to think about them could be done.
6 Conclusion

Drawing upon persuasive systems, judgement and decision making, and software design patterns-related research, this dissertation investigated user engagement with persuasive systems by studying the feasibility of the propositions and software feature categories of the PSD model. The model was applied in both analysing persuasive features in systems and prescribing the development of persuasive design patterns for BCSSs.

The dissertation first investigated the prevalence of behavioural economics studies in IS using persuasion context analysis to categorise the findings. Secondly, the factors affecting users’ perceived competence and continuance intention of an online commitment device were investigated. Thirdly, the use of social web systems, the reasons users continue using these systems, and the features that influence user behaviour, were examined. Lastly, the dissertation prescribed the development of persuasive design patterns based on the dialogue and social support feature categories of the PSD model, which are important in enhancing the persuasiveness of a system.

The findings, as in previous research, show the PSD features to be associated to varying degrees with users’ perceptions of systems and their intent to continue using the systems. The results also reveal the importance of considering the persuasion context and how people’s decisions might be affected by factors beyond the technological artefact. In addition, the findings indicated the various reasons for joining social web platforms, the primary uses for these sites, and the features with which users primarily interact, which hold important design considerations for developers of such systems. The findings supplement the existing research and have implications for both research and practice. Primarily, they show why developing suitable persuasive features in systems can enhance user engagement and increase the likelihood of users adopting the systems and enhancing their post-adoption behaviours.

Improved understanding of how PSD helps users to achieve their objectives could help counterbalance factors leading to the failure of digital interventions. This is especially important for systems designed to support different goals such as the one investigated in Study II, where users might have divergent needs. Future research should concentrate on studying persuasive strategies used in systems targeting behaviour change to improve their overall evaluation (through longitudinal studies and by developing objective measures to study actual use) and
their development process that carefully considers the intent of the systems and how the design can efficiently be used to fulfil users’ day-to-day objectives.

Ultimately, however, persuasive systems design is more than just the mining of users’ data, intelligent, automated analysis, and the presentation of data. Persuasive systems design should be based on understanding and adapting to the needs of users, and recognising that users’ adoption, engaging with, and the continued use of these systems is enhanced through experiences instead of just the persuasive software features. Therefore, it is important to facilitate and provide opportunities for social interaction and consider how different contextual cues might influence user behaviour.
List of references


## Appendix I: Measurement items for Study II

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Indicators</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialogue</td>
<td>The system rewards me</td>
<td>0.778</td>
</tr>
<tr>
<td></td>
<td>The system provides me with appropriate feedback</td>
<td>0.787</td>
</tr>
<tr>
<td></td>
<td>The system provides me with reminders for reaching my goals*</td>
<td>0.570</td>
</tr>
<tr>
<td></td>
<td>The system encourages me</td>
<td>0.743</td>
</tr>
<tr>
<td>Primary</td>
<td>They system makes it easier for me to reach my goals</td>
<td>0.825</td>
</tr>
<tr>
<td>Task Support</td>
<td>The system helps me gradually reach my goals</td>
<td>0.865</td>
</tr>
<tr>
<td></td>
<td>The system helps me keep track of my progress</td>
<td>0.821</td>
</tr>
<tr>
<td></td>
<td>The system offers me personalized content*</td>
<td>0.460</td>
</tr>
<tr>
<td>Perceived</td>
<td>The system provides trustworthy content</td>
<td>0.949</td>
</tr>
<tr>
<td>Credibility</td>
<td>The system provides believable content*</td>
<td>0.961</td>
</tr>
<tr>
<td></td>
<td>The system provides accurate content</td>
<td>0.954</td>
</tr>
<tr>
<td></td>
<td>The system provides professional information</td>
<td>0.837</td>
</tr>
<tr>
<td>Social Support</td>
<td>The system enables me to share with others</td>
<td>0.772</td>
</tr>
<tr>
<td></td>
<td>The system enables me to learn from others</td>
<td>0.883</td>
</tr>
<tr>
<td></td>
<td>The system enables someone (chosen by me) to check on my commitments</td>
<td>0.764</td>
</tr>
<tr>
<td>Perceived Intention</td>
<td>I feel confident in my ability to achieve my goal</td>
<td>0.830</td>
</tr>
<tr>
<td></td>
<td>I am capable of doing what it takes to achieve my goal</td>
<td>0.899</td>
</tr>
<tr>
<td></td>
<td>I am able to achieve my goal</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td>I feel able to meet the challenge of fulfilling my goal</td>
<td>0.885</td>
</tr>
<tr>
<td>Continuance</td>
<td>I intend to continue using the system</td>
<td>0.943</td>
</tr>
<tr>
<td>Intention</td>
<td>I will be using the system in the future</td>
<td>0.936</td>
</tr>
<tr>
<td></td>
<td>I am considering discontinuing using the system</td>
<td>0.870</td>
</tr>
<tr>
<td></td>
<td>I am not going to use the system from now on</td>
<td>0.805</td>
</tr>
</tbody>
</table>

*: removed items
Appendix II: Survey items for Study III

<table>
<thead>
<tr>
<th>Item</th>
<th>Options/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male or Female</td>
</tr>
<tr>
<td>Age</td>
<td>18 -24, 25- 34, 35 – 44, 45 – 54, 55 or older</td>
</tr>
<tr>
<td>Marital status</td>
<td>Married, In a relationship, Single</td>
</tr>
<tr>
<td>Education</td>
<td>High school, Vocational training, Bachelor’s degree, Masters, degree, Other advanced, Doctoral degree</td>
</tr>
<tr>
<td>How long have you been a registered user?</td>
<td>Less than 6 months, 6 months to less than a year, 1 year to less than 3 years, 3 years to less than 5 years, 5 years or more</td>
</tr>
<tr>
<td>Why did you join a particular site?</td>
<td>Suggestion from a friend, for networking, for fun, interest in a topic, to support a particular cause, other.</td>
</tr>
<tr>
<td>What do you primarily use social web sites for?</td>
<td>Free text field</td>
</tr>
<tr>
<td>Is information synced between any of your social web accounts?</td>
<td>Yes or No</td>
</tr>
<tr>
<td>How often do you typically access the preferred social web site?</td>
<td>Multiple times a day, once a day, a few times a week, once a week, less than once a week, I do not use it at all</td>
</tr>
<tr>
<td>What was the main reason for visiting a particular site on your latest visit?</td>
<td>Communicating with friends/colleagues, seeking information, updating information, uploading content, sharing information</td>
</tr>
<tr>
<td>How satisfied are you with the social web sites?</td>
<td>Very dissatisfied to very satisfied</td>
</tr>
<tr>
<td>Do you add content to the social web sites?</td>
<td>Not at all, sometimes, regularly</td>
</tr>
<tr>
<td>Would you describe the kind of content you primarily share?</td>
<td>Free text field</td>
</tr>
<tr>
<td>How relevant do you find the information in the social web site(s) in general?</td>
<td>Not at all relevant to very relevant</td>
</tr>
<tr>
<td>Please rate your satisfaction with the following features found (if present) in the social web site that you mostly use.</td>
<td>Creating a profile, editing profile, inviting and connecting with friends/colleagues, responding to posts and updates, email updates, social tagging (e.g., tagging friend photos, products etc.), recommendations (friends, topics, places), uploading content, forming groups, private communication (messaging), games, other (please specify)</td>
</tr>
<tr>
<td>From very dissatisfied to very satisfied</td>
<td></td>
</tr>
<tr>
<td>Please rank each of the following features in order of importance with #1 being the most important feature.</td>
<td>Creating a profile, editing profile, inviting and connecting with friends/colleagues, responding to posts and updates, email updates, social tagging (e.g., tagging friend photos, products etc.), recommendations (friends, topics, places), uploading content, forming groups, private communication (messaging), games, other (please specify)</td>
</tr>
</tbody>
</table>
Appendix III: Study V – Pseudo-code for example implementation

Instant Feedback Pattern

```ruby
class EntriesController < ApplicationController
  def create
    @entry = Entry.new(params[:entry])
    if @entry.save
      if is_good_performance(@entry)
        redirect_to @entry, notice: 'Good! You’re doing great.'
      else
        redirect_to @entry, notice: 'You should keep going
every day to get results.'
      end
    end
    ...
  end
  
  private
  def is_good_performance(entry)
    entry.is_in_chain ? true : (return false)
  end
end
```

Original publications


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702. Lwakatare, Lucy Ellen (2017) DevOps adoption and implementation in software development practice: concept, practices, benefits and challenges


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