UNIVERSITY OF TWENTE.

MASTER THESIS

DEVELOPMENT OF A GOAL SETTING MODULE FOR A HEART FAILURE TELEMONITORING AND COACHING TECHNOLOGY: A MIXED METHODS STUDY WITH AN AGILE SCIENCE APPROACH

Roberto R. Cruz Martínez

s1774328

Faculty of Behavioural, Management and Social Sciences (BMS)

MSc in Psychology | Specialization in Health Psychology and Technology

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First supervisor | Prof. Dr. Lisette van Gemert-Pijnen

Second supervisor | MSc. Floor Sieverink

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Abstract

Background: The 'Twente TEACH' consortium is a partnership between the University of Twente, Thales, Menzis, Ziekenhuisgroep Twente (ZGT) and Vodafone. By conjoined efforts the consortium developed the iMediSense telemonitoring and coaching technology that aims to provide efficient and effective care for the growing population of chronic congestive heart failure (CHF) patients in the Netherlands. A pilot study showed that this technology was easy to use and that by further improvement it could be useful to increase self-management of CHF populations.

Objective: To improve the feedback and coaching support of the iMediSense technology by exploring and describing the implementation within existing technologies of Goal Setting Theory and goal setting as a behavioural change technique to effectively increase self-management of CHF populations.

Method: A mixed methods approach was employed guided by the CeHRes Roadmap, the Persuasive Systems Design model and the Agile Science Process, also supported by standardization tools like the Behaviour Change Technique Taxonomy (v1). A scoping literature review was conducted, which included a stakeholder consultation stage. Additionally, log data analyses were conducted to explore the use and usage of the iMediSense system. Finally, a concept of a goal setting module based on the agile science criteria was proposed, and its potential implementation was illustrated by the development of personas and use-case scenarios.

Results: The scoping search resulted in thirteen studies that addressed the main theme of technologies aiming to support CHF self-management and which included goal setting as an active component or theoretical basis. Five eHealth technologies were identified from these articles. The Goal Setting Theory constructs addressed by these technologies and their aim and operationalization of goal setting as a behavioural change technique were mapped and described.

Conclusion: To improve the feedback and coaching support of the iMediSense technology a concept for a goal setting module was proposed and described. This module focuses on increasing the patient's confidence to perform self-care behaviours also by providing feedback on progress towards goals. Persuasive principles that could complement this module were found to be reduction, tunneling, tailoring, praise, real-world feel and surface credibility.

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Dedication

For my father, who taught me by example how to be a hard worker and that knowledge is our most powerful tool.

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1. Introduction

1.1. Background

The Twente TEACH consortium is a remarkable partnership where the University of Twente, Thales, Menzis, Ziekenhuisgroep Twente (ZGT) and Vodafone came together to take on the mission of providing efficient and effective care for the growing population of *chronic congestive heart failure* (CHF) patients in the Netherlands. The iMediSense telemonitoring technology was developed for this, and between September 2016 and January 2017, a pilot study was conducted to determine the use, usability and usefulness for practice of the technology and to identify areas of further improvement. A mixed design of qualitative and quantitative research was used to evaluate the telemonitoring functionalities from the perspective of the end-users and key stakeholders of the technology (those who affect or are affected by eHealth technologies). The end-users of iMediSense are patients suffering from CHF, as well as specialized heart failure nurse practitioners from the healthcare end. One of the most important findings of this study was that patients were able to use the technology and found it easy to do on a daily basis, even those with low technological skills. Moreover, caregivers advocated that the technology can be useful to increase self-management, so recommendations to accomplish this were given. In consequence, the next stage of development is to provide further support to decision making by incorporating a personalized coaching system that can enhance the self-management or self-care of patients. The general recommendations from the study are that coaching of patients should be aimed at: (1) education and training in the proper use of the technology, (2) personalized CHF education, (3) support for the interpretation of measurement values and (4) achieving personal goals.

1.2. Promoting Self-Management in Patients with Chronic Congestive Heart Failure

Self-management can be defined as how individuals regulate or manage the way in which particular tasks are carried out (Day & Unsworth, 2013). The term self-care is more commonly used in the healthcare domain, and is defined as the process of maintaining health through health promoting practices and managing illness (Riegel, Jaarsma, & Stromberg, 2012). In this paper *self-management* is used interchangeably with *self-care*.

According to the proposed theory of Riegel et al., self-care is performed in both healthy and ill states, but it is relatively more salient to patients with a chronic illness. The key elements of self-care are maintenance, monitoring and management. First, according to Riegel et al. self-care maintenance is defined as those behaviours used by patients with a chronic illness to maintain physical and emotional stability. Second, they refer to self-care monitoring as the process of observing oneself for changes in signs and symptoms. Finally, self-care management is conceptualized as the response to signs and symptoms when they occur.

In the case of CHF, self-care maintenance includes activities such as reducing risk factors, improving health, and adhering to recommendations (e.g., dietary restrictions, medication, exercise); monitoring includes daily vigilance of symptoms and recognizing change when it occurs (e.g., daily weights, checking for edema); finally, management involves evaluating a change in symptoms to determine what action is needed and to evaluate the effectiveness of these actions (e.g., do nothing, call a health care provider) (Howlett et al., 2016; Riegel et al., 2009). However, a systematic review and meta-analysis by Kessing, Denollet, Widdershoven, and Kupper (2016) showed there are several psychological barriers and facilitators associated with successful performance of CHF self-care. For instance, Kessing et al. outlined a conceptual model that includes personality (e.g., neuroticism as a barrier), cognitions (e.g., self-efficacy as a facilitator) and emotions (e.g., depression as a barrier). In consequence, to effectively improve self-care it is required to apply a comprehensive, multidisciplinary, and patient-tailored approach (Kessing et al., 2016). Furthermore, it is recommended to consider key points like the patient's confidence, cognitive and emotional status, and the relationship with the healthcare provider; all while creating a learning environment, with a teaching and personalized approach, involving family and caregivers and social support (Howlett et al., 2016). Because of this, behavioural interventions play an important role in the promotion of self-care, for instance, in a systematic review Tierney et al. (2012) found that motivational strategies such as goal setting, feedback and problem solving might be effective in the short term to enhance physical activity of patients with stable heart failure, although the long term effects are unclear and the authors suggest that future interventions should be well-defined and based on theoretical frameworks.

1.3. Coaching in Healthcare and eHealth Technologies

A popular strategy to promote behaviour change is *coaching*, generally defined as a human development process that involves structured, focused interaction and the use of appropriate strategies, tools and techniques to promote desirable and sustainable change for the benefit of the coachee and potentially for other stakeholders (Cox, Bachkirova, & Clutterbuck, 2014). When coaching became acceptable to business and individuals as a method to improve performance, manage stress, or achieve work and personal goals, researchers also began to explore its potential to facilitate the promotion of healthy behaviours and help individuals achieve health-related goals (Palmer, Tubbs, & Whybrow, 2003). Coaching applied in healthcare is often referred to as *health coaching*, consequently defined as the practice of health education and health promotion within a coaching context to improve the wellbeing of individuals and to facilitate the achievement of their health related goals (Huffman, 2007). Huffman proposed health coaching as a way of enhancing patient self-management, and added that using this approach in the patient's place of residence could be the key factor in achieving significant health related outcomes. Recent reviews about health coaching summarize it as a goal-oriented, client-centered partnership that is health-focused and occurs through a process of client enlightenment and empowerment (Olsen, 2014).

With the raise of the digital revolution, technologies also began to take a role in the facilitation of behaviour change in healthcare, thus taking coaching as a potential strategy to achieve this. *eHealth* or *electronic health* is the working definition for the use of information and communication technologies to support or improve health and healthcare (Van Gemert-Pijnen, Peters, & Ossebaard, 2013). Although not always to its full extent, some technologies have been used to deliver coaching. For instance, *telemonitoring* technologies, that allow remotely monitoring of patients, are frequently employed to support chronic diseases, also consequently facilitating the delivery of coaching based on the data collected. For example, in a recent study a health coaching program was delivered by trained coaches via mobile phones and supported by telemonitoring, but no beneficial effects were found on the quality of life or clinical status of the participants, who were patients with heart diseases and diabetes (Karhula et al., 2015).

The authors of this work suggested that the use of 'active assistance technology', which they refer to as involving automatic processing of health or behaviour data and delivery of automatic tailored messages, could keep patients motivated and informed and therefore be a way to raise the effectiveness of these type of interventions. Cases like this show that connecting monitoring of data and providing coaching is not a straightforward and simple process. Because of this, eHealth technologies are now incorporating more thoughtful monitoring and coaching designs, aiming to increase effectiveness but also the persuasiveness of interventions with this combination.

Nevertheless, bridging the gap between data monitoring and delivery of coaching through technology seems to really be a challenging task. To address this gap, Patel, Asch, and Volpp (2015) suggest that, to produce health benefits, the design of the engagement strategies is more important than the technical features of a technology. Because of this, research has been focused on identifying key components of eHealth interventions that combine self-tracking and coaching (Lentferink et al., 2017). Lentferink et al. refer to such combination as *persuasive eCoaching*, defined as "the use of technology during coaching to motivate and stimulate (groups of) people to change attitudes, behaviours, and rituals" (p. 2). Other terms such as *virtual coach* (van Wissen, Vinkers, & van Halteren, 2016) or *e-coach* (Beun et al., 2016) have also been used in research. All in all, the implementation of coaching on eHealth still seems to be under early growth, new findings arise often and from different fronts.

1.4. The Challenge of Sensemaking in New Technologies

Another way to describe the aforementioned gap is by talking about Weick's (1990) *sensemaking* concept. Weick discussed the idea of *technology as equivoque*, meaning "something that admits of several possible or plausible interpretations and therefore can be esoteric, subject to misunderstandings, uncertain, complex, and recondite" (p. 789). In the field of eHealth, sensemaking has been used to describe how individuals make sense of their chronic disease using self-monitoring data (Mamykina, Smaldone, & Bakken, 2015). Mamykina et al. proposed a sensemaking framework for chronic disease self-management based on their research on diabetes, but according to them it is also generalizable (although not yet validated) to other diseases that require self-monitoring.

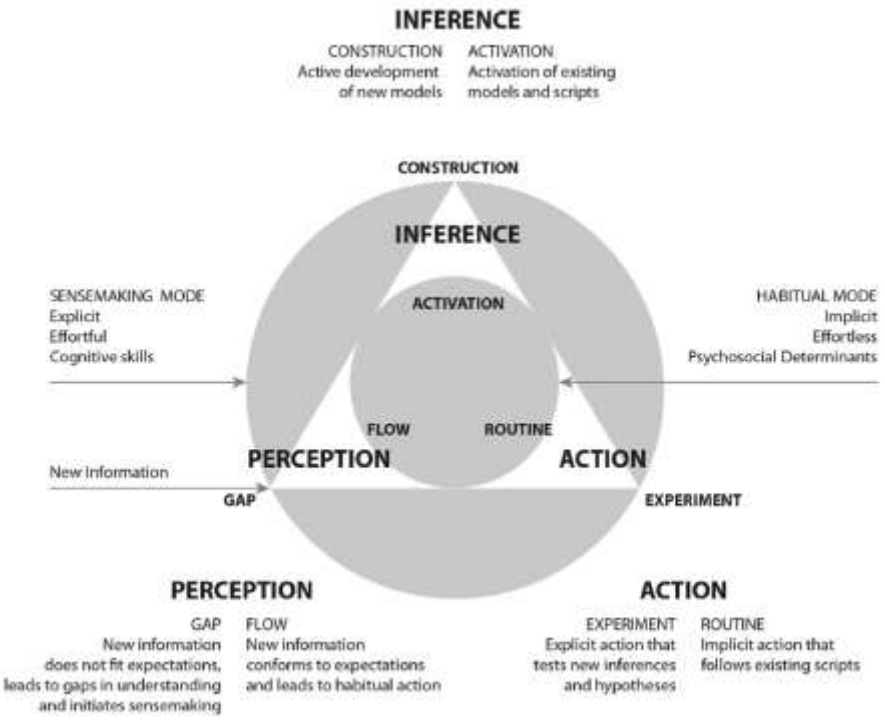


Figure 1. Sensemaking framework for chronic disease self-management (From © Mamykina et al., 2015. Published by Elsevier Inc.)

Their model, seen in Figure 1, involves three interdependent activities: *perception* of new information and experience, development of *inferences* on these perceptions, and use of these inferences to guide *action*. For example, in the perception stage an individual can sometimes be faced with undesirable or unexpected readings while self-monitoring his health, so there is a need to construct an explanation that could suggest action is necessary, coming across a gap in understanding that activates the 'sensemaking mode'. Next, inference leads the individual to engage into explicit, analytical and effortful sensemaking through, for example, examination of current knowledge, past experience or looking for possible clues, such as asking himself what he did prior to the reading that could've led to the undesirable or unexpected outcome. Finally, action is a direct result of these inferences, where the most plausible explanation is selected and then consequently integrated until new observations and experiences challenge the current hypothesis. For example, the individual may conclude that a previous action was the cause for the unexpected reading and might try to avoid it next time.

To support such process, it is stated by Mamykina et al. that new technologies, informed by this sensemaking perspective, could help individuals to not only set specific goals, but also track the impact of these goals on various indicators of health; an idea which pretty much refers to the optimization of feedback and its link to behavioural support in the design of eHealth interventions.

Additional findings support the sensemaking concept by reinforcing the idea that simply collecting patient generated data is only a first step in the sensemaking process (Miyamoto, Henderson, Young, Pande, & Han, 2016). Miyamoto et al. point out that technologies need to provide opportunities for both *reflection* and *action* on the information obtained. For example, they found that often help is required to synthesize data and create meaning from it, proposing that this could be built into the device 'responses' or also occur in partnership with a healthcare team. For this reason, they state that regular, timely, informed and personalized feedback could fill in the gap between the individual's ability to provide meaning and understanding of data and the aim to produce behaviour change, thus helping them reach their goals. Finally, Miyamoto et al. also recognize that addressing the drivers and barriers to technology engagement is important to support and motivate the task of behaviour change. Altogether, these and previous findings seem to support that a thoughtful design of a technology, ideally built with a structure of evidence-based components, can be the best method to successfully support self-management with eHealth (Lentferink et al., 2017; Mamykina et al., 2015; Miyamoto et al., 2016; Patel et al., 2015).

1.5. Developing eHealth Using the CeHRes Roadmap and a Persuasive Systems Design

If effective eHealth design is a key in successfully promoting behaviour change, an important task is to have a reliable method to achieve this. To this end, the Center for eHealth Research (CeHRes) Roadmap addresses the challenge of developing effective eHealth technologies by functioning as a practical guideline to help plan, coordinate, and execute a participatory development process (van Gemert-Pijnen et al., 2011). The roadmap is based on the integration of persuasive technology design, human-centered design, and business modeling. It consists of five different components and connecting cycles of activities to explore and test how eHealth can be perfectly suited to the users and how it can be successfully implemented in practice (Van Gemert-Pijnen et al., 2013).

For this study, the first two phases of the roadmap are of special interest as they can categorize the current state of development of the iMediSense technology. The *contextual inquiry* is the first phase of the roadmap, for which the aim is to identify and describe the needs and problems of the stakeholders. Among other possibilities, the process of a contextual inquiry can be based on a literature review to examine critical factors for the uptake and impact in a given situation (van Gemert-Pijnen et al., 2013). It is also possible to address this through the use of workshops or focus groups where together with stakeholders the needs and goals of an eHealth project can be discussed via *personas* and *scenarios* that represent the goals, tasks, actions, or decisions that are relevant to support the technology (LeRouge, Sneha, & Tolle, 2013; van Gemert-Pijnen et al., 2011; van Velsen, Wentzel, & Van Gemert-Pijnen, 2013). Personas are conceptual models of target user group(s) that, among other things, can also inform the requirements, design and implementation decisions of a technology (LeRouge et al., 2013). Therefore, by using personas, scenarios and task demonstrations, stakeholders can gain insight into and reach consensus on the context, division of roles and scope of the technology (Van Velsen et al., 2013).

The *value specification* is the second phase of the roadmap, where the objective is to provide information about the added values that key stakeholders attribute to the eHealth intervention. The outcome of the contextual inquiry and value specification together can provide the *functional requirements* that reveal the content and persuasiveness of the system which sets the base for the upcoming phases in the roadmap: the design, operationalization and summative evaluation of the technology. According to the Persuasive Systems Design (PSD) model, functional requirements describe how the system should behave (Oinas-Kukkonen & Harjumaa, 2009). As proposed by van Gemert-Pijnen et al. (2013) these requirements are used in the design phase of the roadmap to build working-prototypes to be tested iteratively by the intended end-users. Adding to that, the PSD model proposes a categorization of twenty-eight persuasive principles, labeled as primary task support, dialogue support, system credibility support, or social support. These should also be considered on the basis of which and how they can be implemented in a technology to make sure it is used as intended. Thus, the principles of the PSD model, which are a substantial part of the CeHRes Roadmap's rationale, can provide means for analyzing the persuasion, context, categorization, and design principles that may be useful in motivating and persuading users to reach their own personal goals (Oinas-Kukkonen & Harjumaa, 2009).

1.6. The Agile Science Process and Building of Behaviour Change Modules

Beyond creating a successful eHealth technologies, to effectively advance the field as a whole, optimizing the standardization and sharing of the knowledge and products being generated is now being promoted as a fundamental goal for scientific research (Hekler, Klasnja, et al., 2016; Hekler, Michie, et al., 2016). Indeed, given the importance of generating evidence-based practices in the field, and the need for a more iterative research process to conform to the complexity of behaviour change, the *agile science process* is a method that proposes to facilitate a more efficient knowledge accumulation for behaviour change interventions through an early-and-often sharing of all scientific products (Hekler, Klasnja, et al., 2016). Hekler, Klasnja et al. propose a first draft for such a framework in which three possible products play a role: (1) behaviour change modules, (2) computational behavioural models and (3) personalization algorithms. For a detailed description of the agile science process it is recommended to review the cited papers of this section, as only the most relevant aspects for this study will be described.

In the development of eHealth where support for behaviour change is demanded, such as for the iMediSense technology, the delivery of *behaviour change modules* proposed by agile science is of remarkable interest. Behaviour change modules are defined by Hekler, Klasnja et al. as ‘strategies designed to produce a specific and scoped behavioural outcome’, a similar concept for them to that one of *behaviour change techniques* (BCT). The authors consider an advantage to take inspiration from software development, for example by proposing the creation of modules with an ‘input, process, and output’ structure. An example using goal setting is described by the authors, Figure 2 below is a derived illustration of it.

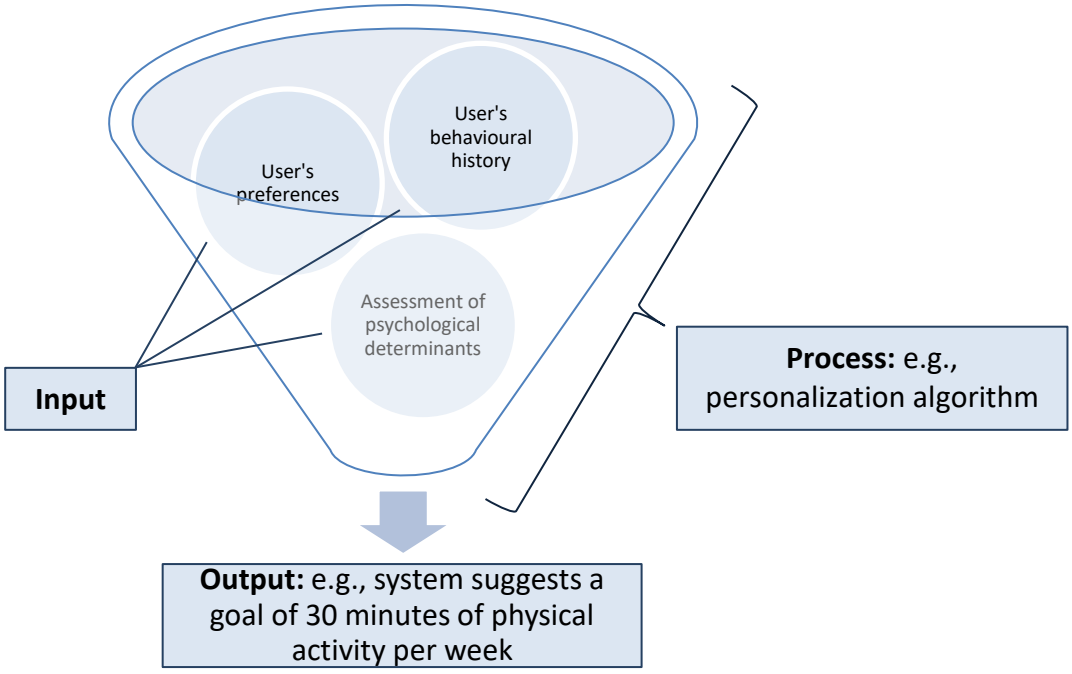


Figure 2. Illustrative example of a goal setting module's input-process-output structure for a fictional physical activity intervention (Based on Hekler, Klasnja et al., 2016)

Hekler, Klasnja et al. (2016) describe that a good module should fulfill four adjectives as criteria: smallest, meaningful, self-contained and repurposable. Modules, when well validated, could then be used for the development and testing of more-robust computational models and personalization algorithms, to act as building blocks for personalized and perpetually adapting interventions (Patrick et al., 2016). Within the agile science process one of two complementary and iterative phases is the *generate phase*. One of the aims of the generate phase is to produce multiple contender operations to specify contender constructs of any of the three proposed products. Such phase can include: *formative work*, which targets the specification of the problem, goal, population, and setting ideation on plausible solutions to achieve targeted goals (e.g., review of previous accumulated knowledge); *simulation studies*, for the specification of computational models and also plausible personalization algorithms with limited or no data; and *prototype testing*, aimed at facilitating a further specification of operations and feasibility testing (e.g., lean start-up methods). The generate phase is characterized to be higly iterative and dynamic, so the three described elements can happen not just repeateadly but also simultaneously.

All in all, although the agile science process is still in formative stage, the main proposal is that agile techniques can be used to iteratively improve system inputs and processes to achieve desired health outcomes for individuals and populations (Patrick et al., 2016). On a broader perspective, the agile science approach supports human-centered methods, and therefore can enhance the effectiveness of eHealth development in a larger scale, mainly by optimizing the accumulation of knowledge and products that frameworks such as the CeHRes Roadmap and the PSD model generate. Indeed, while behavioural modules are the first step, these can serve as a base for the creation and testing of computational models and personalization algorithms that can make possible successful data-driven behaviour change interventions just as it was proposed by Patel et al. (2015) and Mamykina et al. (2015). In cases such as CHF, a data-driven intervention also fits the patient-tailored approach suggested by Kessing et al. (2016). Finally, to additionally support all of this, multidisciplinary proposals, such as the one made by Moller et al. (2017), suggest that increasing precision in the specification and operationalization of theories and techniques also has the potential to accelerate the understanding and implementation of interventions in behavioural medicine.

1.7. Identifying Theories and Behaviour Change Techniques

Indeed, supporting the same level of specification in behavioural science as the agile science process, Moller et al. (2017) recommend that an explicit identification and systematic application of evidence-based BCTs is necessary to maximize opportunities when delivering behaviour change interventions through both traditional ways and via digital technologies. As a starter, Moller et al. identify some of the problems in the specifications of BCTs and behaviour change interventions: 1) the hypothesized mechanisms of action of the included BCTs are frequently not stated; 2) the names of evidence-based-theories, theory-derived mechanisms of action, and BCTs may be specified, but inappropriately operationalized; and 3) the importance of considering the parameters under which a theoretical process or technique is understood to be effective or not (e.g., a parameter to promote autonomy support in the Self-Determination Theory is the absence of pressure to choose a particular option when offering choices to participants).

Perhaps one of the most notable efforts to provide a solution to such problems is the work of Michie, West, Campbell, Brown, and Gainforth (2014), where they provide a research-based compendium of behaviour change theories, aiming to facilitate the task of reviewing and selecting theories to inform the design of behaviour change interventions. Michie et al. identified and described a total of 83 theories of behaviour change, providing for each of them a construct list, a summary, a full description, and a list of explicitly-mentioned contributing theories from those also included in their compendium. The authors propose that their work could be used in an instrumental way for intervention design, making it also a valuable tool for holistic frameworks in eHealth design such as the CeHRes Roadmap (Van Gemert-Pijnen, 2013).

In a related work, the *Behaviour Change Technique Taxonomy (v1)* (BCTTv1) was developed to provide a methodology for identifying content of complex behavioural change interventions, and for it to be a foundation for international cross-disciplinary collaboration for developing more effective interventions to improve health (Michie et al., 2015; Michie, Atkins, & West, 2014). The authors of the BCTTv1 define a BCT as an active component of an intervention designed to change behaviour. In order to fulfill such definition, this component must be observable, replicable, irreducible and postulated as an active ingredient within an intervention designed to change behaviour. Among other strategies, it is suggested by them that intervention designers should pilot, review and amend the strategies to be employed with input from key stakeholders before the implementation of their programs (Michie et al., 2014). For example, Lorencatto, West, Bruguera, Brose, & Michie (2016) used the BCTTv1 to assess the quality of goal setting and its association with outcomes in smoking cessation behavioural support interventions. They found that goal setting is associated with greater likelihood of initiating quit attempts, and that the application of a goal setting rating scale can contribute to quality improvement efforts in clinical practice.

Taking advantage of the theories compendium by Michie et al. (2014) and the BCTTv1 seems to be a promising approach in all manners for behavioural science. First of all, it fits with the agile science process to identify and provide irreducible components of behavioural interventions (Hekler, Klasnja, et al., 2016). Furthermore, the recommendations for practice by Michie et al. (2015) for the BCTTv1 aim for a better characterizing of interventions, their design, synthesis of evidence, and their implementation.

Finally, by using these complementary approaches, there is a potential for ground-breaking developments, such as the creation of *ontologies* (information structures used in information science to define abstract classes and the relations between those classes), which could facilitate new methods for hypothesis generation and a more effective knowledge discovery and accumulation in behavioural science (Larsen et al., 2016). For instance, Social Cognitive Theory (SCT) has been adapted and tested using a dynamical systems computational model (Riley et al., 2016). However, self-management mechanisms are not only explained by SCT but also other theories, so exploring these could outstandingly advance the behaviour change capabilities of eHealth interventions.

1.8. Goal Setting Theory and Health Behaviour Change

Another theory that heavily influences and describes self-management science is Goal Setting Theory. This theory has been built with an inductive approach and is viewed by its authors as an open theory, thus it integrates the findings of many studies across a wide range of disciplines (Locke & Latham, 2013). As summarized by Michie et al. (2014), Goal Setting Theory explains the mechanisms by which goals affect the level of task performance and how performance can be moderated by a number of factors. Furthermore, the body of research included in the work of Locke and Latham shows that "the act of goal setting motivates the development and use of self-management skills that increase the likelihood of goal attainment" (p. 431). Goal Setting Theory is characterized by Michie et al. (2014) as having 12 main constructs, such as persistence, commitment, or feedback, which also contain 7 sub-constructs such as goal difficulty or goal specificity. Furthermore, they identified that the only theory contributing to the development of Goal Setting Theory, of those included in their analysis, is Social Cognitive Theory.

In healthcare, goal setting as a BCT has proved to be an appropriate strategy to facilitate behaviour change (Shilts, Townsend, & Dishman, 2013). Additionally, goal setting has been identified as one of the most frequently found BCTs in behaviour change interventions (Michie et al., 2015). However, according to Shilts et al. current research has not evidently defined how to most effectively implement goal setting when targeting health behaviours, or whether these settings change according to the context or the target audience. All in all, they recommended that different goal attributes (e.g., type, proximity, level of feedback) are explored to determine the optimal implementation of goal setting on varying health conditions and populations.

The BCTTv1 distincts between *goal setting focused on behaviour* and *goal setting focused on the outcome*. The first one means to set or agree on a goal defined in terms of the behaviour to be achieved (e.g., agree a daily walking goal). Alternatively, goal setting focused on an outcome means to set or agree a goal defined in terms of a positive outcome of a wanted behaviour (e.g., set a weight loss goal). In summary, Goal Setting Theory and goal setting as a BCT have been properly identified, specified, and proven to have a significant potential for behaviour change in the healthcare domain, including support for the development of self-management skills. Despite all of this, there is not sufficient research yet to methodologically lead an evidence-based development and implementation of goal setting into a coaching-supportive technology.

1.9. Aim of this Research

This study aimed to guide and describe the development of a coaching function for the iMediSense technology by applying the CeHRes Roadmap and the agile science process as main elements of its framework. Specifically, the objective was to propose an evidence-based goal setting module that can function as a fundamental component to enhance the self-management of CHF populations through the aforementioned technology. It was also intended that, by complying with the agile science process, the module can be furtherly shared, tested and adapted to other health conditions and populations in the future. Therefore, the first objective of this research was to explore and map the current use of Goal Setting Theory and goal setting as a BCT in eHealth technologies that aimed to support or enhance the self-management of CHF populations. A second purpose, relevant to the overarching project, was to better understand the areas of improvement of the iMediSense technology in providing feedback and coaching to its users. Finally, based on such findings, the proposed outcome was to approach an identification of functional requirements for a goal setting module that could be appropriately incorporated in a coaching system for the technology in question. Thus, the research questions were:

a) Which constructs of Goal Setting Theory are addressed in eHealth technologies aimed for the self-management of CHF patients?

b) To what extent has goal setting as a BCT been implemented in eHealth technologies aimed for the self-management of CHF patients?

c) What are the reported outcomes in questions a) and b)?

d) How can the iMediSense technology improve its feedback and coaching to support behaviour change through the implementation of a goal setting module?

e) What are the functional requirements of a 'smallest, meaningful, self-contained, repurposable and interoperable' goal setting module that can be incorporated in a coaching system in the iMediSense technology?

2. Method

By applying the generate phase of the agile science process a mixed methods design was proposed to be effective to answer the research questions. First, a scoping review of the literature was conducted to explore the implementation of goal setting as both a theory and as a BCT in existing eHealth technologies aimed at the self-management of CHF patients. This was expected to provide an answer to research questions a), b) and c). Second, to answer questions d) and e) an analysis of log data collected during the 'Twente TEACH'-pilot was performed together with a stakeholder consultation (also as follow-up of the scoping process). The consultation was meant to specifically identify potential areas of improvement in the feedback and coaching currently provided by the iMediSense system, by assessing and reviewing the preliminary results of the literature review. It's worth noting that a stakeholder consultation is not only an important iterative task within the CeHRes Roadmap but also a final recommended stage for scoping studies in order to validate the findings and enhance applicability of the results (Arksey & O'Malley, 2005; Levac, Colquhoun, & O'Brien, 2010). To summarize, the generate phase for the goal setting module included a scoping review of existing literature, a log data analysis to identify behavioural support gaps in the technology, and a stakeholder consultation. All of them generally aimed at providing a better understanding of the areas of improvement of the iMediSense technology, as well as the needs of its target population and key stakeholders, deriving in a description of a goal setting module proposed to be considered as a meaningful addition to the system.

The framework for conducting a scoping study includes the following steps: 1) identifying the research question, 2) identifying relevant studies, 3) study selection, 4) charting the data, 5) collating, summarizing, and reporting the results and 6) consultation (Arksey & O'Malley, 2005). In this matter, for each stage in Arksey and O'Malley's framework, Levac et al. (2010) outlined several recommendations to maximize the usefulness and rigor of this method, these include: clarifying and linking the purpose and research question; balancing feasibility with breadth and comprehensiveness of the scoping process; using an iterative team approach to selecting studies and extracting data; incorporating a numerical summary and qualitative thematic analysis; identifying the implications of the study findings for policy, practice, or research; and adopting consultation as a required component of a scoping study. Given that the research questions have been previously established, below the consequent stages of the scoping process applied in this study are orderly described.

2.1. Identifying Relevant Studies

On the 8th of May 2017, the next databases were searched to collect publications: Cumulative Index of Nursing and Allied Health Literature (CINAHL), PsycInfo, Scopus and Web of Science. Databases were selected according to their coverage of medical, social and technological disciplines and considering possible overlapping. CINAHL was specifically added given the relevance for the research topic. The amount of databases selected was expected to be enough to answer the respective research questions, although it is important to point out that potentially relevant papers could have been missed due to various circumstances (e.g., discrepancy in terminology used in the search and the targeted papers).

The search strategy included four sets based on the main key terms: 'goal setting', 'heart failure', 'self-management', and 'eHealth'. Equivalent, relevant and related terms were identified for each set by using different strategies. For goal setting only 'Locke, E', first author of Goal Setting Theory, was added but in this case more important was a combination of proximity operators and keywords in the search string to detect 'goal(s)' being described as an 'active component', or an equivalent term, in an intervention. The previous effort aimed to detect the theme even when not properly identified as a BCT, for the same reason the first set was targeted for full text searching.

For heart failure, self-management and eHealth, all of these concepts were searched in the MeSH (Medical Subject Headings) and Emtree (EMBASE Subject Headings) databases and then extra terms were selected from the entry terms, synonyms and keywords displayed in the query results. Additionally, in the case of eHealth more terms were added derived from the discussion on the evolution of the concept by Van Gemert-Pijnen et al. (2013) (e.g., consumer health informatics). Some self-determined terms were also added to include related concepts that were connected to the objectives and research questions of the study. For example, 'coaching', 'health coaching' and 'persuasive coaching' were added to the self-management set given that by definition all of them imply or in some cases explicitly include self-management tasks.

As previously mentioned, the first set of key terms was the most important one, as it would restrict the search to studies that included goal setting or its theory in their publication. In this matter, although in the BCTTv1 other BCTs are 'coded' together with goal setting or grouped within the same category, such as 'behavioural contract' or ' action planning', for simplicity and to comply with the agile science's criteria for a BCT module, terms like this were not included in the search. The search strategy was customized to each database according to their possibilities (e.g., use of limiters or combined search queries). A complete list of the terms considered, the search strings implemented, and the search strategy for each database can be found in the appendices (6.1). In general, limiters or filters were used when possible (e.g., title, abstract, keywords, period of publication).

2.2. Study Selection

The study selection was done by uploading the citations from the search results to the Mendeley Desktop software (version 1.17.9). The results went through the following procedure to select relevant studies: 1) eliminate duplicates, 2) review for the title, abstract and keywords and 3) full text review. The inclusion criteria considered for each step were as follows:

1. The paper refers to the development, implementation, or evaluation of an eHealth technology.
2. The eHealth technology is aimed for / or includes CHF patients.
3. The eHealth technology is aimed at / or includes support for self-management.
4. The article is available in English language, full text and published between January 2005 and May 2017.

Studies were excluded when they didn't meet any of the inclusion criteria, although exceptions were considered when, for instance, the target population belonged to a CHF related condition (e.g., cardiac rehabilitation, coronary heart disease) and at the same time the publication showed high relevance for the aims of this research by fulfilling the rest of the criteria. Any type of publication was of interest: conference papers, manuscripts, literature reviews, etc. Furthermore, to identify additional relevant publications before the full text review, a hand search was conducted using the main terms as input via standard Google Search, Google Scholar, and in the database of the Journal of Medical Internet Research. In these cases besides reviewing for title, abstract and keywords, a quick text search scan was performed to look for any mention of the terms in the 'goal setting' set. Finally, during the full text review if a relevant referenced paper was identified then it was consequently included for this stage.

2.3. Charting the Data

In order to map the information of the selected studies, a data extraction form (Appendix 6.2) was designed to:

1. Describe the characteristics of the studies, specifically by: year of publication, study location, study design, study participants and eHealth technology referred to in the publication.
2. Identify constructs of goal setting theory addressed by the study.
3. Identify the aim and operationalization of goal setting as a BCT.
4. Identify the reported outcomes of goal setting, both theory and technique.

To add depth to the description of eHealth, the elements of the CONSORT-EHEALTH checklist were considered (Eysenbach & CONSORT-EHEALTH Group, 2011). In addition, the persuasive principles of the PSD model (Oinas-Kukkonen & Harjumaa, 2009) were also included in the data extraction form. A theoretical construct was identified if explicitly stated in the study or if a clear identification was possible taking into consideration the theory characterization by Michie et al. (2014) as a base and informed by the latest updates on the original theory (Locke & Latham, 2013), especially those regarding health promotion.

This combination was necessary because the theory characterization study was conducted previous to the publication of the latest work by the original authors. Informed by such literature and to facilitate consistency during the extraction of the constructs, a conceptual model to outline the theory was created, which can be seen in Figure 3. The conceptual model was used together with the data extraction form to guide the following stages. Briefly, the model illustrates a sequence of elements covering possible external stimuli, goal-related characteristics, mechanisms (hypothesized process), moderators (mediators of goal performance), and outcomes.

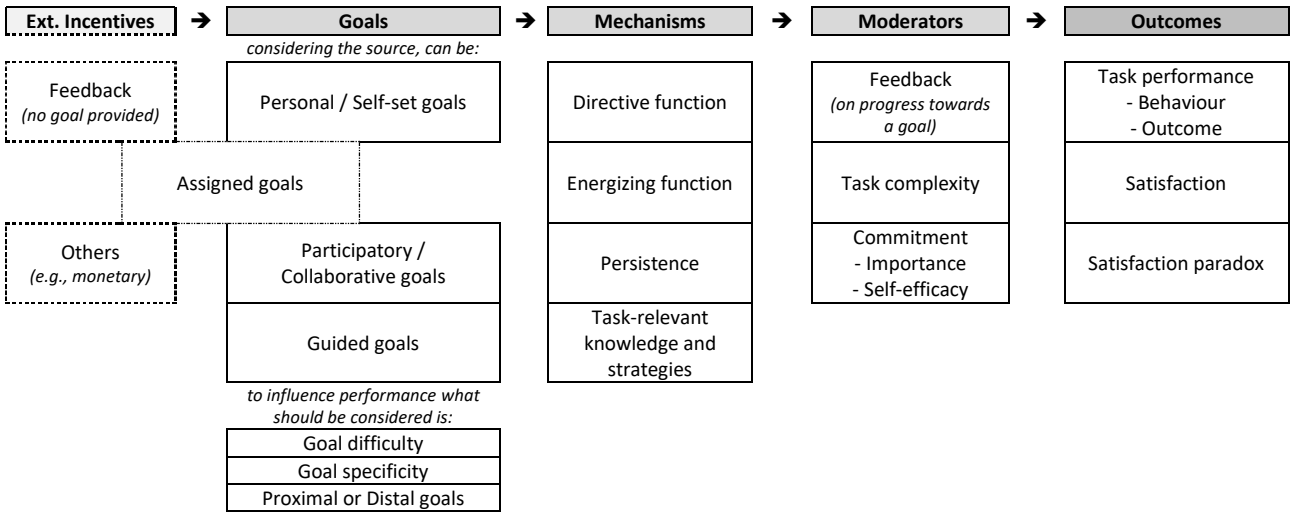


Figure 3. Conceptual model of Goal Setting Theory based on Michie et al. (2014) and Locke and Latham (2013)

In accordance to the BCTTv1, the *aim* of goal setting as a BCT was identified either as focused on *behaviour* or focused on *outcome* by extracting the specific target (e.g., walking as behaviour or losing weight as outcome). Furthermore, the *operationalization* was defined as a broader categorization of the aim, first of all in terms of which self-care element it belongs to and subsequently by the self-care affecting factor(s) that goal setting could be identified to be aimed at, both according to the summary provided by Howlett et al. (2016) (e.g., self-care maintenance with a teaching approach). Although the reported outcomes of goal setting or the underlying theory, when included, were also of interest in the selected studies, this research did not aim to present a methodological quality assessment or 'weight' of the evidence found, as this is not the usual objective of a scoping study (Arksey & O'Malley, 2005; Levac et al., 2010) and it wasn't seen as necessary to answer the research questions. Therefore, if included, reported outcomes were only categorized as *positive* or *negative* when extracted.

2.4. Collating, Summarizing, and Reporting the Results

Each data component from the data extraction form was coded and analyzed using the qualitative software package ATLAS.ti version 8.0.37., an illustrative example of the use of this software can be found in the appendices (6.3). The use of this type of qualitative research tool is recommended by Levac et al. (2010) as it facilitates this process. The coding stage was performed using a codebook derived from the data extraction form, which can also be found in the appendices (6.4). The coding stages described by Fereday & Muir-Cochrane (2006) were considered for the complete process. In general, each code was only applied when the content was referring to goal setting either exclusively or as an 'active component' in a self-management intervention. Due to the diversity in the type of publications, codes were more thoroughly applied when the link between goal setting, self-management, technology and / or any of the topics relevant for the research questions and aim of this study were sufficiently addressed. For example, a section describing goal setting in the workplace setting was reviewed but mostly omitted from coding to focus instead on the section referring to goal setting in the technology-assisted healthcare context.

Likewise, the coding of the PSD model principles was based on the rationale and methodology of Kelders, Kok, Ossebaard, & Van Gemert-Pijnen (2012), thus by focusing on the technological element rather than the content of an intervention. Following recommendations for this stage (Arksey & O'Malley, 2005; Levac et al., 2010), a first version of the codebook was tested with the first two studies by having two researchers code them independently. Consequently, the codebook was adjusted after both researchers discussed any discrepancies in the coding results. Due to time constraints, the coding of the PSD principles was done by a single researcher. To report the results, first of all, the characteristics of the selected studies and the eHealth technologies addressed within them were narratively summarized in tables. Next, a descriptive numerical summary was performed to present the coded data concerning the appearance of goal setting theoretical constructs in the literature. The same format was applied to the results on the aim, operationalization, and reported outcomes of goal setting as a BCT, and to the PSD principles that could be identified in the publications that referred to a particular eHealth technology.

2.5. Log Data Analysis and Development of Personas and Use-Case Scenarios

Log data was collected and analyzed during the 'Twente TEACH'-pilot to assess the adherence of the users to the main goal of the system (to facilitate daily self-monitoring of health parameters) as well as the use and navigation of iMediSense's present features (e.g., history charts and contact menu). An automatic log data file was generated every day that contained information such as the actions performed within the system, date and time they occurred, and accompanied with anonymized user IDs. Given such background, the aim of a new log data analysis for this research was to enhance the understanding of individual usage, and by this mean to identify gaps in the system's feedback and coaching functionalities where a goal setting module could be of value. Moreover, the descriptive log data analysis was meant to provide insights that could serve as a base for the creation of personas and *use-case scenarios*, to showcase the potential improvements in the effectiveness of the technology acquired via coaching focused on goal setting support. Hence, the use-case scenarios were defined as representations of the actions that would be performed by a persona in a hypothetical goal setting module of the iMediSense technology.

To serve the established purpose, based on the results from the 'Twente TEACH'-pilot three individual cases were selected out of its twenty-five participants. The selection was made arbitrarily from a discussion between the lead researcher of the pilot and the lead researcher of the present study, and the cases were judged to be representative of the total pool of participants. The specific aims were to look deeper into the contrasts observed between these users in terms of their general *use* (e.g., total exposure) and the more specific *usage of content* (e.g., interaction with features) of the technology. Adherence was defined during the pilot as 'complying with the recommendation of use', which was to take daily measurements (weight and blood pressure) as well as answering a brief report on symptoms. Based on this, it was found that the majority of users were adherent to the technology. The same conceptualization of adherence was kept for the present study. Thus, the three cases chosen for analysis had distinctive and / or representative characteristics that fulfilled or not with this behaviour. The three cases are described below:

- *Case 1 – Low adherence*: A user that wished to stop participation in the pilot but, through an intervention of a nurse practitioner, was motivated to continue. The interaction between patient and nurse was known to be based on the self-care *goals*, as the indication to perform measurements was since then tailored to this individual, from daily measurements to one every two or three days. The user fully complied with the new recommendations from that point on until the end of the study, therefore, the user later became *adherent* through *coaching*.
- *Case 2 – Adherence*: A user that complied with the recommendations almost perfectly, missing sending a measurement in only one day during the full study. A representative case of the majority of participants from the pilot.
- *Case 3 – Adherence and high self-monitoring:* A user that did not only show perfect adherence but also exceeded the recommendations. The user performed measurements two or three times a day for around forty days. In interview during the pilot the user recognized well-established habits of staying informed about the disease (e.g., looking up information on the internet) and frequently monitoring the medical status through several devices (e.g., traditional weight scale).

The log files of these three cases were extracted, charted and analyzed using Microsoft Excel 2010, following the protocol recommendations by Sieverink et al. (2017). Several functionalities of the software were used to perform a descriptive analysis (e.g., formulas to create new variables) but also to allow a clear visualization of the log files (e.g., through conditional formatting). The analysis on the use and usage focused on the *sessions*, *measurements*, *history* and *contact menu* (messages) features of the iMediSense technology. A sample illustration of how the log data protocol was performed using the Microsoft Excel 2010 software can be seen in Figure 4.

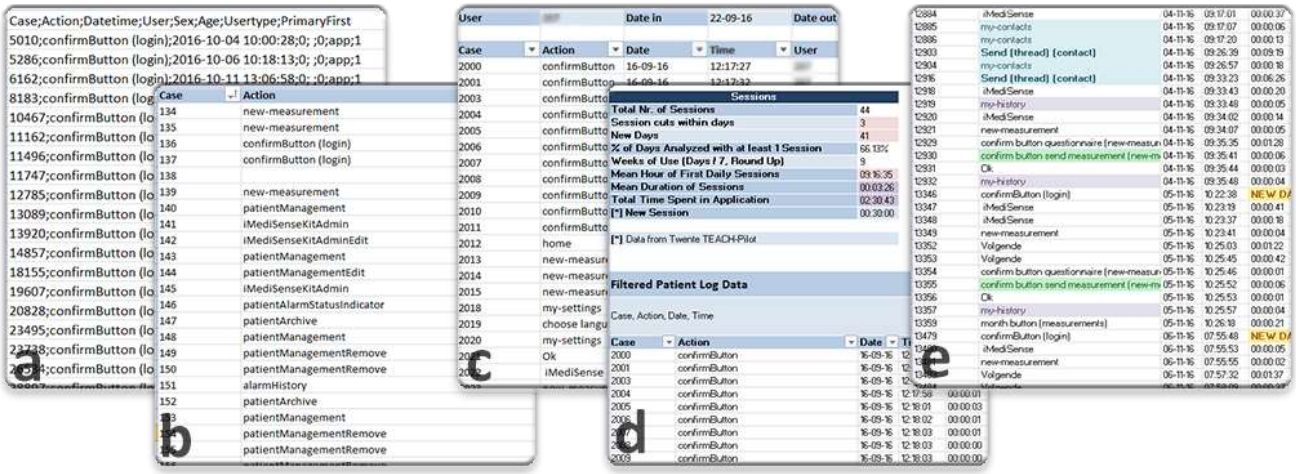


Figure 4. Sample of log data protocol implementation in Microsoft Excel
Note. a) raw data; b) and c) data preparation; d) and e) data transformation and analysis

In Figure 4, a) the log files in CSV format (comma-separated values) represent the 'data collection' phase as it resulted from the 'Twente TEACH'-pilot. b) Then, at the beginning of the 'data preparation' phase the values are split into different cells and filters are added. c) At that point it was possible to filter the data by each selected case. d) Next, the filtered user log files were moved to a new sheet where several steps of 'data transformation' were conducted to calculate new variables (e.g., calculating time between each case in the log files which consequently allowed to detect the number of sessions). e) At the same time, conditional format allowed a clear visualization of the target actions (e.g., completing a measurement), which allowed to manually scan when necessary for any possible errors or to crossreference results with previous analyses from the pilot. Creating and applying the protocol through this tool was naturally an iterative task. The results of the log data analysis served then as the shell for the development of the personas. In order to add substance to the content, relevant quotes were extracted from the full set of patient interviews performed during the pilot. This phase was vital since one of the usefulness of personas is that they provide insight into the mental model of the users (LeRouge et al., 2013). No previous research could be identified that specifically outlined the development of personas for CHF patients interacting with eHealth. Hence, the methodological basis considered for this task was the model from LeRouge et al. (2013), which study-example addressed the Chinese elderly population, and a study focused on coronary heart disease (CHD) patients (Vosbergen et al., 2015).

Additionally, the findings from the consultation phase were also considered as they provided context-specific evidence of characteristics and needs of the target group from the perspective of other stakeholders. So, the first step to develop the personas was to establish a distinction between the full set of participants from the pilot, in order to identify additional cases similar to the ones that were selected as representative during the descriptive log data analysis. To do this, a second and more general log data analysis was performed, calculating the number of measurements each user conducted in relation to the total number of days of their participation during the pilot (e.g., 60 measurements in 60 days = 100%). This way, users were grouped in three categories according to this measure of their adherence. Group one was designated as the 'low adherents', those with the lowest percentage of adherence calculated. Those who fulfilled recommendations as requested or closely approached it formed group two, the 'adherents'. Finally, group three was labeled as the 'adherent and high self-monitoring' users because they notably exceeded recommendations of use. Of course it is worth noting that, as previously stated, the adherence of the first group was still not dramatically low, so such label is rather just a way to describe what was observed during the pilot in comparison with other cases. Several options on the percentage to cut on between the groups were considered by testing different thresholds for the data, the final decision is presented in the results section. Next, in order to extract and apply relevant quotes, a codebook used for the analysis of patient interviews during the pilot study was reviewed. Relevant coding categories were selected (e.g., demographics, living with CHF, self-management, experience with iMediSense) and then all of the quotes within them were extracted into a new Microsoft Excel sheet, being clustered and ordered in the three groups. Once this sheet concentrating all relevant quotes was ready, each persona was built step by step by iteratively selecting quotes that could fit the results from the first log data analysis. Following the guidelines of the model from Le Rouge et al. (2013), each persona was iteratively structured by systematically applying content on a common structure which consisted of demographics, educational level or professional background, healthcare specifics (e.g, mobility), technical ability in general (with technology), iMediSense experience, self-management (in general) and a latent need for self-care coaching (self-management through a goal setting module). Given that the original quotes were in Dutch and the lead researcher didn't speak this language, these were translated using a commercial translator and with the assistance of another psychology student fluent in the language.

Again following the example of Le Rouge et al., a trail of evidence that illustrates the process of adding the content can be found in the appendices (6.5). Use-case scenarios were then developed and presented taking into consideration the structure of each persona. Although the initial plan of the study was to use the personas as a main input during the consultation stage, due to adjustments in such phase, personas and use-case scenarios were developed as a final step, thus summarizing and providing meaning to the complete body of evidence from this study.

2.6. Consultation of Key Stakeholders

The consultation stage was aimed at individuals identified as stakeholders of the technology, such as the potential end-users, or also members of the 'Twente TEACH' consortium, part of the development team. The selection was based considering the guidelines for stakeholder involvement and co-creation by van Woezik, Braakman-Jansen, Kulyk, Siemons, and van Gemert-Pijnen (2016). First of all, a list of stakeholders of the iMediSense technology that was created during the pilot was reviewed and adjusted according to their relevance to support the aims of the present study. Again, a selection criterion for participation was that the participants had fluency in English language, so the recruiting of participants was done considering this requirement. Another important aspect was that the consultation occurred at different moments and times guided by convenience of the availability of each stakeholder.

Although a focus group was initially proposed, aiming to involve as many stakeholders as possible, this proved to be difficult to arrange so it was decided to also consider other methods to conduct the consultation. Therefore, semi-structured interviews and a focus group based consultation meeting were employed. The stakeholders that participated in the consultation had the following roles: expert user (cardiologist), potential end-user (patient under diagnosis of HF), and developers (software developer and product owner). For this study it was planned but in the end not possible to conduct a consultation with another key end-user, the specialized heart failure nurse practitioners. The procedures for this stage were reviewed and approved by the ethical committee of the Faculty of Behavioural, Management and Social Sciences (BMS) of the University of Twente under requests number 17259 and 17464. The informed consent form used for this stage can be found in appendix 6.6.

In general, the aim of this step was to gather additional sources of information, perspectives, and to enhance the meaning and applicability of the preliminary results (Arksey & O'Malley, 2005). Although in the end no focus group was conducted, the work of Morgan (1996) regarding this method formed the rationale behind the preparation of the complete consultation stage. For instance, given that the main topic of discussion was the incorporation of goal setting into a coaching functionality of the iMediSense technology, which is a complex and multidisciplinary subject, a focus group design, according to Morgan, would allow the researcher to achieve new insights even considering budget and time constraints. Therefore, his guidelines on moderator involvement, the preparation of a guide (script) and materials and the techniques to moderate a discussion were actively used by the researcher during the consultation stage.

The script for the consultation varied between the stakeholders, but in general it consisted of the following: First, an overview of the research was provided, including an introduction to the most relevant topics (e.g., coaching and feedback) and ending by stating the objectives of the consultation. Next, specific topics and questions regarding the preliminary results of the scoping study and the log data analysis were addressed. The interviews were semi-structured, so the researcher had an active participation, especially when it was necessary to introduce a certain topic to the interviewee in order to explore and provide sense into the findings. The scripts and a sample of materials used during the consultations can be found in the appendices (6.7). The different consultations were audio-recorded, transcribed, and analyzed using the ATLAS.ti software. A thematic analysis was applied to the transcripts, this is a method for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). For this step, a mixed approach of inductive and deductive coding based on the work of Fereday & Muir-Cochrane (2006) was conducted. First, deductive coding was used to identify common themes regarding the scope of this research. A codebook was developed for this purpose (Appendix 6.8). Finally, inductive or open coding was employed to identify sub-themes within each of the initial codes (themes), and the results were then clustered in higher order themes that better described the data.

3. Results

The findings of this study are introduced in the order outlined by the scoping process, with the log data analysis anteceding the consultation stage, as the former was a planned input for the latter. Afterwards, the main outcomes of this research are presented and described.

3.1. Scoping Review: Study Selection

From an initial set of forty-one publications, thirteen were selected for full text review. Figure 5 shows the flowchart of the study selection process.

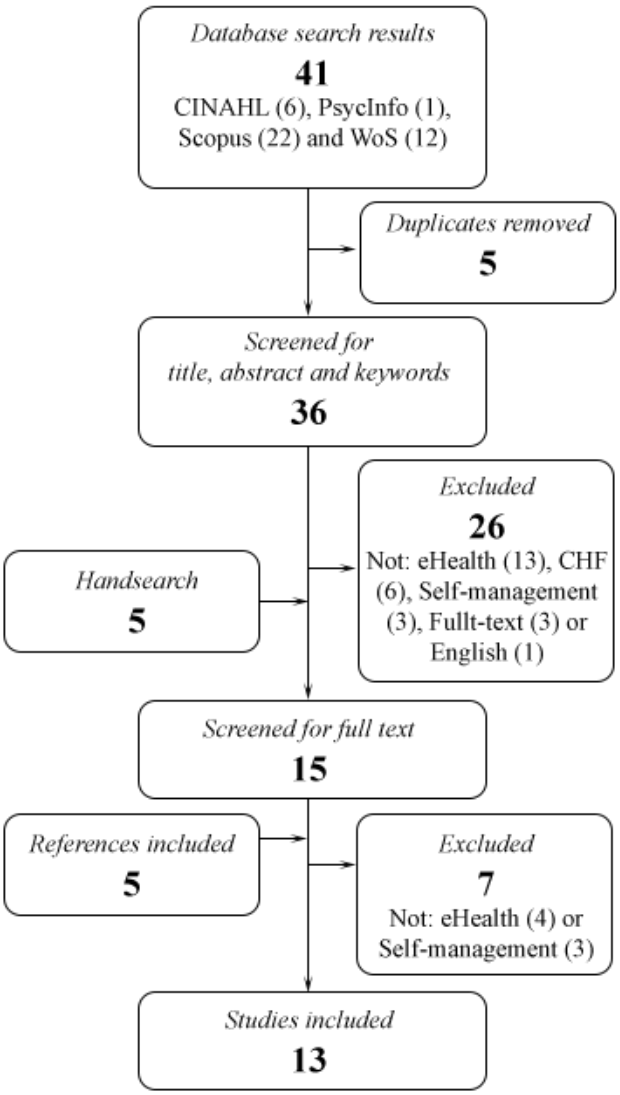


Figure 5. Flowchart of study selection

3.2. Scoping Review: Description and Numerical Summaries

Articles selected cover a range of eight years, from 2009 to 2017. Three of them address goal setting in healthcare with a lesser (but still relevant) focus on technology (Bodenheimer & Handley, 2009; Bosworth, Powers, & Oddone, 2010; Suter, Suter, & Johnston, 2011). The rest are entirely aimed at describing or evaluating at least one eHealth technology (Ammenwerth et al., 2015; Bartlett et al., 2014; Burns et al., 2010; Davies et al., 2011; Jacelon, Gibbs, & Ridgway, 2016; Nolan et al., 2014; Nooitgedagt, Beun, & Dignum, 2017; Payne et al., 2015; Stut et al., 2014; Stut, Deighan, Cleland, & Jaarsma, 2015). Four are viewpoint papers (Bosworth et al., 2010; Davies et al., 2011; Nooitgedagt et al., 2017; Suter et al., 2011), two are literature reviews (Bodenheimer & Handley, 2009; Jacelon et al., 2016).

One is a randomized controlled trial (RCT) protocol (Nolan et al., 2014). The rest are implementation or observational studies with very heterogeneous methods and levels of analysis. Two use human-centered qualitative approaches such as focus groups, semi-structured interviews and usability tests (Burns et al., 2010; Payne et al., 2015), three mainly conduct log file analysis accompanied with other methods like surveys or self-reports (Ammenwerth et al., 2015; Stut et al., 2014, 2015) and one applies a ‘realist evaluation’ model (Bartlett et al., 2014). Considering first authors, the articles cover five different countries, three European and two from the American continent. Specifically, by the same criterion four are from the United States (Bodenheimer & Handley, 2009; Bosworth et al., 2010; Jacelon et al., 2016; Suter et al., 2011), three from the United Kingdom (Bartlett et al., 2014; Burns et al., 2010; Davies et al., 2011), three from the Netherlands (Nooitgedagt et al., 2017; Stut et al., 2014, 2015), two from Canada (Nolan et al., 2014; Payne et al., 2015) and one from Austria (Ammenwerth et al., 2015). Table 1 shows a summary of each article, their design, targeted medical condition(s), and characteristics of the participants, when applicable.

Table 1

Description of selected studies on chronological order

[nr.] Author (year) location	Design (method + objective)	Target and participants
[1] Bodenheimer and Handley (2009) United States	Literature review Explores the behaviour change method of goal setting and reviews the literature on goal setting in primary care for patients with chronic conditions.	TC: As selection criterion for studies - 'Patients engaged with goal setting, who had a disease requiring self-management activities, or were in a 'high risk' population for which behaviour change would be of benefit'.
[2] Bosworth, Powers and Oddone (2010) United States	Viewpoint Addresses patient self-management of hypertension and cardiovascular diseases (CVD) as a crucial component of effective, high quality health care.	TC: Hypertension and CVD.
[3] Burns et al. (2010) United Kingdom	Focus group (usability tests) Presents the technical details of the CHF Personalized Self-Management System (CHF PSMS) along with the initial feedback following evaluation conducted within a focus group setting.	TC: CHF Nr. participants : 8
[4] Davies et al. (2011) United Kingdom	Viewpoint Focuses on presenting the technical details of the PSMS system architecture.	TC: CHF, chronic pain and stroke
[5] Suter, Suter and Johnston (2011) United States	Viewpoint Describes how remote monitoring, in combination with the application of salient adult learning and cognitive behavioural theories applied to telehealth care delivery and practice, can promote improved patient self-efficacy with disease management.	TC: Chronic diseases
[6] Bartlett et al. (2014) United Kingdom	Realist evaluation To evaluate the CHF PSMS using a realist evaluation framework. This methodological approach involves the formulation of a number of detailed hypotheses, followed by testing their validity using multiple methods of data collection.	TC: CHF Nr. participants: 7
[7] Nolan et al. (2014) Canada	RCT Protocol Aims to establish and evaluate a Canadian e-platform that will provide a core, standardized protocol of behavioural counseling and education to facilitate long-term adherence to self-care among patients with CHF.	TC: CHF Nr. participants: Planned for 278. 139 each for intervention and control arms.
[8] Stut et al. (2014) United Kingdom, Germany and Spain / First author: The Netherlands	Multi-site observational study (design and log file analysis) To develop and test an intervention to increase self-care in patients with CHF using a novel, online, automated education and coaching program.	TC: CHF Nr. participants: 123 (97/26) / Mean age: 66 Comorbidities: Diabetes mellitus (53) and cancer (13)
[9] Ammenwerth et al. (2015) Austria	Multi-phased study (surveys and log file analysis) To evaluate the MyCor telemonitoring programme regarding technical feasibility, user acceptance, patient adherence, change in health status, and change in quality of life.	TC: Patients hospitalized for acute myocardial infarction and/or percutaneous coronary intervention Nr. participants: 25 (24/1) / Mean age: 63 Comorbidities: Obesity, diabetes mellitus, hypertension

[10] Payne et al. (2015) Canada	Qualitative (semi-structured interviews and usability tests) To assess the usability of the CHF-CePPORT e-Counseling platform in terms of navigation, content, and layout.	TC: CHF patients recently admitted or outpatients with NYHA III /IV symptoms. Nr. participants: 7 (5/2) / Mean age: 57
[11] Stut et al. (2015) United Kingdom, Germany and Spain / First author: The Netherlands	Multi-site observational study (self-reports and log file analysis) To evaluate a novel online education and coaching program (HeartCycle) to promote self-care among patients with heart failure.	TC: CHF, (66% in NYHA III) Nr. participants: 123 (97/26) / Mean age: 66 Comorbidities: Diabetes mellitus (53) and cancer (13)
[12] Jacelon, Gibbs and Ridgway (2016) United States	Scoping review To explore the types of computer-based systems used for self-management of chronic disease, the goals and success of these systems, the value added by technology integration and the target audience for these systems.	TC: Chronic diseases
[13] Nooitgedagt, Beun and Dignum (2017) The Netherlands	Viewpoint To present the rationale and requirements for an e-coaching system in the domain of intensive cardiac rehabilitation.	TC: Intensive cardiac rehabilitation

Note. TC = Targeted medical condition(s)

From the selected studies, five different eHealth technologies were identified to have objectives, features and / or technical devices that made them relevant to the aims of this research. Table 2 gives an overview of these technologies. The SMART2/CHF PSMS system was addressed by four studies (Bartlett et al., 2014; Burns et al., 2010; Davies et al., 2011; Jacelon et al., 2016). The HeartCycle E&C program was covered by a couple of papers (Stut et al., 2014, 2015), same with the CHF-CePPORT platform (Nolan et al., 2014; Payne et al., 2015). MyCor (Ammenwerth et al., 2015) and a conceptual 'e-coach' (Nooitgedagt et al., 2017) were described by one article each. Four of these technologies are already in a stage of testing or implementation (SMART2/CHF PSMS, Heart Cycle E&C, CHF-CePPORT and MyCor) while one is a concept derived from a requirement analysis (Nooitgedagt et al., 2017). Three of them are specifically aimed at CHF populations (HeartCycle E&C, CHF-CePPORT, and SMART2 which also has functionalities to support other diseases), one to coronary heart disease (MyCor, but also applied for diabetes and obesity) and the conceptual e-coach is aimed at 'intensive cardiac rehabilitation' (Nooitgedagt et al., 2017). Together with goal setting all of the technologies included self-monitoring and provided some level of feedback, although the way they did it or devices that relied on for this varied between them.

Table 2

Description of eHealth technologies

Studies	System name	Objective (O), main features (F) and instructions or recommendations of use (I)	Devices
[3,4,6,12 [a]]	Self-Management Supported by Assistive, Rehabilitation and Telecare Technologies (SMART2) / SMART Personalised Self-Management System for CHF (CHF PSMS)	*O:* SMART2: To facilitate self-management for those suffering from clinical conditions, including Chronic Pain (CP), CHF and Stroke. CHF PSMS: Was designed to increase a) symptom awareness; b) knowledge of the condition, and c) physical activity of the user. *F:* Goal setting, self-monitoring, feedback and access to quality-assured information about condition *I:* Participants received an instruction booklet including contact details for research team and descriptions of each component of the system. They were asked to use the system on a daily basis in their own homes for a four week period.	Touch screen computer Touch screen mobile device Commercially available sensor devices (for weight and blood pressure) 'MiFi' device for participants without internet connection
[8, 11]	HeartCycle Education and Coaching (E&C) program	*O:* To provide patients with education on CHF and associated self-care behaviours and to coach them in adopting these behaviours. *F:* Tailored education, goal setting, self-monitoring (electronic diary) and feedback *I:* Patients were asked to measure weight and blood pressure and to answer a short questionnaire on breathlessness and edema every day. System provides assessment and guides them depending on their current behaviour and knowledge level.	Philips Motiva telehealth system (requires set-top box, remote control and TV) PC access for HF nurses
[7, 10]	Canadian e-Platform to Promote Behavioral Self-Management in Chronic Heart Failure (CHF-CePPORT)	*O:* Designed to improve long-term adherence to self-care behaviours and quality of life among patients with CHF. *F:* Validation of stages of "readiness" for behaviour change, self-monitoring, goal setting, feedback and proactive e-mails *I:* Subjects were asked to document their daily step count for 7 days prior to baseline assessment, and at 4 and 12 months.	Internet-based platform Accelerometer
[9]	MyCor telemonitoring programmee (Myokardinfarkt und Koronarstent Programm in Tirol)	*O:* To improve adherence with medication regimens and lifestyle changes and to improve clinical outcome. *F:* Patient education, self-monitoring, goal setting, feedback and regular clinical visits *I:* Patients were asked to measure blood pressure and weight at least once daily and to use pedometer for continuous step counting. They were also asked to document drug intake and subjective well-being on the smartphone once per day.	The system includes the following devices that can communicate via Near Field Communication (NFC): Smartphone, pedometer and a NFC personal identification card. Diabetes patients received a glucometer and obese patients received a weighing scale.
[13]	No name (referred to as 'e-coach')	*O:* Two roles: Support of the organizational process of the CR program (e.g., collecting and analyzing data) and support of the patient's process of making lifestyle changes (e.g., triggering and motivational support) *F:* Goal setting, collection of data (medical, risks and social situation), activity monitoring and triggering, social media group *I:* None provided	Proposed to involve the following: access to electronic patient files, sensors (apps, smartwatches, phones), and a web-based platform.

[a] The scoping review by [12] Jacelon et al. (2016) reports on other eHealth technologies but their source articles didn't meet the inclusion criteria and therefore were not included. Likewise, [2] Bosworth et al. (2010) discuss briefly about the Heart 360 program which also was found through the database search. However, no full text could be retrieved and the website was offline during the search, so this program couldn't be analyzed. The rest of the papers didn't specifically address an eHealth technology.

Despite the differences in the reporting, several goal setting theoretical constructs could be identified in each article and in consequence for every eHealth described within them. Table 3 provides the complete numerical summary of the constructs. In total, eighteen of the twenty possible constructs included in the codebook were found at least once. Only *persistence* (mechanism) and *task complexity* (moderator) could not be identified from the content of the articles. As an external incentive, *feedback (when no goal is provided)* was identified in at least half of the articles (54%) which covered three different technologies (HeartCycle E&C, SMART2 and CHF-CePPORT). In almost one third (31%) *other external incentives* were discussed, in all cases within studies that didn't describe a specific 'functional' technology (Bodenheimer & Handley, 2009; Bosworth et al., 2010; Nooitgedagt et al., 2017; Suter et al., 2011). *Assigned goals*, which according to the theory are a type of goals that can also work as external incentives, were only identified to be addressed in three articles (23%) covering two different technologies (HeartCycle E&C and SMART2). *Collaborative goals* was a widely identified construct (62%) found also in four different technologies (SMART2, CHF-CePPORT, MyCor and the conceptual e-coach) compared to *personal or self-set goals* found in a third (38%) of the papers but also in four eHealth solutions (HeartCycle E&C, SMART2, CHF-CePPORT and the conceptual e-coach). Mechanisms were barely addressed or discussed in the articles. The most frequently found construct was *feedback (on progress towards a goal)*, identified in eleven of the thirteen articles (85%) and covered by all technologies. *Self-efficacy* was addressed by half of the studies (54%) and covered by three of the technologies, all in a functional stage and specifically aiming CHF (HeartCycle E&C, SMART2 and CHF-CePPORT). *Importance* was also identified in a third of the articles (38%) but only in one functional intervention (HeartCycle E&C). The constructs regarding the outcomes were rarely identified in the papers. The HeartCycle E&C intervention (12) and the SMART2 / CHF PSMS technology (11) had the highest number of constructs that were identified, the conceptual 'e-coach' was just behind them (10).

Table 3

Descriptive numerical summary of goal setting theoretical constructs

eHealth [study]		External Incentives		Goals							Mechanisms				Moderators				Outcomes		Total	
		Feedback (No goal)	Others	Assigned	Collaborative	Self-set	Difficulty	Specificity	Proximal / Distal	Guided	Energizing function	Task-relevant knowledge	Directive function	Feedback (goal)	Self-efficacy	Importance	Commitment	Satisfaction	S. Paradox	Per study	Per eHealth
HeartCycle E&C	[8]	X				X	X	X	X	X		X		X	X	X				10	12
	[12]	X		X		X								X	X	X	X			7	
SMART2 / CHF PSMS	[3]	X		X	X	X								X						5	11
	[4]	X												X						2	
	[6]	X		X			X			X	X	X		X	X			X		9	
	[12]	X			X									X						3	
CHF-CePPORT	[7]				X	X								X	X					4	5
	[10]	X												X						2	
MyCor	[9]				X									X						2	2
e-coach (concept)	[13]		X		X	X	X				X		X	X		X		X	X	10	10
Non-specific eHealth	[1]		X		X			X	X					X	X	X				7	
	[2]		X		X			X							X					4	
	[5]		X		X		X		X						X	X				6	
Total		7	4	3	8	5	4	3	3	2	2	2	1	11	7	5	2	1	1		
%		54	31	23	62	38	31	23	23	15	15	15	8	85	54	38	15	8	8		

Task performance (outcome) is also a construct of Goal Setting Theory but this one was instead coded as the aim of goal setting as a BCT. Table 4 shows the complete numerical summary of the goal setting aim, operationalization (*self-care elements* and *factors that affect it*) and reported outcomes as a BCT. Goal setting is focused on *behaviour* in most of the articles (69%) and all of the described technologies. Furthermore, in a third (38%) of the papers and two functional technologies (SMART2 and MyCor, plus in the 'e-coach' concept) it is also focused on the *outcome* of a wanted behaviour. Regarding the possible self-care elements in which goal setting can be operationalized, *self-care maintenance* was the most frequent, being widely identified in twelve of the articles (92%) and for all of the technologies.

Self-care monitoring and *self-care management* were only identified in one article each. The two most commonly identified affecting factors to operationalize goal setting were the confidence of the patient and providing a teaching approach, both being addressed in eight articles (62%). Provision of learning environment was a factor identified in a third of the articles (38%). The c*ognitive* and *emotional* statuses of the patients were the only two factors that were not identified in any of the articles. *Outcomes* of goal setting as a BCT were only reported in five articles (Ammenwerth et al., 2015; Bartlett et al., 2014; Bosworth et al., 2010; Stut et al., 2014; Suter et al., 2011), mostly positive except for one case (Suter et al., 2011). The reported outcomes, or in other words, the value(s) of implementing Goal Setting Theory was only discussed in one paper, which was actually the earliest one published from all of the selected studies (Bodenheimer & Handley, 2009), and didn't particularly address a technology.

Table 4

Descriptive numerical summary of goal setting aim, operationalization, and outcomes

eHealth [study]		Focused on		Self-care element			Affecting factors						Outcomes		
		Behaviour	Outcome	Maintenance	Management	Monitoring	Confidence	Teaching approach	Learning environment	Personalization	Relationship with HCP	Social Support	BCT +	BCT -	GST +
HeartCycle E&C	[8]			X			X	X	X	X			X		
	[12]	X		X		X	X		X	X	X				
SMART2 / CHF PSMS	[3]	X		X						X					
	[4]														
	[6]	X	X	X			X						X		
	[12]			X				X							
CHF-CePPORT	[7]			X			X	X	X						
	[10]	X		X					X						
MyCor	[9]	X	X	X				X					X		
e-coach (concept)	[13]	X	X	X			X	X		X	X	X			
Non-specific eHealth	[1]	X	X	X			X	X							X
	[2]	X		X			X	X					X		
	[5]	X	X	X	X		X	X	X		X			X	
Total		9	5	12	1	1	8	8	5	4	3		4	1	1
%		69	38	92	8	8	62	62	38	31	23	8	31	8	8

Note. HCP = healthcare provider; BCT = behaviour change technique; + = positive reported outcomes; - = negative reported outcomes; GST = Goal Setting Theory

The final layer in the description of the selected articles puts the focus back on the technology itself. Eighteen persuasive principles were identified at least once in the articles describing an eHealth technology. *Rewards*, *social role*, *verifiability*, *competition*, *cooperation*, *normative influence*, *recognition*, *social comparison*, *rehearsal* and *simulation* were not identifiable from the content of the papers. On the contrary, five principles for 'primary task support' were recognized (*reduction*, *self-monitoring*, *tailoring*, *personalization* and *tunneling*), five also for 'dialogue support' (*praise*, *liking*, *suggestion* and *similarity*), six for 'system credibility' (*real world-feel*, *surface credibility*, *expertise*, *authority*, *third-party endorsements* and *trustworthiness*), and two for 'social support' (*social learning* and *social facilitation*). *Reduction*, *self-monitoring* and *tailoring* were distinguished in all of the technologies, while *praise*, *real-world feel* and *surface credibility* in four of them. *Liking*, *suggestion*, *expertise* and *social learning* were addressed by three technologies. The CHF-CePPORT was the system with the highest number of recognized persuasive principles (13), followed by the HeartCycle E&C program (12) and the MyCor telemonitoring technology next (10). Table 5 presents the complete numerical summary for the PSD principles.

Table 5

Descriptive numerical summary of PSD principles identified in eHealth technologies

eHealth	Primary Task Support					Dialogue Support				System Credibility							Social Support		T
	Reduction	Self-monitoring	Tailoring	Personalization	Tunneling	Praise	Liking	Suggestion	Similarity	Reminders	Real-World Feel	Surface credibility	Expertise	Authority	Third-party endorsements	Trustworthiness	Social learning	Social facilitation	
CHF-CePPORT	X	X	X	X		X		X	X		X	X	X		X	X	X		13
HeartCycle [a]	X	X	X		X	X		X	X		X	X	X	X			X		12
MyCor [b]	X	X	X	X	X	X	X	X			X	X							10
SMART2 / CHF PSMS	X	X	X				X					X	X						6
e-coach (concept)	X	X	X			X	X			X	X						X	X	9
Total (T)	5	5	5	2	2	4	3	3	2	1	4	4	3	1	1	1	3	1	
%	100	100	100	40	40	80	60	60	40	20	80	80	60	20	20	20	60	20	

[a] Multimedia appendices also reviewed (Stut et al., 2014)

[b] Additional publication also reviewed as it provided further description of the technology (Kreiner & Welte, 2015)

3.3. Log Data Analysis

The results from the log file analysis for each case are presented next, a larger size of the charts can be found in the appendices (6.9).

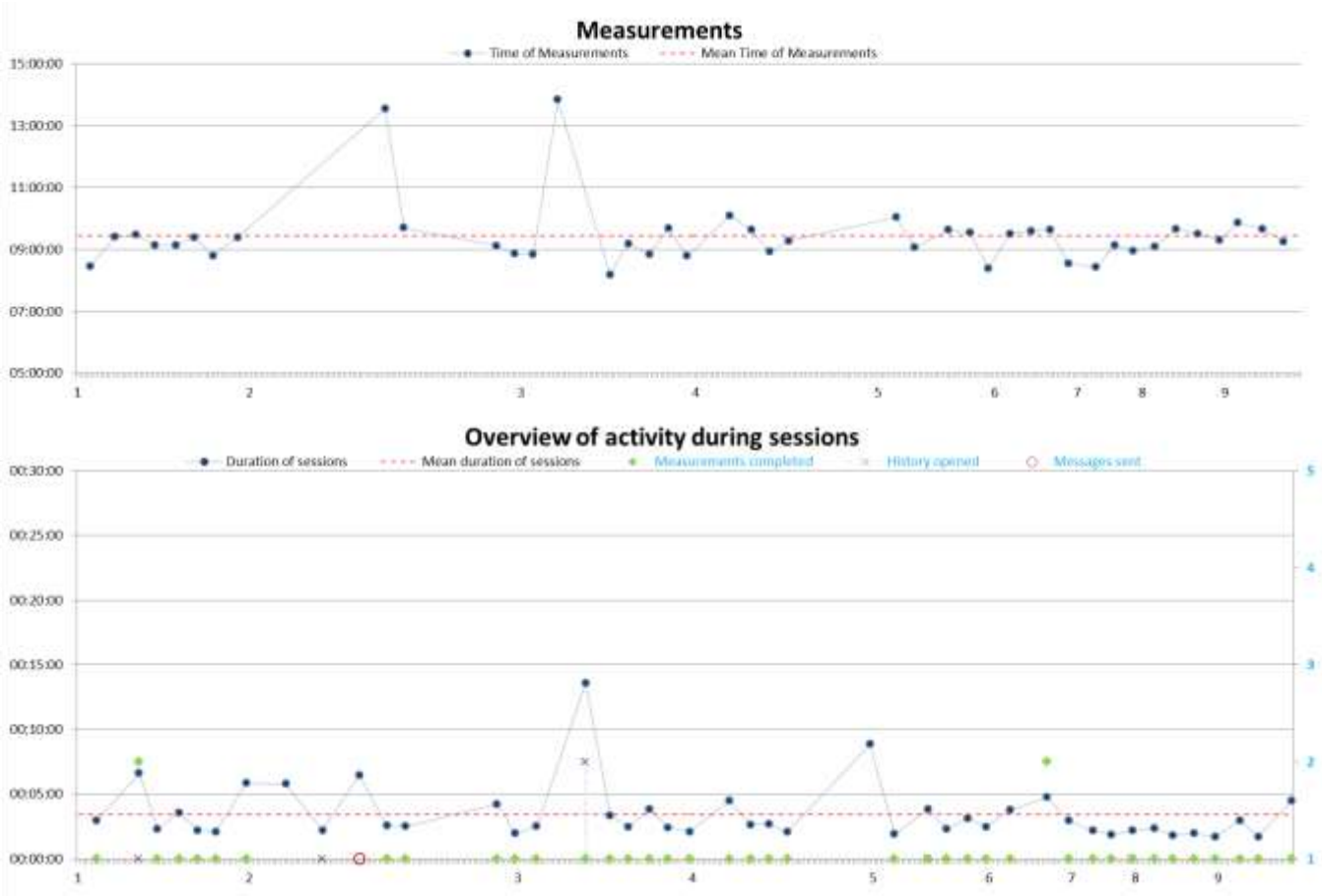


Figure 6. Case 1 – Low adherence
Note. At the *lower* graph the left Y axis measures the duration and mean duration of sessions. The right Y axis measures the frequency of measurements completed, history opened and messages sent (highlighted in blue).

Figure 6 shows the results for case 1. In the *upper* graph each blue dot equals a measurement and its position in the Y axis refers to the time of the day it was sent. The X axis in all of the charts is divided by the log file 'cases' and the beginning of every week is marked by a number (1st to 9th). The irregular distance between each week number represents a higher or lower number of interactions with the technology (cases registered in the log file). At the *lower* graph, an overview of the activity is presented, the blue dots mark a session and its position in the left Y axis equals the duration of each.

Furthermore, completed measurements can be identified as green diamonds and their position in reference to the right Y axis equals the number of measurements performed at that session, naturally most of the sessions consisted of only one measurement being sent. The number of times the history feature was opened is marked with an 'X' and a dotted line, although it is worth noting that this was calculated as a simple sum of 'open history' cases within a session and without any rules based on time. Messages sent are marked as a red circle, its frequency can also be distinguished based on the right Y axis.

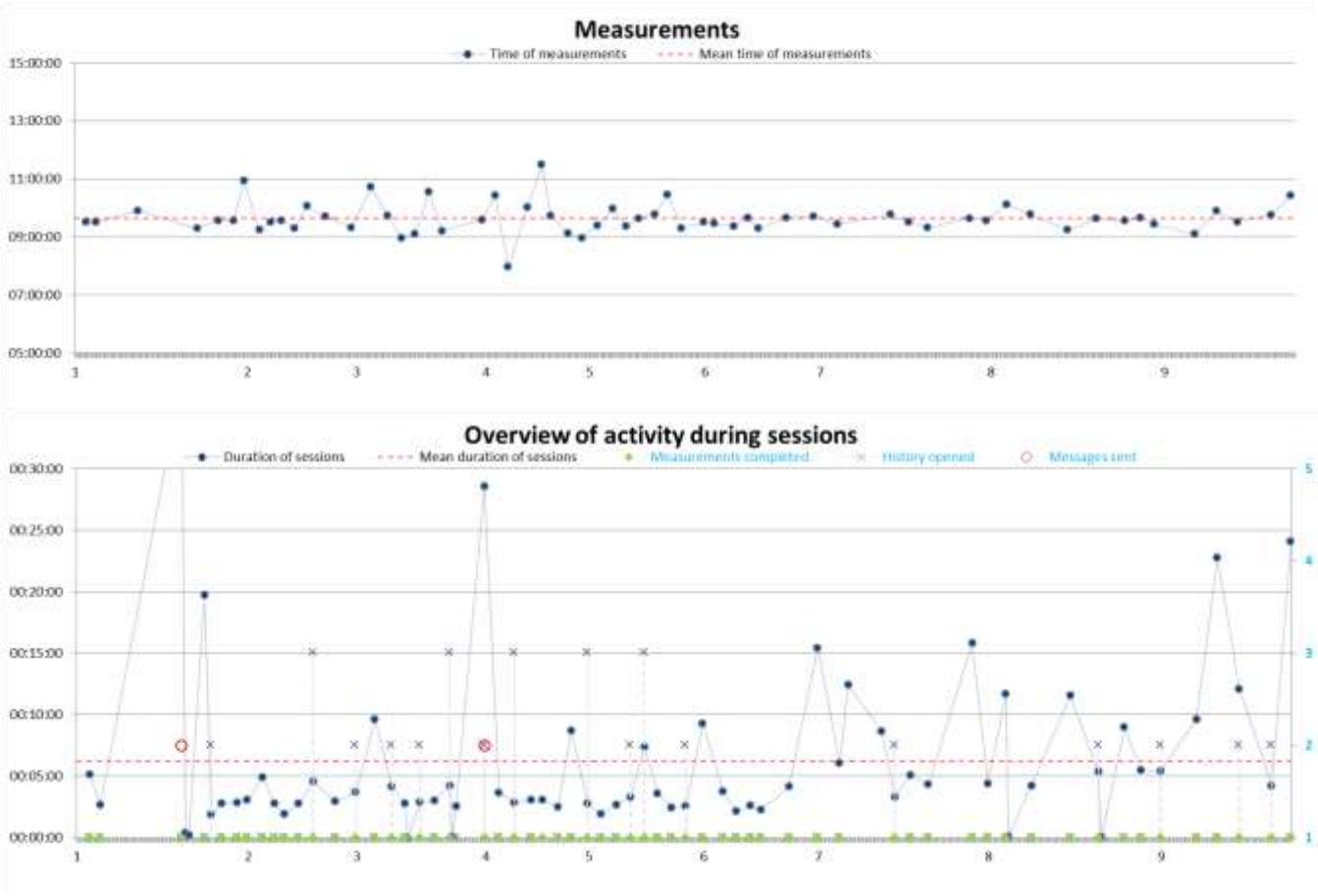


Figure 7. Case 2 – Adherence

Note. At the *lower* graph the left Y axis measures the duration and mean duration of sessions. The right Y axis measures the frequency of measurements completed, history opened and messages sent (highlighted in blue).

Figure 7 presents the results for the second case, where it can be appreciated a clear difference compared with case 1. For instance, in the *upper* graph the number of measurements and their time shows a higher consistency throughout the full pilot. At the *lower* graph, the activity is clearly richer in all of its features and with notorious spikes at several points.

The number of measurements completed can be better appreciated when compared to the previous case. This case also showed a high frequency in the interaction with the history function. The number of messages sent didn't vary much between the pilot participants, this case shows four of them (two in a session, twice), notoriously matching a high duration of those sessions.

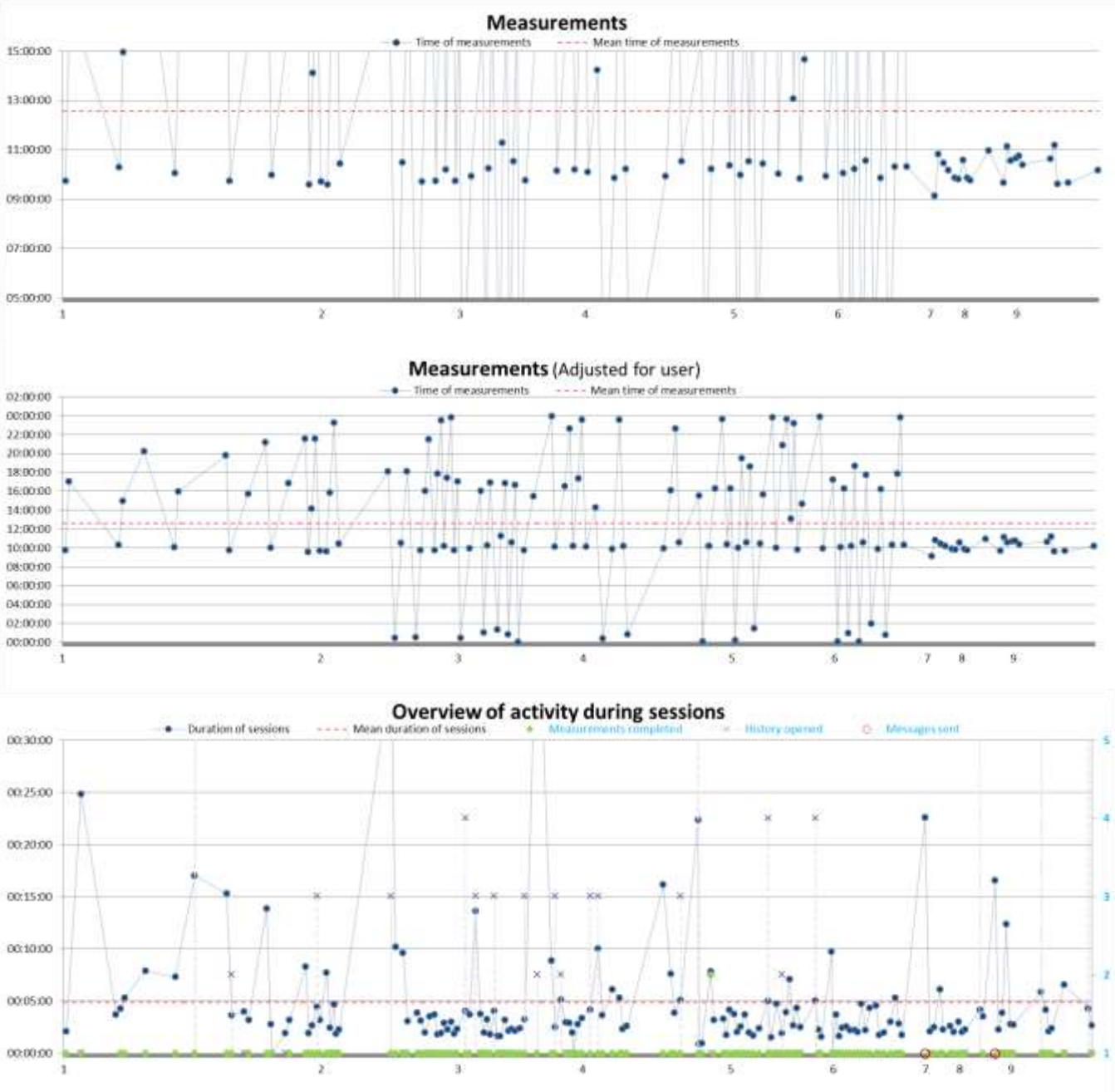


Figure 8. Case 3 – Adherence and high self-monitoring

Note. At the *lower* and *middle* graph the left Y axis measures the duration and mean duration of sessions. The right Y axis measures the frequency of measurements completed, history opened and messages sent (highlighted in blue).

Figure 8 shows the results for case 3. In the *upper* graph the consistency in the measurements is similar to the previous case. However, an extra chart (*middle*) is presented with an adjusted time span for the Y axis to better describe the multiple points during the day where this user conducted a measurement, some of them around midnight. In the overview shown at the *lower* graph, the activity is somewhat similar to the previous case but with a higher number of sessions under the five minute mark, as well as higher spikes in activity both in the duration of the sessions and the interaction with the history feature. Also note that the interaction with the technology (seen via the X axis) in the first week is way higher than the previous cases. The data on messages sent was similar to the previous case (two messages at two different sessions).

Table 6

Use and usage of content case comparison

	Low adherence	Adherence	+ High self-monitoring
Sessions			
Total nr. of sessions	44	70	151
Nr. of days with at least 1 Session	41	60	62
% of days with iMediSense with at least 1 Session	66.13%	100%	100%
Mean hour of first daily sessions	09:16:35	09:32:35	07:23:23
Mean duration of sessions	00:03:26	00:06:11	00:04:54
Total time spent in application	02:30:43	07:13:25	12:20:02
Measurements			
Total measurements completed	42	60	136
Nr. of sessions with measurements completed	40	60	135
% of sessions with measurements completed	90.91%	85.71%	89.40%
Mean duration of sessions with measurements only [a]	00:02:49	00:03:03	00:03:39
Adherence [b]	62.90%	98.33%	100%
Mean hour of measurements	09:26:19	09:39:00	12:35:15 [c]
History			
Nr. of sessions with history opened	5	62	38
% of sessions with history opened	11.36%	88.57%	25.17%
Mean duration of sessions with history opened	00:05:41	00:06:36	00:08:11
Messages			
Nr. of sessions with contact menu opened	7	6	16
% sessions with contact menu opened	15.91%	8.57%	10.60%
Messages sent	1	4	2
Mean duration of sessions with messages Sent	00:06:28	00:32:50	00:19:34

[a] Sessions with ‘measurements completed’ but no ‘history opened’ and / or ‘message sent’

[b] Adherence defined as compliance by the instructions given during the pilot to conduct ‘daily measurements’

[c] Rather odd value due to multiple measurements being conducted at different points in the day (including midnight)

Table 6 provides a comparison between all cases. Differences in the use and usage of content, as expected, emerged in this analysis. The total number of sessions increases across all cases. Cases 2 and 3 had at least one session every day of the pilot which didn't occur in case 1. The mean hour of first daily sessions is lower for case 3 but this can be understood because the calculation included the sessions that occurred after midnight which for this analysis were already considered to count as a 'new day'. There is also a clear difference in the total time spent in the application between all three cases, from two and a half hours to more than twelve hours of use in total. Regarding the measurements, the differences remain except that the percentage of sessions with measurements completed is virtually the same. Likewise, the mean time duration of sessions when only a measurement was completed in the sessions when history was not opened and / or a message was not sent is also really similar. Case 2 had a notoriously higher percentage of sessions when history was opened, but case 3 had the highest mean time duration of sessions when history was opened. Finally, all cases showed a 'low' usage of the contact menu.

3.4. Stakeholder Consultation: Thematic Analysis

Three consultation rounds were conducted: an individual interview with an expert user (cardiologist), another one with a potential end-user (individual undergoing an initial stage of diagnosis of CHF) and a meeting with two developers of the technology. Given that the contributions of the potential end-user cannot be generalized, these are mostly used in the thematic analysis to illustrate or exemplify the most conclusive findings when applicable. The insights and perspectives of the stakeholders have great significance as they are representative in their role within the development team of the iMediSense technology. The thematic analysis resulted in eight descriptive higher-order themes that were relevant for the research questions of this study, these are presented next.

Enhancement, challenges and key elements of self-care for heart failure

According to the data to promote self-care it is important to provide *education* to the patient, assist on their *decision making* and promote the *collaboration and trust with the healthcare provider (HCP).* However, the challenges identified are: promoting *effective self-care*, prompting *adherence* towards it, and dealing with the *symptoms, co-morbidities and overall burden of the patient's condition.*

> "Great management would be if we prevent the patient from going in the wrong direction, because it has many implications: the patient gets complaints, has to go to the hospital, has to get diuretics to lose fluid, and the cost will be higher and higher. Heart failure is getting higher and higher in the coming years, in the Netherlands and the world." [Expert user]

Regarding its key elements, self-care is more commonly focused on *maintenance*, such as promoting adherence to the medical recommendations, but it can also be targeted at the *monitoring* (e.g., vigilance of symptoms) and *management* (e.g., decision making) aspects of the disease. The focus on these depends on the clinical status of the patient, but it is considered important to always have the HCPs at the lead of these efforts.

> "Management of the disease must not be done without the interference of the nurse practitioner, general practitioner or the physician. It is very important that one of them is the captain on board." [Expert user]

> "If I know what my limits are, in physical doing, that's important for me, knowing what to do and to know what not to do." [Potential end-user]

Value, challenges and types of goal setting for self-care

Goal setting was seen by all stakeholders as a component of value, because of its potential benefits to increase the health of the patients, to guide them in doing what is required and the potential contribution in establishing what is needed or wanted in a coaching feature for the technology. On the other hand, the challenges identified to implement goal setting are that it requires the participation of several agents and contexts (e.g., patient and HCP, hospital and home), and that, as previously stated, needs to be implemented in a way that keeps the HCPs in the lead of self-care while still supporting the patients in reaching their own goals and individual ways of coping with the disease.

CHF patients are considered to be commonly good and motivated at striving for self-care goals, mostly in the form of *personal goals* focused on avoiding the negative symptoms and consequences of their condition (e.g., breathlessness, re-hospitalization). *Collaborative or participatory goals* are recommended as the best approach to implement for self-care. On the

other hand, *guided goals* can also be applied, but in a manner that doesn't diminish the sense of autonomy of the patients.

> "I find motivating the overall feeling of feeling better, feeling well, not feeling like an old man." [Potential end-user]

> "We can start with a simple list of 5 goals, they choose one to their own taste, for example weight loss. Give them limited time, half a year or a year so they can reach it and then they can choose another point. So we're keeping them busy and you can stimulate them when they reach their goal." [Expert user]

> "At least for heart failure, the patients, the age group, almost dictates more co-guided goal, very small, reduced, tunneled goal." [Developer]

Key factors to consider in goal setting for heart failure

The perceived *difficulty* of the goals is seen as a relevant aspect to take into account, while the *importance* of these might usually be dictated by the clinical status of the patient (e.g., not feeling tired). *Confidence or self-efficacy* to perform self-care is considered to be the most important factor to aim for in goal setting implementation. *Feedback* is important to keep for health parameters but feedback on performance might depend on the preference of the user (potential end-user reacted differently to different feedback mock-ups shown during consultation, see appendix 6.6. *Social support* is seen as a valuable resource to boost goal setting but also an end of effective self-care.

> "I try to get back to my physical condition of the past and I don't know how realistic that is but… but now I'm tired, I'm tired, half of the day I'm tired." [Potential end-user]

> "I don't think that the goal should be very high, should be very reasonable, otherwise they will get disappointed, we will lose them. But, if we can make this development work for the patient, they would be more mobile, if you're more mobile you talk to people, change your mood. I think it would be important not to be isolated, I think that if this system works well it will provide the patients with the ability not to be isolated: socially, emotionally, and medically." [Expert user]

Functionalities and challenges in the implementation of coaching in the technology

It's considered important that, through a premature detection of deterioration, the HCPs can intervene and coach the patient in order to avoid panic and uncertainty, this by facilitating the contact between them and the patient (the potential end-user, just like most of the pilot participants, also found the possibility to send a message quite useful, along with the self-monitoring that is already incorporated in the technology). Additionally, self-care education and training in the use of the technology through videos or tutorials was also considered useful. All in all, self-monitoring was considered to be the key source for the coaching interactions (e.g., anticipate deterioration and provide advice or by allowing the tracking of behavioural data such as resting hours or activity during the day or week).

> "I think we should anticipate before the patients get in panic. We will be informed just before the patient, and we can inform the patient do this, do that, or the other. For example, take more medicine, drink less water, come to the hospital for lab investigation, ECG, etc. HCPs should be able to be in the lead. Simultaneously we have to give the patient good advice, not afterwards as this would be no good. Premature detection of deterioration of the patient." [Expert user]

Persuasiveness for self-care coaching

Several persuasive principles were identified to be addressed during the consultations, *tailoring* was the most commonly found as it plays a key role in the core functionalities of the technology (e.g., adapting frequency of health measurements according to the clinical status of the patient). Furthermore, it was agreed that users could use the system in different ways, so tailored case-by-case recommendations might be required to promote the desired adherence.

> "In case of exacerbation or heart failure we have to do it daily, but if the patient is stable we might be able to perform it once a week or once every two weeks. It varies between patients. Some patients might do it without any panic, it just feels like 'I would like to play with the machine'". [Expert user]

Reduction and *tunneling* were also highly valued among all the stakeholders, especially as these were seen as persuasive principles that already made the technology successful during the pilot. The same principles were expected to be incorporated in a coaching feature.

Furthermore, the identification of the most effective enhancement for self-care that goal setting could offer was seen as a highly valuable outcome in order for the technology to provide coaching without decreasing its usability.

> "You have a lot of goals you can achieve and try to figure out, just choose the top 3 or maybe the top 1 goal that you want to achieve and work it out." [Developer]

> "The time the patients 'must be' using it must be as small as possible and the time they 'want to' use it must be as big as possible. I think we want to do something where the things you 'need' to do are 'small' but the application should still invite to explore it." [Developer]

Other principles that were addressed, although not widely enough to be conclusive, were*:* *liking* (potential end-user referred to the interface and animated tutorial function of the 'Reanimatie' mobile app from Hartstichting as appealing due to its simplicity), *real-word feel* (value of the contact function with HCPs), *surface credibility* (e.g., links to recognized websites instead of just straightforward delivery of information), *social facilitation* (potential end-user was not attracted to a hypothetical feature based on this principle: "forums on the internet, not for me") and *trustworthiness* (e.g., key factor in promoting effective self-care).

Present and future of the iMediSense technology

Overall the current state of the technology was highly regarded, focusing the following steps on maintaining its already earned added value in future iterations of development, which would include research into new functionalities and a bigger scale deployment of the product in its current state.

> "My expectation is that we can improve the patients' status at home by telemonitoring and, hence, we can decrease the expenses of the care, of the general care. Hopefully we can anticipate when the patient is going to decompensate, to develop heart failure. If we can have some clues to act early, to prevent the event of heart failure, this will be a very great win for the patients and for the project. So, prevention of the development of heart failure, earlier detection, and low costs." [Expert user]

> "Our current role is to lift iMediSense from a pilot phase to the product phase which is that we can deliver it to a company, to more hospitals as a maintainable, a co-maintainable product." [Developer]

As part of the framework that has been applied for its development, further stages call for iterative phases of testing for any major change in the architecture, including a coaching feature, also taking into account the possibility that not everyone might be fit or willing to give eHealth an opportunity in the end.

> "If you look at phases, this (proposal of a goal setting module) is the first phase, then the engineering part comes in, there is also a part of prototyping at first, update all the system which then you can use to do again a usability testing, because if you add it to the system you get more interaction, more details that you have to work out. Then after that if you've done the usability again you get the confidence now, that we're sure that if we implement this to the system, to the final system, that it really increases something for the patient." [Developer]

> "You cannot satisfy everybody, it's impossible. I think we will meet the needs of 80% or 90% of the patients with our developed system and 10% to 20% you can never please them whatever you do, with the system, medication, lifestyle, psychologists, psychiatrists, they are doomed to be like this." [Expert user]

Enhancing the applicability of the present study and of future research

In order to increase the applicability of this research, it was found that providing as much relevant information as possible is appreciated, all in order to consider the wide range of possible improvements for the technology (the "*what if*'s"). The *personas*, *use-case scenarios* and a *conceptual model of a goal setting feature* (including a lo-fi prototype) were agreed to be potentially useful outcomes to initiate further discussion and analysis regarding a future incorporation of a self-care coaching feature in the iMediSense technology. The *functional requirements*, an initial target of this research, were seen as being relevant but most likely for phases still at large in the development task.

> "The functional requirements are more sort of how we're going to do this in the system, but the goals are what come before that and that is the most important. Not describing that

> in terms of the system because that comes later on. The conscious goal or intentions to regulate behaviour is basically the first step to identify, the goal setting and after that the functional requirements, as these are just a method to get it done into the system." [Developer]

> "I would suggest to focus on the personas, use-case scenarios, the goal setting and the lo-fi prototype, and basically that's the output that you can give to us that we can translate to functional requirements, into input-process-output and so, that is more for the engineering part and that's how you're going to make it." [Developer]

Recommendations for future research and development efforts were widely suggested to continue to be based on multidisciplinary collaboration and usability tests on the outcome of the present research (e.g., via mock-ups), as these were also a source for the success of the project so far.

> "What I really would be interested in is if you have that persona, you have the use-case scenario, you have the goal setting (model), you have an idea of how you can achieve something with goal setting, if you also have the usability testing done, as for the basic concept, then you have sort of proof of concept that the idea works, you haven't implemented anything but you have tested the idea." [Developer]

> "Then basically work it out together with all kinds of disciplines, from behavioural science, the medical staff, us from an engineering point of view, the key is to have that multidisciplinary approach. To do it together." [Developer]

Factors to consider for end-user profiling to support self-care coaching

Finally, through the consultation rounds multiple elements provided a hint at factors that could be of interest when seeking to provide an accurate description of the target group (or its most distinct characteristics) that a technology like iMediSense could focus on when providing coaching. First of all, it was agreed by all stakeholders that the *use of the technology* is the main point to consider, which could be coming from several sources such as past experience (e.g., usage of other mobile apps or the internet) or simply by their system preferences (e.g., preferring textual feedback instead of charts). Secondly, the *education level* of the users is also seen as an important determinant linked to the previous point (e.g., being expected that the higher the

education level, the better the adherence and experience will be). Finally, the characteristics of their *medical condition* were also considered to be important (e.g., physical symptoms such as being frequently tired or the psychological stress caused by this decrease in capacity). Less conclusive findings point toward the relevance of more subjective and personal driven factors such as their *life-goals* (and the impact of the disease on these), their *feeling of autonomy* (potential end-user countered the idea of 'guided goals' with a statement of 'being able to make my own choices'). In sum, these factors could form individual needs that the users might attempt to fulfill through the technology.

> "Until now, every year we always planned long cycling trips, 2,000 kilometers a year or so, which was also the case for this year. That's all finished, that is over. Partly, because I'm not able to do it, and also a little bit unsure what to do and what to do not." [Potential end-user]

> [Discussing case two of the log data analysis, its higher percentage of history opened in total of sessions] "A conclusion for me is that there is a need to see the history, which could explain the eighty eight percent, there is a need to see the history, if it fulfills the need I don't know, but there is a need." [Developer]

3.5. Goal Setting Module: A Contender Construct to Support Self-Care of Heart Failure

This section presents the main outcome of this research, a goal setting module to support self-care of CHF, and its structure and rationale based on the results previously presented. In the language of the agile science process, this module is the product of *formative work* consisting of a mixed-methods research which included a literature review performed at several levels (theoretical, behaviour-change and persuasive technology), enhanced by stakeholder consultations with a log data analysis as key input. The first step consisted on discerning between the sources of information in order to provide meaning and the right dimension to the findings. Therefore, as the intention is to propose an evidence-based goal setting module for a telemonitoring and coaching technology, the priority was given to the traces of evidence that were conclusively supported by all sources taking this into consideration.

Table 7

Summary of evidence

Existing evidence (CHF self-care and eHealth)	Supportive contextual evidence (iMediSense)
Scoping literature review	Log data analysis (as input) & stakeholder consultation
Goal Setting Theory: External incentives (E), type of goals (G) and moderators (M)	
E: Feedback as an external incentive	Yes
G: Collaborative / Participatory goals	Yes
G: Personal / Self-set goals	Inconclusive from literature but supported [a]
M: Feedback on progress towards goals	Yes
M: Self-efficacy	Yes
M: Importance [b]	Inconclusive from literature but supported [a]
Goal setting aim (A) and operationalization as a BCT (O)	
A: Behaviour	Yes
A: Outcome of wanted behaviour	Inconclusive from literature but supported
O: Self-care maintenance	Yes
O: Confidence to perform self-care	Yes
O: Teaching approach	Yes
O: Learning environment	No, inconclusive from both sides
PSD principles: Primary task support (PTS), Dialogue support (DS) and System credibility (SC)	
PTS: Reduction	Yes
PTS: Tunneling	Yes
PTS: Tailoring	Yes
DS: Praise [c]	Yes [d]
SC: Real-world feel [c]	Yes
SC: Surface credibility [c]	Yes

[a] Personal goals and the importance of goals play a combined role in the motivation of CHF patients.

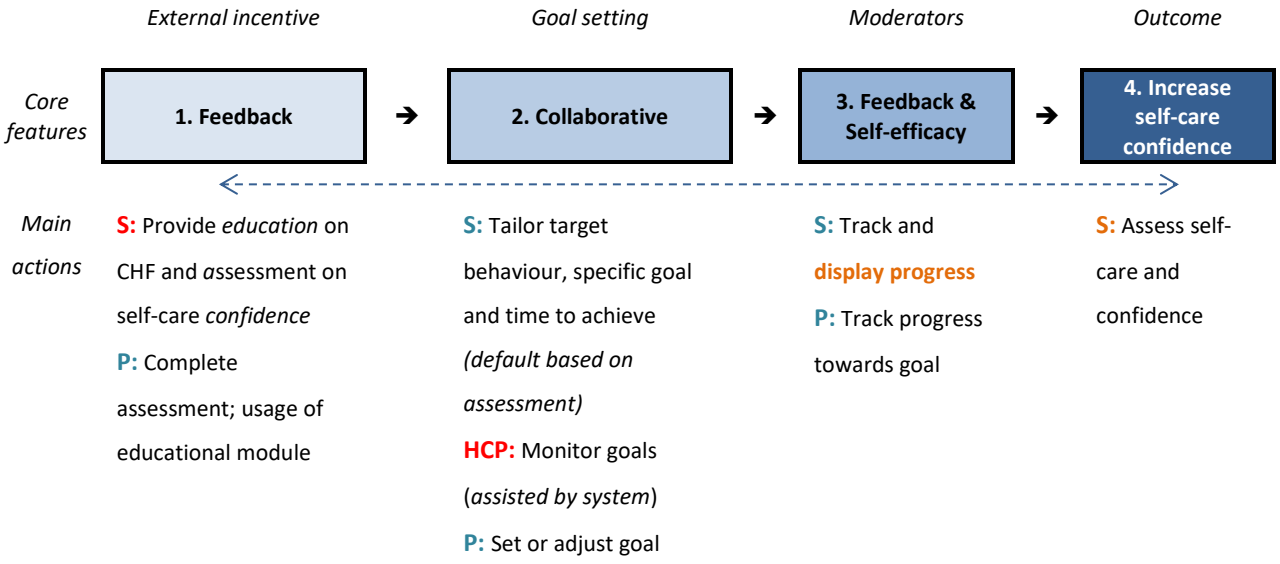
[b] Importance is a sub-construct of Goal Setting Theory (Michie et al., 2014) which has an influence on the *commitment* to the goals. *Commitment* as a construct couldn't be identified from the literature review but was discussed in the consultation.

[c] Unlike the other principles in this table, praise, real-world feel and surface credibility were not unanimously supported but they still appeared to show sufficient relevance from both sides when reviewing the full evidence.

[d] Praise was not sufficiently identified during the consultation analysis, however, when reviewing the full body of evidence it arises as a supported principle.

Table 7 presents a summary of the most salient evidence found by this study. The theoretical constructs that have conclusively been addressed in eHealth technologies aimed to support the self-care of CHF are: *feedback*, as an external incentive to prompt goal setting; *collaborative or participatory* goals as the supported choice for the type of goal; finally, *feedback on progress towards goals* and *self-efficacy* as moderators were also found to be addressed in the context that this study aimed to shed light upon. Furthermore, goal setting as a BCT was found to be mostly *focused on behaviour* and aimed at *self-care maintenance* in order to increase the patient's *confidence to perform self-care* and conducting it with a *teaching approach* (practice and learn self-care skills over time).

Persuasive principles that have been identified to be of relevance for a goal setting module embedded in eHealth are *reduction*, *tunneling*, *tailoring*, *praise*, *real-world feel* and *surface credibility*. Based on the conceptual model shown in Figure 3 and adjusting it with the evidence described above, a concept of a goal setting module to support self-care of CHF is presented in Figure 9.



Note. S = System; HCP = Healthcare provider; P = Patient

Primary Task Support, Dialogue Support, and System Credibility.

Figure 9. Goal setting module to support self-care of CHF

Module description

This conceptual goal setting module is focused on enhancing self-care of CHF patients by aiming to increase their confidence to perform the recommended behaviours through facilitating education and practice over time. Educational information is important and should be made available through this module, both general about CHF but also especially concerning self-care. Furthermore, the module requires a general baseline assessment and an enquiry on self-care behaviours, requesting the users to input their confidence in their skill to perform each of them (e.g., confidence to increase physical activity or to reduce salt intake). This derives on the system giving feedback and advice based on their results, the users are consequently prompted to set a goal for a specific behaviour, and this is where the coaching begins.

Theoretical foundation

The mechanisms of this module to support behaviour change are grounded in Goal Setting Theory, thus, it aims to enact an energizing and directive function towards self-care behaviours, increasing persistence and prompting the development of task-relevant knowledge and strategies. It focuses on two key moderators, feedback and self-efficacy, which have been identified as being significantly appropriate for the target population.

Evidence-based

The foundation of this conceptual module is the result of a literature review which identified, described and analyzed, at multiple levels, five eHealth technologies that aimed to increase or support self-care. Throughout the research and implementation of these existing programs, goal setting was found to be useful, motivational and generally supported by CHF patients who were stable, knowledgeable and active; via goal setting they were encouraged to perform daily walks which in some cases resulted in weight loss (Bartlett et al., 2014). Adding to that, in another intervention it was found that, at different phases, from 72% to 89% of goals set for physical activity were achieved by users (Ammenwerth et al., 2015). Likewise, it was established that around 80% of patients who started a coaching program for physical activity and low-salt diet were able to reach their personal goals for at least two consecutive weeks, and most of them continued to use this feature (Stut et al., 2014). The proposed module is expected to achieve similar or greater outcomes by also having an added value based on persuasiveness and an 'agile' basis that facilitates further improvement, characteristics that other coaching systems have not focused on.

Persuasiveness

The module considers several persuasive principles based on primary task support, dialogue support and system credibility. Reduction, tunneling and tailoring are attained by guiding the users in a simplified process based on 'feedback → goal setting → feedback' focused and adjusted based on their level of confidence to perform different self-care behaviours. Furthermore, dialogue support is provided through praise according to the progress and attainment of their goal.

System credibility is accounted for by considering the surface credibility of the educational information that is made available through the system. Providing links to reliable websites was suggested by stakeholders during the pilot study to be a sufficient and reliable way of doing this (e.g., www.hartstichting.nl), and the findings of this research back this up. Finally, the real-world feel is kept through facilitating the interaction and monitoring of HCPs also in the goals the users set and strive for. For example, HCPs should be allowed to see the goals the users have set and the progress they report on them, that way they could provide praise, or suggestions for new goals via the message system or a built-it notification linked to the coaching feature.

Smallest, meaningful, self-contained, repurposable and interoperable

The module aims to fulfill the criteria of the agile science process by focusing on the specific case of effectively enhancing confidence in performing self-care behaviours of CHF patients interacting with a telemonitoring technology. The architecture of the iMediSense system is based on sensors, so in case more are added in future stages of development, it would also reshape the mechanics of this module (e.g., adding a physical activity tracker). Finally, the module could also be extended for new diseases by considering different and specific self-care behaviours along with their key moderators (e.g., enhancing adherence to medication in patients with diabetes).

3.6. Goal Setting Module: Personas, Use-Case Scenarios and Design for Lo-Fi Prototype

Now that the module has been presented, the final task at hand was to provide meaning to the results and to enhance their usefulness and applicability. This step consisted of three elements: personas, use-case scenarios and a series of mock-ups to inspire the design of a lo-fi prototype. Altogether, these products seek to showcase how the proposed goal setting module can enhance the self-care of CHF patients with distinct profiles based on data from the ‘Twente TEACH’-pilot. As described by the methodology, the users were clustered in three different groups according to a calculation of their adherence during the pilot taken from analyzing their log files. Testing different thresholds, it was finally decided that the cut would be at 10% +/- using full adherence as the middle point, therefore, the groups are formed as following: group 1, below 90%; group 2, 90 to 109%; and group 3, 110% or higher.

The decision reflects what was generally observed during the pilot, that the majority of users complied with the indications of use (group 2, the 'adherents'), others that struggled a bit in keeping up (group 1, labeled as 'low adherents), and a few cases that notoriously exceeded the recommendations (group 3, 'adherents and high self-monitoring'). Table 8 presents the descriptors for each group.

Table 8

Case-groups for the development of personas

	Measurements			Demographics							
Case-group	Min.	Max.	Mean	T	M	F	Mean age	NYHA II	NYHA III	EHEALS	EQ5D5L
1	37	48	44.86	7	1	6	63.29	6	1	3.31	8.71
2	51	69	62.08	13	6	7	69.23	12	1	3.18	7.85
3	70	138	88.75	4	3	1	70.75	3	1	3.30	9.00

Note. One user was removed from analysis due to early exit from pilot study. T = total of participants in the group; M = male; F = female; NYHA = New York Heart Association classification; EHEALS = eHealth literacy scale; EQ5D5L = perceived health states questionnaire.

In Table 8 it can be seen that between the three case-groups there is a clear difference in the mean number of completed measurements during the pilot, although as it has been stated they all show a rather high amount of measurements. As a result of the analysis, seven participants were categorized in the 'low adherent' group (1), thirteen as 'adherent' (2) and four patients into the 'adherent and high self-monitoring' (3) group. The first group has more female participants than male, the second group is balanced in gender, and the third group is composed of three males and one female. The mean age is similar between the groups, group one has the lowest and three the highest. All groups were predominantly formed of patients classified as NYHA II (slight limitation of physical activity) and each only had one case of NYHA III (marked limitation of physical activity). In terms of eHealth literacy (ability to seek, find, understand, and appraise eHealth) all groups have virtually the same scores, while the EQ5D5L score was the lowest in group two, which translates into a better health state for this group (less health problems perceived). This summary analysis of the characteristics of the pilot participants was also added into the data considered for the creation of personas that would illustrate the three representative cases of this study.

Following the methodology, personas were structured by a basis of their demographics, educational level or professional background, healthcare specifics, technical ability in general, iMediSense experience, self-management and a latent need for self-care coaching (goal setting module). This stage resulted in three personas described below.

Low adherent	*Suzanne Bakker*
Personal profile	*"My health is important, but how do I start?"*
Suzanne is 63 years old, she is married and has two children and three grandchildren. She retired from work life just three years ago, she used to work as a secretary for a big manufacturing company in the Netherlands. Six months ago she was diagnosed with heart failure, she has never been hospitalized but she does feel very limited in her daily life, she cannot walk or cycle for long periods, and activities like climbing are just too much for her. Suzanne owns a smartphone and also has a laptop but barely uses it, when she does it is mainly to play games if she is bored. Suzanne used the iMediSense system for the last two months and found it interesting. For example, she liked the way the graphs looked in the history section but admitted difficulties in providing meaning to them. She used the system as much as she could but after the first month she wasn't feeling any change in her health so she felt demotivated to continue. Whenever she remembered she would still use the system to send a health measurement to the hospital but in the second month she tended to forget to do it quite often. Suzanne recalls some of the recommendations her doctor gave her, such as tracking her weight or implementing fluid restriction. Measuring her weight, for instance, is something she really dislikes because she feels it creates too much stress to 'confront' the scale on a daily basis, but she still does it as much as she can. On the other hand, fluid restriction is also very challenging for her as she often struggles to achieve this recommendation. Suzanne is determined to keep trying on her efforts to improve her health but her biggest challenge is that she loses motivation quite easily.	 *Background* - Family woman, recently retired - Recent diagnosis of heart failure - Low use of technology, mainly for leisure *Attributes* - Low confidence - Low adherence - Stable condition *User needs* - Education on disease - Guidance on self-care

Figure 10. Low adherent persona

Figure 10 describes the persona of a 'low adherent' user, this case would be the main target group for the goal setting module, a patient with low confidence in performing one or several self-care behaviours. Next a use-case scenario for this persona is briefly described.

- *Low adherent – use-case scenario*: Suzanne begins to try a new prototype of the iMediSense technology with a coaching feature. From the main menu she accesses this new function and is welcomed by a simple interface that offers two options: education and coaching (Figure 11). She proceeds to open the educational section which provides links to reliable websites about heart failure. Specific information is organized based on the subject, including self-care. Suzanne is informed of strategies (e.g., 'Tools and resources' category) to achieve the recommendations on fluid restriction, eventually she is prompted to consider the new goal setting function within the system.

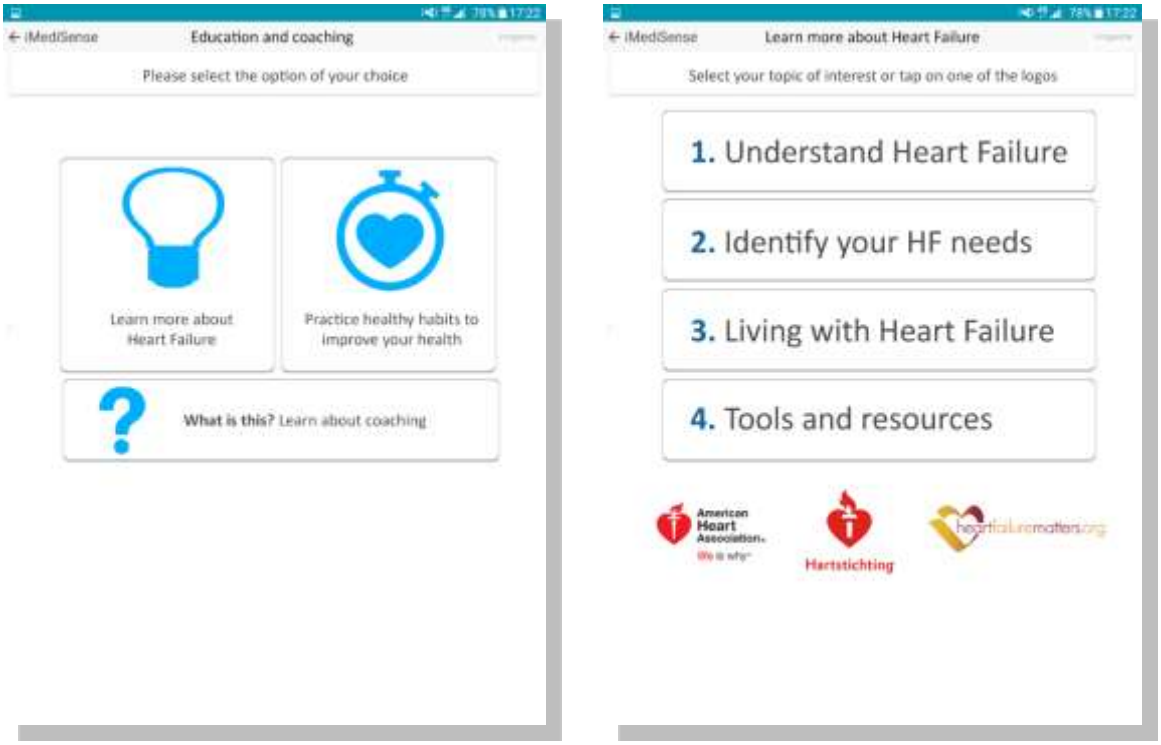


Figure 11. Mock-ups of interface and educational provision in a coaching module

Adherent	*Jet Meijer*
Personal profile	*"Sometimes I feel completely out of control"*

Jet is 69 years old, she has been married for 35 years and together they have three children and four grandchildren. She worked in the food industry for more than forty years as a warehouse assistant manager. Jet suffered a heart attack eight years ago, which led her to retire from her job. Since then, she went through a bypass surgery and three years ago she was diagnosed with heart failure.

She has a smartphone and an iPad but she doesn't really use them that much, usually two or three times a week, mainly to check her e-mail or her bank account. Jet used the iMediSense system for a couple of months and found it really simple and easy to use. She especially liked how easy it was to measure different parameters so the people at the hospital could see them, which she considered important. She also enjoyed tracking her progress through the history charts which she would show frequently to her husband and children.

Because of the length of her condition, Jet knows the value of self-monitoring her health just as the doctors recommended, and she has been doing so even before using the technology. She does her best to follow all the suggestions the HCPs give but often feels too dependent on them as she usually has a lot of questions in every consultation about things she doesn't understand or about what she is supposed to be doing now. Often she deals with uncertainty as she is afraid of doing something that might negatively affect her condition. The end-goal seems out of reach which is why she would rather advance in small steps to build up her confidence.

Background

- Family woman, retired almost eight years ago
- Medical history of cardiac events
- Low use of technology, mostly functional

Attributes	*User needs*
- Low confidence	- Education on disease
- Good adherence	- Feedback on progress
- Stable condition	

Figure 12. Adherent persona

Figure 12 shows an 'adherent' persona, this is expected to be one of the most common users of iMediSense, the benefit is not on a specific self-care behaviour but on the outcome of accumulating confidence in general, to achieve a sense of control on the disease. A use-case scenario for this case is presented below.

- *Adherent – use-case scenario:* After exploring the educational section in the new iMediSense prototype, Jet has recently been trying the new coaching function. At first she was required to complete an assessment about her current practice of self-care behaviours and how confident she feels for each of them (Figure 13). This way she found out that her lowest confidence lies on the performance of physical activity. Using the system Jet decided to set a goal for the following four weeks and was satisfied when she could fulfill her objective. When feedback on goal is provided, the system re-directs her to the educational section where further recommendations are highlighted prioritizing the ones Jet has not yet consulted or those related to the behavioural goals she has set.

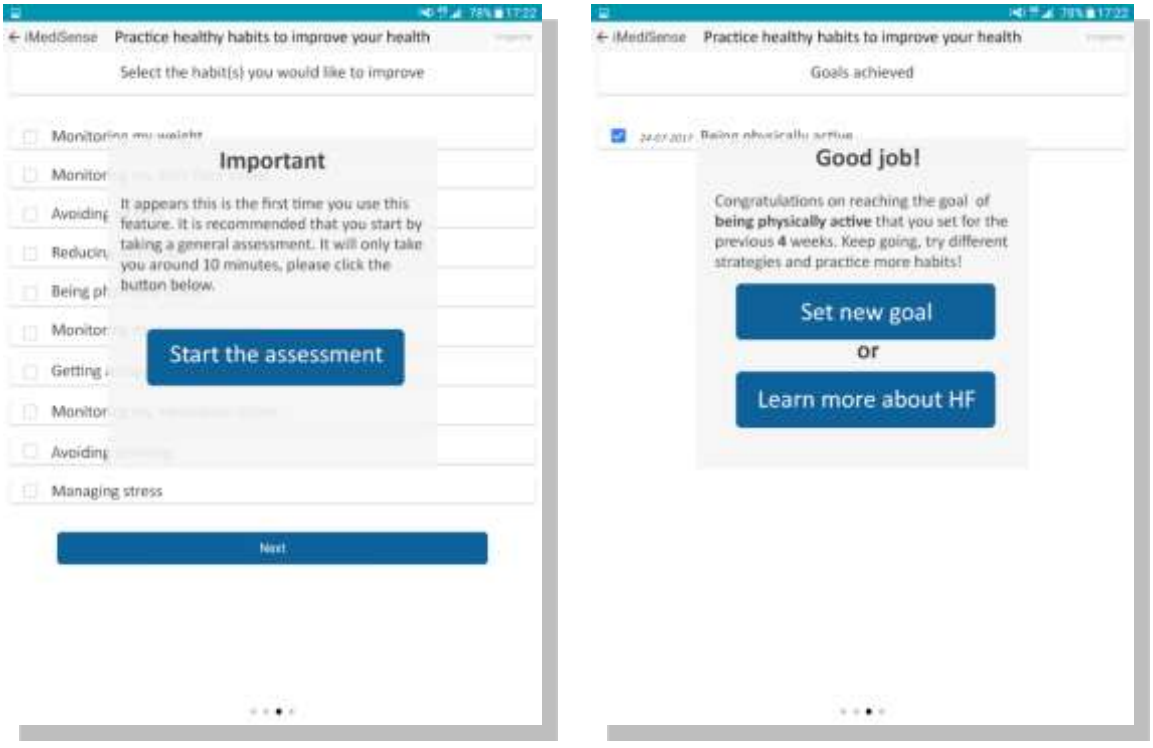


Figure 13. Mock-ups of prompt for self-care assessment and feedback on progress

Adherent and high self-monitoring	*Jeroen de Vries*
Personal profile	*"I do what I can and put my trust in the doctors"*
Jeroen is 71 years old, he is married and has three children and six grandchildren. He had a career in the field of civil engineering from which he retired more than ten years ago. He had a bypass surgery and an ICD implanted a couple of years ago, at that time he was also diagnosed with heart failure but since then his condition has stabilized. He usually feels full of energy and is able to do daily walks with his dog. Because of his professional background, he feels comfortable using a computer, but he doesn't own a tablet and admits that despite owning a smartphone he rarely uses it for anything other than calls and messaging. Jeroen used the iMediSense system for two months and found it quite useful as it facilitated the task of performing health measurements. He was motivated to try and test the system in different ways and would even perform multiple measurements on some days. However, he admits that he didn't bother to use the technology beyond that, as he prefers to leave the decision making to the doctors, limiting his role to supply as much information as possible. He also noted that there was rarely a need to send a message to the hospital since nothing seemed to be going wrong for him. Even before using the system Jeroen was already used to keeping track of his weight and other health parameters, also applying any recommendations that the HCPs requested of him. Jeroen feels confident and in relative control of his disease, he believes that everything will be alright as long as he focuses on monitoring his health and reporting how he feels to the staff at the hospital.	 *Background* - Family man, retired more than ten years ago - High mobility due to stability of condition - High use of technology, mostly functional *Attributes* - High confidence - Good adherence - Stable condition *User needs* - Ease of use - Tailored monitoring

Figure 14. Adherent and high self-monitoring persona

Figure 14 describes an 'adherent and high self-monitoring' persona. Although this case is expected to be less common, a goal setting module can still have an added the value for the general monitoring and for the HCPs to provide coaching when it's needed. Indeed, the proposed benefit for a case like this might be greater for the HCP than the patient itself, as the interaction might start from the former rather than the latter. For instance, it would be facilitated that new recommendations or adjustments to self-care can occur within the system. A use-case scenario for this persona is presented next.

- *Adherent and high self-monitoring – use-case scenario:* Jeroen has received the new prototype of the iMediSense system. He explored the new functions in the first week but after that he mostly continued to use the system in the same way as before. One month later, however, he received a message from his HCP notifying him that they considered it was necessary to change to a more strict regime of medications, the indication was accompanied by a 'built-in' suggestion to set a new goal for this in order to support his compliance to the new recommendations (with specifics suggested by the HCP), and so that they could monitor from the hospital how this was going for him (Figure 15). Jeroen agreed and spent the next weeks also tracking and reporting the progress on his medication intake goal.

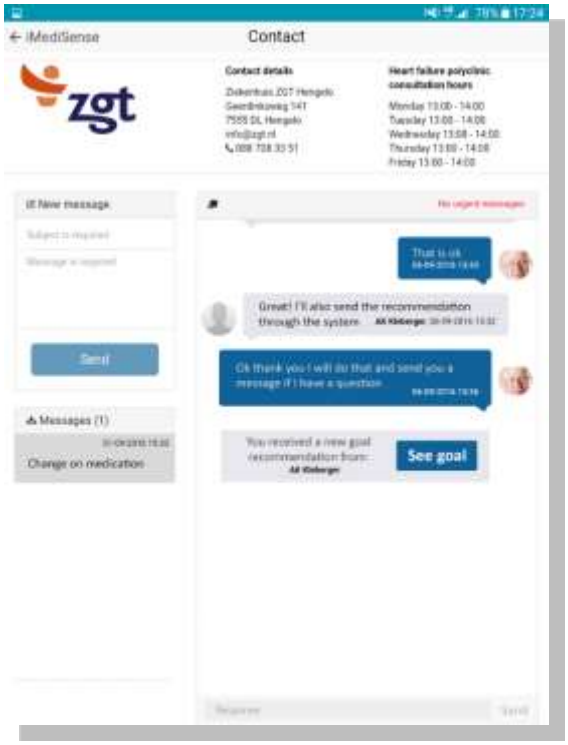


Figure 15. Mock-up of goal recommendation from a HCP via the message function

4. Discussion

In this section the different results of this study are discussed. First and foremost, thirteen articles were successfully identified that described the main theme of technologies that aim to support self-care of CHF patients, this included four functional technologies and one conceptual e-coach. Most articles specifically addressed the development or evaluation of at least one functional technology, the earliest one to do so was from Burns et al. (2010) evaluating the CHF PSMS system, a work originated by that team as part of the 'SMART Consortium' which, as described by Jacelon et al. (2016), "[…] in England has developed several prototype self-managements systems" (p. 1187). Furthermore, the HeartCycle E&C program (Stut et al., 2014, 2015) and the CHF-CePPORT from Canada (Nolan et al., 2014; Payne et al., 2015) are described by works published in a parallel timeframe. The publications describing the HeartCycle E&C program, while having a first author from the Netherlands, actually refer to a multi-site observational study that also covered the United Kingdom, Germany and Spain.

The MyCor telemonitoring programmee (Ammenwerth et al., 2015) from Austria mainly focused on patients hospitalized for acute myocardial infarction and / or percutaneous coronary intervention. Finally, recently the concept for an e-coach, derived from a requirements analysis, was outlined by Nooitgedagt et al. (2017) by taking a persuasive technology perspective.

A first research question of the present study was to identify which constructs of Goal Setting Theory are addressed by the literature. In general it was found that using *feedback (when no goal is provided)* as an external incentive, setting *collaborative or participatory goals*, and in a lesser degree also setting *personal or self-set goals* are the theoretical constructs that describe how goal setting is frequently based. While regarding moderators of goal performance, the literature extensively addresses the provision of *feedback (on progress towards a goal)* and taking into account the *self-efficacy* and the *importance* towards the goals that are set. Of course, the functional technologies that were identified differed on the amount of constructs that were detected in their respective papers. For example, for the MyCor system (Ammenwerth et al., 2015) only setting collaborative or participatory goals together with the provision of feedback on progress towards goals were identified as constructs. On the other hand, the papers describing the HeartCycle E&C program (Stut et al., 2014, 2015) had the highest number of identified constructs from Goal Setting Theory, including some that were not extensively addressed by the rest of the literature such as also considering the *difficulty*, *specificity*, and the *proximity* of goals.

It should be noted that there was a notable inconsistency not only in the reporting methods but also in the scope and underlying principles of each functional technology found in this research. The recommendations for a better specification of interventions by Moller et al. (2017) certainly aims to avoid this situation in contemporary research. For instance, it is striking that with the amount of technologies and papers discussing goal setting, only one of them (Bodenheimer & Handley, 2009) provided a direct reference to Goal Setting Theory. If logic is applied, this would suggest that no added value has been identified for such theory in the eHealth field. However, from the background literature it was already known that this is not the case (Shilts et al., 2013), and when taking a closer look it can be confirmed that it is, in fact, in the methodology, that some of these studies fall short to reference sufficient theoretical basis in their published papers.

The ideal case was the CHF-CePPORT system developed and reported by Nolan et al. (2014) and Payne et al. (2015). This team relies on the CONSORT-EHEALTH checklist (Eysenbach & CONSORT-EHEALTH Group, 2011), which without a doubt proved to be a great utility and should be encouraged for any work surrounding eHealth interventions. For example, the CHF-CePPORT platform had only five constructs of Goal Setting Theory that could be identified from the articles, but this could be due to that, as they report, their intervention is based on and uses motivational interviewing and cognitive-behavioural therapy as theoretical frameworks (Stut et al., 2014), so a link to Goal Setting Theory could be rationalized at that level rather than having to infer their basis from their content.

Beyond the theoretical coverage, the second research question was to describe the extension by which goal setting as a BCT is implemented. Overall, it was found that most extensively goal setting is aimed at specific *behaviours* (e.g., walking) and in a lesser degree at *outcomes of a wanted behaviour* (e.g., losing weight). Furthermore, goal setting is usually focused on *self-care maintenance*, seeking to boost *confidence* of the patient to perform self-care, by using a *teaching approach* and providing a *learning environment*. Similar to the analysis of the constructs, the literature and more specifically the eHealth technologies included had similar ways to implement goal setting. For instance, the HeartCycle E&C program used the information on the progress towards the goal to *personalize* its self-care coaching for the following week, for example by suggesting the user to set a less ambitious goal for the next week (Stut et al., 2014). It was also the only eHealth intervention that described a specification of the role for the HCP in its eCoaching scheme, stating that "only when patients repeatedly fail in adopting self-care behaviours do heart failure nurses intervene to offer help" (Stut et al., 2015, p. 1196). Moreover, the potential focus on goal setting targeting outcomes of wanted behaviours also varied among technologies that addressed it. For example, the CHF-PSMS papers report that some patients lost weight during their intervention or that others explicitly stated goals to do this or also to regain fitness (Bartlett et al., 2014), but the MyCor system was the only functional technology that explicitly operationalized this aim by providing information on its weekly feedback reports about reaching individual goals on blood pressure, weight, or blood glucose (for users with diabetes) (Ammenwerth et al., 2015).

At this point it is also worth discussing again the efforts for standardization of concepts that should be highly encouraged in behavioural science. In this study, the theory characterization of Michie et al. (2014) and the BCTTv1 (Michie et al., 2013, 2014) were a great addition. However, it is recognized by the authors that it is still a work in progress, and there were some instances in this research that point to this. For instance, 'feedback' was widely found and identified in the selected studies, but it could be safely assumed that it was almost unanimously seen as a BCT rather than a moderator or mediator of goal setting success, as it is the case for the precepts of Goal Setting Theory. Therefore, even when it can certainly function or be applied as both, an understanding of how these technologies achieve their desired outcomes couldn't be fully understood yet.

Goal Setting Theory establishes that the provision of feedback is a moderator that can increase goal performance (Michie et al., 2014), while the in the BCTTv1 'feedback' can have by itself different characterizations or focus (e.g., behaviour, outcome, biofeedback) and, therefore, distinct effects on behaviour change. How this dual function works is unknown. Indeed, following this rationale it was clearly observed that the feedback the five technologies provide or claim to provide is also different. For example, the MyCor technology provides feedback on pedometer data by displaying a graph (Ammenwerth et al., 2015), the CHF PSMS delivers a flower animation where petals progressively appear as the activity increases and the goal is attained (Burns et al., 2010), while the HeartCycle E&C intervention gives textual feedback (Stut et al., 2014). Which type of feedback works better was also not part of the analysis of the present research so no conclusions can be provided.

A final and important layer to describe the technological component of the selected studies was the identification of persuasive principles from the PSD model (Oinas-Kukkonen & Harjumaa, 2009), a step which also proved to have its own challenges. The reporting issue was also found here, especially since only one of the technologies explicitly addressed the subject of persuasiveness. This exception was the conceptual e-coach which was itself published in a persuasive technology compendium (Nooitgedagt et al., 2017). In general, some studies included figures or appendices that sufficiently showed the front-end of their systems, at least enough to allow a superficial analysis of its persuasive characteristics.

Therefore, as the analysis of persuasion happened to be superficial, there are also uncertainties in the conclusions that could be drawn from this. For example, surface credibility was identified rather than authority or trustworthiness, but the distinction between the principles for system credibility support could be under debate. Surface credibility by definition uniquely refers to the 'firsthand inspection' by the user (Oinas-Kukkonen & Harjumaa, 2009).

However, in the context of this study, it is clear that telemonitoring technologies should be most likely always linked to a healthcare team somewhere. Therefore, principles like authority, third-party endorsements or trustworthiness are most frequently provided in a telemonitoring-supported intervention through human support, without the need of enforcing this aspect in a technology. That is, deploying telemonitoring technology usually originates from a recommendation by a healthcare institution. A similar case occurs for the real-world feel principle, as from the results it's difficult to picture a telemonitoring and coaching technology that operates completely independent from any healthcare team. While perhaps technically possible, such scenario might be far long into the future as a lack of expert supervision seems to decrease effectiveness. All things considered, the conclusion of the analysis on persuasiveness puts surface credibility as the most important front-end element to engage users in this manner, while the real-world feel serves as the last line, by supporting connectivity from the system to a healthcare provider. Any other type of system credibility support could certainly enhance persuasion, but most likely not with the same effect than the others (e.g., see logos in the mock-up of the educational module, Figure 11).

The third research question was to identify the reported outcomes of the literature regarding the implementation of goal setting. Although it didn't address a specific technology, which is understandable by the time of its publication, it can be noted that the work of Bodenheimer & Handley (2009) proposes and describes several hypotheses about how goal setting can be implemented in healthcare. Their analysis also included an early reference to technological assistance, stating that "using computer technology would assist primary care practices to implement goal setting… thereby reducing time spent by primary care practice clinicians and staff… although finding protected staff time for this activity is not easily accomplished" (p. 179). Their work covers most of the constructs known to the theory at that point in time, so it appears to still be a valuable source of information for future reference.

As a BCT, collaborative goal setting specifically was proposed by Bosworth et al. (2010) as an effective method to promote self-management. Finally, the effectiveness of goal setting embedded in eHealth that was reported in the literature was part of the description of the goal setting module. To recall and summarize, goal setting was found to be useful, motivational and generally supported by CHF patients who were stable, knowledgeable and active (Bartlett et al., 2014). It was also found that from 72% to 89% of goals set for physical activity were achieved by users following a goal-based coaching program (Ammenwerth et al., 2015). Moreover, around 80% of patients who started another goal setting program for physical activity and low-salt diet were able to reach their personal goals for at least two consecutive weeks, and most of them continued to use this feature afterwards (Stut et al., 2014).

The following research question was to identify and describe how the iMediSense technology could improve its feedback and coaching to support through an implementation of a goal setting module. For this matter, the results of the descriptive log data analysis proved to be sufficiently explanatory and confirmed most of the expectations that derived from what was observed during the pilot. Users of the iMediSense technology, while generally embracing the system and valuating it as useful, displayed different levels of overall use and usage of its features. For instance, it was seen in all cases that when used only for its main self-monitoring feature, a session in iMediSense could last on average around three minutes, but its architecture still allowed users to make a more extensive use of its features. As an example, the second case displayed a notably higher interaction of the history function, while the third case exceeded the amount of measurements per day that were expected, together with a notable total time of use of the system (more than twelve hours). These behaviours were discussed during the stakeholder consultation as they could reflect potential individual needs that the system could address. Of course, as with any other method, the analysis of log data also shed light upon new questions. For instance, the motivation behind the third case's high self-monitoring behaviour can be up to a certain level explained by reviewing the pilot interview, but no in-depth specific enquiry about this was performed. More importantly, it is certainly unknown the exact amount of users that could be expected to display a similar use in a large scale implementation. Hence, questions like this one could be answered with additional user-centered approaches (e.g., interviews) in order to fully understand and identify the full range of potential paths and needs that a solution like iMediSense could fulfill or support.

To further discuss log data, it can be noted that some of the selected studies also included analyses of log files from their systems, namely the MyCor telemonitoring programme (Ammenwerth et al., 2015) and the HeartCycle E&C intervention (Stut et al., 2014, 2015). For instance, Stut et al. in both of their studies describe the usage of their coaching module via this method, focused on the time and responses to the components of their system's coaching features. This was quite explanatory of the effectiveness of their program, with an architecture that also relies on tunneling the self-management support. Basically, out of the 123 participants, 50 completed an assessment based on the importance and confidence of self-care behaviours, 35 started the coaching program and 28 became adherent (defined as two weeks achieving a user-set self-care goal) (Stut et al., 2014). Such flowchart of information and the rest of their results notably serve as an example of the usefulness and potential for behaviour change of a coaching module supported by telemonitoring. Their work certainly adds value for the advancement of eHealth coaching and was considered an important base of knowledge for the module proposed by the present research. Moreover, the assessment performed by the HeartCycle E&C program is applied by submitting the European Heart Failure Self-care Behavior Scale (Jaarsma, Arestedt, Martensson, Dracup, & Stromberg, 2009) to the participants, a validated tool which could also be used for evaluating the potential changes in self-care achieved through the iMediSense system. Ammenwerth et al. (2015), in a similar manner, employed log data analysis to evaluate the effectiveness of their coaching module by measuring the performance of physical activity tracked via pedometers that communicated automatically to other devices within the architecture of their system. By testing its features against cases like this, the iMediSense system could not only validate its added value but also significantly advance the knowledge on several fields of science, including of course, addressing the existing gap between feedback and coaching (Patel et al., 2015).

Besides the question regarding the provision of feedback which was previously discussed. There are other pieces of evidence that can't be conclusively apprehended. One case is the only 'negative reported outcome' that could be identified regarding goal setting. This one refers to a situation described by Suter, Suter, and Johnston (2011). It refers to a 'trend' that was observed after the deployment of a telehealth service in a hospital. Suter et al. found that some patients desired to retain the monitor in the home when it was time for them to be discharged.

They interpreted this as a 'dependency' on the device, which goes against the objective to promote self-management development in the patient and to increase their confidence to perform it. Following the discovery, they accounted for this by making sure they addressed expectations when deploying their system at the patients' homes, communicating that there would be a 'graduation day' for the technology, that is, it was to be a mean not an end by itself. Beyond the generalization of this claim and its relevance for goal setting and not just self-management in general, it is certainly a topic that could be discussed. For instance, when talking about telemonitoring it is by essence a technology that is meant to be consistently used, or at least when the management of the disease demands it. However, at what moment or if it's even necessary to establish an 'end' or 'time-off" from coaching could be a remarkable question for future work.

For the previous situation it would perhaps be the sensemaking concept (Weick, 1990) and the derived model for chronic diseases developed by Mamykina et al. (2015) that could explain this interaction. For instance, it is the end of this model to explain how meaning is extracted from information (feedback) that consequently derives into actions. Hence, if we discuss a potential 'dependency' situation we could discuss that it must be important for technologies that these actions are not just effectively prompted but that they also promote the perception that they are a result of the individual's capacity and not attributed entirely to the assistance of the technology. The sensemaking process described by Mamykina et al. is by its core cyclical, therefore if an action is successful but attributed to the technology rather than one's own efforts it would feed the idea that the self-management development is occurring because of the latter. Considering this possibility and all of the previous results, the recommendations of improvement for the feedback and coaching support of the iMediSense technology were inserted in the goal setting module that was proposed, which is discussed next.

Indeed, this leads to the final research question, which was to identify the functional requirements of a 'smallest, meaningful, self-contained, repurposable and interoperable' goal setting module that can be incorporated in a coaching feature in the iMediSense technology. Rather than describing it in terms of functional requirements, it was decided to deliver the final proposal by a theoretical, evidence-based and persuasion-focused concept, as this type of content was valued higher for the present development stage of iMediSense. Hence, a process of great significance and value to answer such question was the stakeholder consultation.

It certainly fulfilled to accomplish its goal, which was to gather different perspectives on the results and to enhance their understanding and applicability (to what extent, time will tell) (Arksey & O'Malley, 2005; Levac et al., 2010). It is truly an area for improvement that it was not possible to perform a consultation round with specialized heart failure nurse practitioners or with a higher amount of stakeholders for that matter. Nevertheless, every bit of information extracted during this stage provided at the very least validation to put together all pieces of the puzzle. For this study, stakeholders were contacted via e-mail by the lead researcher, and their willingness to participate was notable, it was mostly a matter of timing and work schedules, but the strength of the 'Twente TEACH' consortium in its multidisciplinary approach should be recognized. Altogether, the results of the thematic analysis show that goal setting is a viable strategy to offer coaching support, and that its implementation can also be of added value for the collaboration between the HCPs and CHF patients, which is vital for the general management of the disease.

A goal setting module was described and proposed by this study. According to the agile science process, a module as a contender construct doesn't necessarily require to be evidence-based (Hekler, Klasnja, et al., 2016). This is actually still the case for the proposed module since, as also pointed by the developers, the concept still demands at least a minimal phase of testing to prove it's added value and effectiveness. The fact that it was developed based on existing evidence increases the chance that it will show satisfactory results in real world implementation, but it doesn't guarantee it. By complying with the agile architecture, the module also singles out from more 'robust' coaching interventions, such as the ones that are delivered in the described technologies. For instance, the outcome of the module, matching the current state of the technology, is to increase self-care confidence rather than assessing and evaluating the actual performance of the behaviours. As was previously hinted, the HeartCycle E&C intervention already performs a similar and even extended assessment that includes addressing the importance of behaviours for the user. In another case, the CHF-CePPORT (Nolan et al., 2014; Payne et al., 2015) performs a validation of the 'stages of readiness' for behaviour change (Marcus, Rakowski, & Rossi, 1992), a whole different parameter to start coaching which is also worth considering. Therefore, the coaching provided by the current systems could be seen as more complex than the one proposed here, but in the full scheme of development this is just but a first step in the inclusion of full coaching functionalities for the iMediSense system, and such effort especially strives to maintain the high level of persuasion that the technology showed in its pilot phase.

Finally, the task of providing substance to the results via personas was also an added value of the study. Log files are traces of human behaviour (Dumais, Jeffries, Russell, Tang, & Teevan, 2014) and in this study these served as the basis to develop and describe representative cases to promote a better understanding of the goal setting module and its potential application. However, it should be considered that the three personas provided here are obviously not final representations of all possible scenarios in a real world implementation. Achieving this would certainly require a larger approach that collects data on a representative sample of the target population. Coping with the challenge of developing personas, arbitrary decisions had to be made when feeding in the data to create each of them, inconsistencies should be valued in conscience of the still lacking data and insights for the aforementioned target population in general research. To put it simply, the present version of the personas could better describe users of iMediSense (according to what was observed so far) rather than CHF patients in general. All things considered, as with most elements of this study, they could be subject of further development and validation, or invalidation, if that was to be the case.

4.1. Limitations

By applying multiple methods, naturally there are several limitations to consider for this research, some of them have already been introduced. One which was previously described in the methodology refers to the multiple coding stages performed during the study. Also identified by Fereday & Muir-Cochrane (2006) in their paper, it originates mainly due to the nature of this work, which was that most of the coding process was conducted by a single researcher, only with direct assistance of a second coder for a test of the codebook (for goal setting related components, not persuasive principles or thematic analysis). This assistance was marked by convenience, meaning that the codebook tester was another master student of the 'Health Psychology and Technology' programme working on a different assignment, which also involved goal setting but had a different focus and technological component.

Therefore, a few decisions based on this situation could've influenced the results. For example, the consistency in the knowledge of the background literature, which was predominantly intended to guide coding, might have not been the ideal. Moreover, only one phase of coding adjustment was performed and due to time constraints no additional reliability measure was taken.

In consequence, it is assumed that a bigger number of researchers applying several iterative phases to adjust the codes, and employing inter-rater reliability measures such as Cohen's Kappa or other statistics (Gwet, 2014) could've delivered a more reliable set of results.

The task of identifying and describing goal setting as an active component of interventions was a strenuous and highly iterative task. Perhaps the most notorious example of this was the fact that mechanisms of change from Goal Setting Theory were barely identifiable, this recalls again what Moller et al. (2017) found to be one of several problems in the specification of BCTs. Therefore, the mapping of constructs consisted of what was possible to identify rather than what might have been there. This means that, for example, the fact that theory-driven mechanisms couldn't be pinpointed doesn't necessarily mean that the described technologies don't rely on these to accomplish their aim and explain their effectiveness.

Concerning the analysis of the log file, Microsoft Excel, while not specifically designed for this purpose, was useful for exploring and analyzing the data. The methodology implemented took advantage of the software features. However, it is clear that the use of more advanced tools, accompanied by the provision of training to use them, especially in the case of behavioural scientists, could be important in the efforts to promote and enhance multidisciplinary collaboration and more efficient research and development of eHealth. Machine learning, Markov modelling, and Market-basket analysis are some of the high-end possibilities in the future potential of log data analysis (Sieverink et al., 2017).

Regarding the development of personas, their validity should also be tested if it is to be applied as a basis for further research. Creating personas is certainly a time consuming task, but by its thoughtful and effective creation its reward can be a high degree of user satisfaction (LeRouge et al., 2013). The guidelines by LeRouge et al. were the main basis for the methodology of this study, but other models can be considered. such as the one employed by Vosbergen et al. (2015), an analysis of online survey and a pilot validation of such findings. All in all, there appear to be several paths to accomplish the same end, but the method employed by this study also was still restricted by the small sample of participants that have experienced iMediSense, even though the data analyzed so far has been extensive and insightful. Finally, as a consequence of the previous point, this study still doesn't consider data from CHF patients that show no adherence to the system, and / or with an unstable CHF condition (NYHA Class III +).

Additionally, the pool of pilot participants also shows adequate levels of eHealth literacy, which could naturally be influencing the reach of the analyses. Therefore, it is possible that different goal setting moderators could be more important for patients with different characteristics, or that different principles of persuasion are required to motivate certain user groups to continue making use of the system.

4.2. Future Work

Some suggestions for future research were already provided in the previous sections, in the following paragraphs some of them are more thoughtfully described, and new ones are provided. Although the number of selected studies was small, thus facilitating iterative reviews by the lead researcher, the recommendation for future work is that multiple researchers are involved in the coding process, this to increase consistency with the research question and purpose of a study, consequently increasing the reliability of the results (Levac et al., 2010). This would be rather important especially when multiple levels of coding are applied to the data, as it was the case for the present work, and careful thought should be considered into which measure of inter-rater reliability must be used (Gwet, 2014). Furthermore, future research that concerns behaviour change science should follow the recommendations set by new approaches that endorse a better specification of behaviour change elements (Moller et al., 2017). The agile science process (Hekler, Klasnja, et al., 2016), the BCTTv1 (Michie et al., 2014) and the CeHRes Roadmap (Van Gemert-Pijnen et al., 2013) all vouch for a better specification of elements and a highly iterative performance of user-centered tasks applied through several phases of development and permanent analysis. By collectively generating knowledge, the field will advance faster and in a more efficient manner. Regarding the specific topic of this research, this idea is accurately summarized by Jacelon, Gibbs and Ridgway (2016): “As the science of self-management advances, the technology is likely to move towards redefining the process of self-management, creating new strategies that have been previously unimagined” (p. 1189).

Moving on to the discussion on persuasiveness, focused research should be conducted to widely and deeply identify specifications to incorporate persuasive principles into technology, as it is also something that could be implemented by different means.

For instance, the Behaviour Change Wheel (Michie et al., 2014; Michie, van Stralen, & West, 2011) is a model that could inform this process, and the team is already publishing guidelines focused on the development of digital interventions (West and Mitchie, 2016).

An example of the questions to be solved by future work is the principle of 'praise'. Despite being valued as supported by the evidence, no specification was given for its implementation. Praise could occur via text, as it was portrayed in the mock-up (Figure 13), but it could also be done with an illustration (e.g., thumbs up) or many other ways. Here also lies a dilemma, as a technology like iMediSense is meant to avoid time consuming activities for the HCPs but at the same time their role is also important to keep the patients motivated. Indeed, there is even evidence that eHealth web-based interventions with blended-in human support can be effective when targeting cardiovascular risk factors in middle-aged and elderly populations (Beishuizen et al., 2016). How exactly this specific combination of human and automated support must be done for coaching in chronic diseases was beyond the scope of this study, but it can definitely be addressed in following stages of development and research.

As it was mentioned in the previous sections, a continuous and improved development of personas should be promoted. Mainly there seems to be a lack of research on this matter regarding CHF populations, but such improvement could inform and assist an effective development of a technology in terms of usability. To support this effort, recent papers by leading research teams that appeared often in the scoping review should also be considered, for example Riegel et al. (2017) have helped to clarify the mechanisms by which motivational interviewing (also a term related to coaching) facilitates behaviour change, they even outline in their results a set of techniques that "stimulated openness to goal setting, positive self-talk, perceived ability to overcome barriers, and change talk" (p. 283). Likewise, Jaarsma et al. (2017), have developed into the Middle-Range Theory of Self-Care Chronic Illness to identify factors that can make self-care interventions successful.

Another important task of especial relevance for a next phase is to involve the specialized heart failure nurse practitioners. An immediate and suggested approach could be through usability tests or consultation rounds that evaluate the feasibility and usefulness of the goal setting module proposed by this study. This would fit the prototype testing step also included in the generate phase of the agile science process (Hekler, Klasnja, et al., 2016).

A lo-fi prototype based on the mock-ups presented in this paper could be a sufficiently adequate starting point for evaluation. Finally, future work should also focus on the general questions that this work didn't directly tackle. For instance, sensemaking remains a challenge that the iMediSense system, and other technologies, will have to cope with. As seen in the pilot and supported by the literature, patients that can't provide meaning into their own data face uncertainty (Mamykina et al., 2015). If usability tests are to be performed in subsequent stages of development, they should be informed by a sensemaking model, thus adding also a valuable theoretical basis to it.

4.3. Conclusion

To sum up, this research has served as an extension of the 'Twente TEACH'-pilot, focused on the improvement of the feedback and coaching support of the iMediSense technology. There are also other projects being carried out, such as in the improvement of the alarm system which is embedded in the technology. One of the most important findings of this research is that a goal setting module could be effective to improve the behavioural support through coaching of self-care, although further testing is recommended. Furthermore, according to the existing evidence and considering the contextual needs of the iMediSense technology, goal-based coaching support should be focused on self-care maintenance (reducing risk factors, improving health, adhering to recommendations).

Additionally, aiming to improve the patient's self-confidence through the provision of feedback on progress towards the goals seems to be the most effective path to achieve behaviour change. Moreover, for the design of a coaching module persuasive principles that should be considered are reduction, tunneling, tailoring, praise, real-world feel and surface credibility. On top of this, in this research three representative personas were profiled according to what is known about how users interact with the iMediSense technology. It was found that, beyond fulfilling its main goal, the iMediSense technology also allows for different paths of usage, and that this could mean that through further research and improvement it could also effectively fulfill the needs of different types of users. By and large, a mixed methods approach was useful and effective in providing meaning and focus to multidisciplinary themes of high complexity, as it is the general case of eHealth technologies aimed for chronic diseases.

This approach was guided by the CeHRes Roadmap, the Agile Science Process and supported by standardization tools like the BCTTv1, the implementation of all of these is highly encouraged. Finally, the agile science process was the core essence that inspired this research, and it has proved to be an effective framework which should be expanded and operationalized. However, it is important that its processes are also standardized, and then time will tell if its added value for knowledge accumulation and curation is certified by a more efficient advancement in science, which without a doubt, is needed.

5. References

Ammenwerth, E., Woess, S., Baumgartner, C., Fetz, B., Van Der Heidt, A., Kastner, P., … Poelzl, G. (2015). Evaluation of an integrated telemonitoring surveillance system in patients with oronary heart disease. *Methods of Information in Medicine, 54*(5), 388–397. http://doi.org/10.3414/ME15-02-0002

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19–32. http://doi.org/10.1080/1364557032000119616

Bartlett, Y. K., Haywood, A., Bentley, C. L., Parker, J., Hawley, M. S., Mountain, G. A., & Mawson, S. (2014). The SMART personalised self-management system for congestive heart failure: results of a realist evaluation. *BMC Medical Informatics and Decision Making, 14*(1), 109. http://doi.org/10.1186/s12911-014-0109-3

Beishuizen, C. R. L., Stephan, B. C. M., Van Gool, W. A., Brayne, C., Peters, R. J. G., Andrieu, S., … Richard, E. (2016). Web-based interventions targeting cardiovascular risk factors in middle-aged and older people: A systematic review and meta-analysis. *Journal of Medical Internet Research, 18*(3). http://doi.org/10.2196/jmir.5218

Beun, R. J., Brinkman, W.-P., Fitrianie, S., Griffioen-Both, F., Horsch, C., Lancee, J., & Spruit, S. (2016). Improving Adherence in Automated e-Coaching. In A. Meschtscherjakov, B. De Ruyter, V. Fuchsberger, M. Murer, & M. Tscheligi (Eds.), *Persuasive Technology: 11th International Conference, PERSUASIVE 2016, Salzburg, Austria, April 5-7, 2016, Proceedings* (pp. 276–287). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-31510-2_24

Bodenheimer, T., & Handley, M. A. (2009). Goal-setting for behavior change in primary care: An exploration and status report. *Patient Education and Counseling, 76*(2), 174–180. http://doi.org/10.1016/j.pec.2009.06.001

Bosworth, H. B., Powers, B. J., & Oddone, E. Z. (2010). Patient Self-Management Support: Novel Strategies in Hypertension and Heart Disease. *Cardiology Clinics*. http://doi.org/10.1016/j.ccl.2010.07.003

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. http://doi.org/10.1191/1478088706qp063oa

Burns, W. P., Davies, R. J., Nugent, C. D., McCullagh, P. J., Zheng, H., Black, N. D., &

Mountain, G. A. (2010). A Personalised Self-Management system for Chronic Heart Failure. *Computing in Cardiology*, *37*, 1075–1078.

Cox, E., Bachkirova, T., & Clutterbuck, D. (2014). *The complete handbook of coaching*. Sage, 2014.

Davies, R., Galway, L., Nugent, C., Jamison, C., Gawley, R., McCullagh, P., … Black, N. (2011). A Platform for Self-Management Supported by Assistive, Rehabilitation and Telecare Technologies. *Proceedings of the 5th International ICST Conference on Pervasive Computing Technologies for Healthcare*, 458–460. http://doi.org/10.4108/icst.pervasivehealth.2011.245964

Day, D. V., & Unsworth, K. L. (2013). Goals and self-regulation: Emerging perspectives across levels and time. *New Developments in Goal Setting and Task Performance*. http://doi.org/10.4324/9780203082744

Dumais, S., Jeffries, R., Russell, D. M., Tang, D., & Teevan, J. (2014). Understanding User Behavior Through Log Data and Analysis. In J. S. Olson & W. A. Kellogg (Eds.), *Ways of Knowing in HCI* (pp. 349–372). New York, NY: Springer New York. http://doi.org/10.1007/978-1-4939-0378-8_14

Eysenbach, G., & CONSORT-EHEALTH Group. (2011). CONSORT-EHEALTH: improving and standardizing evaluation reports of Web-based and mobile health interventions. *Journal of Medical Internet Research*, *13*(4). http://doi.org/10.2196/jmir.1923

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, *5*(1), 80–92. http://doi.org/10.1063/1.2011295

Gwet, K. L. (2014). Agreement coefficients for nominal ratings: A review. *Handbook of Inter-Rater Reliability (4 Ed)*, 27–70.

Hekler, E. B., Klasnja, P., Riley, W. T., Buman, M. P., Huberty, J., Rivera, D. E., & Martin, C. A. (2016). Agile science: creating useful products for behavior change in the real world. *Translational Behavioral Medicine*, *6*(2), 317–328. http://doi.org/10.1007/s13142-016-0395-7

Hekler, E. B., Michie, S., Pavel, M., Rivera, D. E., Collins, L. M., Jimison, H. B., … Spruijt-Metz, D. (2016). Advancing Models and Theories for Digital Behavior Change Interventions. *American Journal of Preventive Medicine*, *51*(5), 825–832.

http://doi.org/10.1016/j.amepre.2016.06.013

Howlett, J. G., Chan, M., Ezekowitz, J. A., Harkness, K., Heckman, G. A., Kouz, S., … Zieroth, S. (2016). The Canadian Cardiovascular Society Heart Failure Companion: Bridging Guidelines to Your Practice. *Canadian Journal of Cardiology*, *32*(3), 296–310. http://doi.org/10.1016/j.cjca.2015.06.019

Huffman, M. (2007). Health coaching: a new and exciting technique to enhance patient self-management and improve outcomes. *Home Healthcare Nurse*, *25*(4), 271–276. http://doi.org/10.1097/01.NHH.0000267287.84952.8f

Jaarsma, T., Arestedt, K. F., Martensson, J., Dracup, K., & Stromberg, A. (2009). The European Heart Failure Self-care Behaviour scale revised into a nine-item scale (EHFScB-9): A reliable and valid international instrument. *European Journal of Heart Failure*, *11*(1), 99–105. http://doi.org/10.1093/eurjhf/hfn007

Jaarsma, T., Cameron, J., Riegel, B., & Stromberg, A. (2017). Factors Related to Self-Care in Heart Failure Patients According to the Middle-Range Theory of Self-Care of Chronic Illness: a Literature Update. *Current Heart Failure Reports*, *14*(2), 71–77. http://doi.org/10.1007/s11897-017-0324-1

Jacelon, C. S., Gibbs, M. A., & Ridgway, J. V. E. (2016). Computer technology for self-management: a scoping review. *JOURNAL OF CLINICAL NURSING*, *25*(9–10), 1179–1192. http://doi.org/10.1111/jocn.13221

Karhula, T., Vuorinen, A.-L., Raapysjarvi, K., Pakanen, M., Itkonen, P., Tepponen, M., … Saranummi, N. (2015). Telemonitoring and Mobile Phone-Based Health Coaching Among Finnish Diabetic and Heart Disease Patients: Randomized Controlled Trial. *Journal of Medical Internet Research*, *17*(6), e153. http://doi.org/10.2196/jmir.4059

Kelders, S. M., Kok, R. N., Ossebaard, H. C., & Van Gemert-Pijnen, J. E. W. C. (2012). Persuasive system design does matter: A systematic review of adherence to web-based interventions. *Journal of Medical Internet Research*, *14*(6), 152–1521. http://doi.org/10.2196/jmir.2104

Kessing, D., Denollet, J., Widdershoven, J., & Kupper, N. (2016). Psychological Determinants of Heart Failure Self-Care: Systematic Review and Meta-Analysis. *Psychosomatic Medicine*, *78*(4), 412–431. http://doi.org/10.1097/PSY.0000000000000270

Kreiner, K., & Welte, S. (2015). A Personalized Feedback System for Supporting Behavior

Change for Patients After an Acute Myocardial Infarction. ... *Meets EHealth: ...*, 50–56. http://doi.org/10.3233/978-1-61499-524-1-50

Larsen, K. R., Michie, S., Hekler, E. B., Gibson, B., Spruijt-Metz, D., Ahern, D., … Yi, J. (2016). Behavior change interventions: the potential of ontologies for advancing science and practice. *Journal of Behavioral Medicine*, *40*(1), 1–17. http://doi.org/10.1007/s10865-016-9768-0

Lentferink, A. J., Oldenhuis, H. K., de Groot, M., Polstra, L., Velthuijsen, H., & van Gemert-Pijnen, J. E. (2017). Key Components in eHealth Interventions Combining Self-Tracking and Persuasive eCoaching to Promote a Healthier Lifestyle: A Scoping Review. *Journal of Medical Internet Research*, *19*(8), e277. http://doi.org/10.2196/jmir.7288

LeRouge, C., Ma, J., Sneha, S., & Tolle, K. (2013). User profiles and personas in the design and development of consumer health technologies. *International Journal of Medical Informatics*, *82*(11). http://doi.org/10.1016/j.ijmedinf.2011.03.006

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: advancing the methodology. *Implementation Science : IS*, *5*, 69. http://doi.org/10.1186/1748-5908-5-69

Locke, E. A., & Latham, G. P. (2013). *New developments in goal setting and task performance*. Routledge.

Lorencatto, F., West, R., Bruguera, C., Brose, L. S., & Michie, S. (2016). Assessing the Quality of Goal Setting in Behavioural Support for Smoking Cessation and its Association with Outcomes. *Annals of Behavioral Medicine*, *50*(2), 310–318. http://doi.org/10.1007/s12160-015-9755-7

Mamykina, L., Smaldone, A. M., & Bakken, S. R. (2015). Adopting the sensemaking perspective for chronic disease self-management. *Journal of Biomedical Informatics*, *56*, 406–417. http://doi.org/10.1016/j.jbi.2015.06.006

Marcus, B. H., Rakowski, W., & Rossi, J. S. (1992). Assessing motivational readiness and decision making for exercise. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *11*(4), 257–261. http://doi.org/10.1037/0278-6133.11.4.257

Michie, S., Atkins, L., & West, R. (2014). *The behaviour change wheel : a guide to designing interventions. (1st ed.). Silverback Publishing: Sutton, Surrey, UK. (2014).*

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., … Wood, C.

E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*(1), 81–95. http://doi.org/10.1007/s12160-013-9486-6

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science: IS*, *6*, 42. http://doi.org/10.1186/1748-5908-6-42

Michie, S., West, R., Campbell, R., Brown, J., & Gainforth, H. (2014). *ABC of Behaviour Change Theories*. *(1st ed.). Silverback Publishing: Sutton, Surrey, UK. (2014)*. Silverback Publishing.

Michie, S., Wood, C. E., Johnston, M., Abraham, C., Francis, J. J., & Hardeman, W. (2015). Behaviour change techniques: The development and evaluation of a taxonomic method for reporting and describing behaviour change interventions (a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative da. *Health Technology Assessment*, *19*(99), 1–187. http://doi.org/10.3310/hta19990

Miyamoto, S. W., Henderson, S., Young, H. M., Pande, A., & Han, J. J. (2016). Tracking Health Data Is Not Enough: A Qualitative Exploration of the Role of Healthcare Partnerships and mHealth Technology to Promote Physical Activity and to Sustain Behavior Change. *JMIR mHealth and uHealth*, *4*(1), e5. http://doi.org/10.2196/mhealth.4814

Moller, A. C., Merchant, G., Conroy, D. E., West, R., Hekler, E., Kugler, K. C., & Michie, S. (2017). Applying and advancing behavior change theories and techniques in the context of a digital health revolution: proposals for more effectively realizing untapped potential. *Journal of Behavioral Medicine*, *40*(1), 85–98. http://doi.org/10.1007/s10865-016-9818-7

Morgan, D. L. (1996). *Focus Groups as Qualitative Research*. *Focus Groups as Qualitative Research* (Vol. 16). Sage publications. http://doi.org/10.4135/9781412984287

Nolan, R. P., Payne, A. Y. M., Ross, H., White, M., D'Antono, B., Chan, S., … Zbib, A. (2014). An internet-based counseling intervention with email reminders that promotes self-care in adults with chronic heart failure: Randomized controlled trial protocol. *Journal of Medical Internet Research*, *16*(1). http://doi.org/10.2196/resprot.2957

Nooitgedagt, A., Beun, R. J., & Dignum, F. (2017). e-Coaching for Intensive Cardiac Rehabilitation A Requirement Analysis. http://doi.org/10.1007/978-3-319-55134-0_3

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Key Issues , Process Model , and System Features Persuasive Systems Design : Key Issues , Process Model , and System Features. *Communications of the Association for Information Systems*, *24*(28), 485–500.

Olsen, J. M. (2014). Health Coaching: A Concept Analysis. *Nursing Forum*, *49*(1), 18–29. http://doi.org/10.1111/nuf.12042

Palmer, S., Tubbs, I., & Whybrow, a. (2003). Health coaching to facilitate the promotion of healthy behaviour and achievement of health-related goals . *International Journal of Health Promotion & Education*, *41*(July 2015), 91–93. http://doi.org/10.1080/14635240.2003.10806231

Patel, M. S., Asch, D. a, & Volpp, K. G. (2015). Wearable Devices as Facilitators , Not Drivers , of Health Behavior Change. *JAMA : The Journal of the American Medical Association*, *313*(5), 459–460. http://doi.org/10.1001/jama.2014.14781.Conflict

Patrick, K., Hekler, E. B., Estrin, D., Mohr, D. C., Riper, H., Crane, D., … Riley, W. T. (2016). The Pace of Technologic Change: Implications for Digital Health Behavior Intervention Research. *American Journal of Preventive Medicine*, *51*(5), 816–824. http://doi.org/10.1016/j.amepre.2016.05.001

Payne, A. Y., Surikova, J., Liu, S., Ross, H., Mechetiuc, T., & Nolan, R. P. (2015). Usability Testing of an Internet-Based e-Counseling Platform for Adults With Chronic Heart Failure. *JMIR Hum Factors*, *2*(1), e7. http://doi.org/10.2196/humanfactors.4125

Riegel, B., Dickson, V. V., Garcia, L. E., Masterson Creber, R., & Streur, M. (2017). Mechanisms of change in self-care in adults with heart failure receiving a tailored, motivational interviewing intervention. *Patient Education and Counseling*, *100*(2), 283–288. http://doi.org/10.1016/j.pec.2016.08.030

Riegel, B., Jaarsma, T., & Stromberg, A. (2012). A middle-range theory of self-care of chronic illness. *ANS. Advances in Nursing Science*, *35*(3), 194–204. http://doi.org/10.1097/ANS.0b013e318261b1ba

Riegel, B., Moser, D. K., Anker, S. D., Appel, L. J., Dunbar, S. B., Grady, K. L., … Whellan, D. J. (2009). State of the science: Promoting self-care in persons with heart failure: A scientific statement from the american heart association. *Circulation*, *120*(12), 1141–1163. http://doi.org/10.1161/CIRCULATIONAHA.109.192628

Riley, W. T., Martin, C. A., Rivera, D. E., Hekler, E. B., Adams, M. A., Buman, M. P., … King,

A. C. (2016). Development of a dynamic computational model of social cognitive theory. *Translational Behavioral Medicine*, *6*(4), 483–495. http://doi.org/10.1007/s13142-015-0356-6

Shilts, M., Townsend, M., & Dishman, R. K. (2013). 26 Using Goal Setting to Promote Health Behavior Change. *New Developments in Goal Setting and Task …*, 415.

Sieverink, F., Kelders, S., Akkersdijk, S., Poel, M., Siemons, L., & Van Gemert-Pijnen, L. (2017). A protocol for the collection, analysis, and interpretation of log data from eHealth technology. *JMIR Research Protocols*.

Stut, W., Deighan, C., Armitage, W., Clark, M., Cleland, J. G., & Jaarsma, T. (2014). Design and Usage of the HeartCycle Education and Coaching Program for Patients With Heart Failure. *JMIR Research Protocols*, *3*(4), e72. http://doi.org/10.2196/resprot.3411

Stut, W., Deighan, C., Cleland, J. G., & Jaarsma, T. (2015). Adherence to self-care in patients with heart failure in the heartcycle study. *Patient Preference and Adherence*, (9), 1195–1206. http://doi.org/10.2147/PPA.S88482

Suter, P., Suter, W. N., & Johnston, D. (2011). Theory-based telehealth and patient empowerment. *Population Health Management*, *14*(2), 87–92. http://doi.org/10.1089/pop.2010.0013

Tierney, S., Mamas, M., Woods, S., Rutter, M. K., Gibson, M., Neyses, L., & Deaton, C. (2012). What strategies are effective for exercise adherence in heart failure? A systematic review of controlled studies. *Heart Failure Reviews*, *17*(1), 107–115. http://doi.org/10.1007/s10741-011-9252-4

Van Gemert-Pijnen, J. (2013). The CeHRes Roadmap. *Van Gemert-Pijnen, JEWC, Peters, O. & Ossebaard, HC (2013). Improving eHealth, p33-48. ISBN: 978-94-6236-067, 9*.

Van Gemert-Pijnen, J. E. W. C., Nijland, N., van Limburg, M., Ossebaard, H. C., Kelders, S. M., Eysenbach, G., & Seydel, E. R. (2011). A holistic framework to improve the uptake and impact of eHealth technologies. *Journal of Medical Internet Research*, *13*(4). http://doi.org/10.2196/jmir.1672

Van Gemert-Pijnen, J. E. W. C., Peters, O., & Ossebaard, H. C. (2013). *Improving eHealth*. Eleven international publishing Den Haag, The Netherlands.

Van Velsen, L., Wentzel, J., & Van Gemert-Pijnen, J. E. W. C. (2013). Designing ehealth that matters via a multidisciplinary requirements development approach. *Journal of Medical*

Internet Research, *15*(6). http://doi.org/10.2196/resprot.2547

Van Wissen, A., Vinkers, C., & van Halteren, A. (2016). Developing a Virtual Coach for Chronic Patients: A User Study on the Impact of Similarity, Familiarity and Realism. In A. Meschtscherjakov, B. De Ruyter, V. Fuchsberger, M. Murer, & M. Tscheligi (Eds.), *Persuasive Technology: 11th International Conference, PERSUASIVE 2016, Salzburg, Austria, April 5-7, 2016, Proceedings* (pp. 263–275). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-31510-2_23

Van Woezik, A. F., Braakman-Jansen, L. M., Kulyk, O., Siemons, L., & van Gemert-Pijnen, J. E. (2016). Tackling wicked problems in infection prevention and control: a guideline for co-creation with stakeholders. *Antimicrobial Resistance and Infection Control*, *5*(1), 20–016–0119–2. eCollection 2016. http://doi.org/10.1186/s13756-016-0119-2 [doi]

Vosbergen, S., Mulder-Wiggers, J. M. R., Lacroix, J. P., Kemps, H. M. C., Kraaijenhagen, R. A., Jaspers, M. W. M., & Peek, N. (2015). Using personas to tailor educational messages to the preferences of coronary heart disease patients. *Journal of Biomedical Informatics*, *53*, 100–112. http://doi.org/10.1016/j.jbi.2014.09.004

Weick, K. E. (1990). Technology as Equivoque: Sense Making in New Technologies. *Technology and Organizations*, 1–44.

West R and Mitchie S. (2016). *A Guide to Development and Evaluation of Digital Behaviour Change Interventions in Healthcare*. Silverback Publishing.

6. Appendices

6.1. Search Terms in Full and Search Strategy

Set	*Terms considered*	*Search string*
1	goal setting / goal setting theory / Edwin Locke	(("goal setting" OR "Locke, E") OR ((goal*) N5 (bct OR set OR suggest* OR recommend* OR strateg* OR component* OR technique* OR element* OR ingredient* OR procedure* OR function* OR feature* OR mechanism*)))
2	heart failure / heart decompensation / heart insufficiency / heart incompetence / cardiac failure / myocardial failure / congestive heart failure / backward failure / cardiac decompensation / cardiac incompetence / cardiac insufficiency / cardiac standstill / cardial decompensation / cardial insufficiency / decompensatio cordis / insufficientia cordis	(("decompensatio cordis" OR "insufficientia cordis") OR ((heart OR cardia* OR myocardia* OR backward) W2 (failure OR disease OR disorder OR decompensation OR insufficiency OR incompetence OR standstill)))
3	self-management / self-care / self-treatment / self-regulation / coaching / health coaching / mentoring / counseling / e-coaching / persuasive coaching / virtual coaching	((coach* OR mento* OR counsel* OR "e-coaching") OR ((self) W2 (management OR care OR treatment OR regulation)))
4	eHealth / electronic health / mHealth / mobile health / telehealth / telemedicine / telenursing / health informatics / nursing informatics / interactive technology / internet / online / web / application / computer / smartphone / tablet	((eHealth OR mHealth OR "e-health" OR "m-health" OR electronic* OR informatic* OR technolog* OR internet OR online OR web OR mobile OR application OR smartphone OR computer OR tablet) OR ((tele) W2 (health OR monitoring OR medicine OR nursing)))

Note. Proximity operators (e.g., N5, W2) changed according to the database

Database	*Search strategy*
General	Set 1 AND Set 2 AND Set 3 AND Set 4
CINAHL (EBSCOHost)	Advanced Search > Limit results: Published date (01-2005 to 05-2017) > 4 entries at the same time (TX for Set 1 and AB for the rest)
PsycInfo (EBSCOHost)	Advanced Search > Limit results: Published date (01-2005 to 05-2017) > 4 entries at the same time (TX for Set 1 and AB for the rest)
Scopus	Advanced > 4 entries then combine (ALL for Set 1 and TITLE-ABS-KEY for the rest)
Web of Science	Advanced Search > Language: English > Timespan: 2005-2017 > 4 entries then combine (All sets: TS or 'Topic' which equals to title, abstract and key words; there is no full text option)

6.2. Data Extraction Form

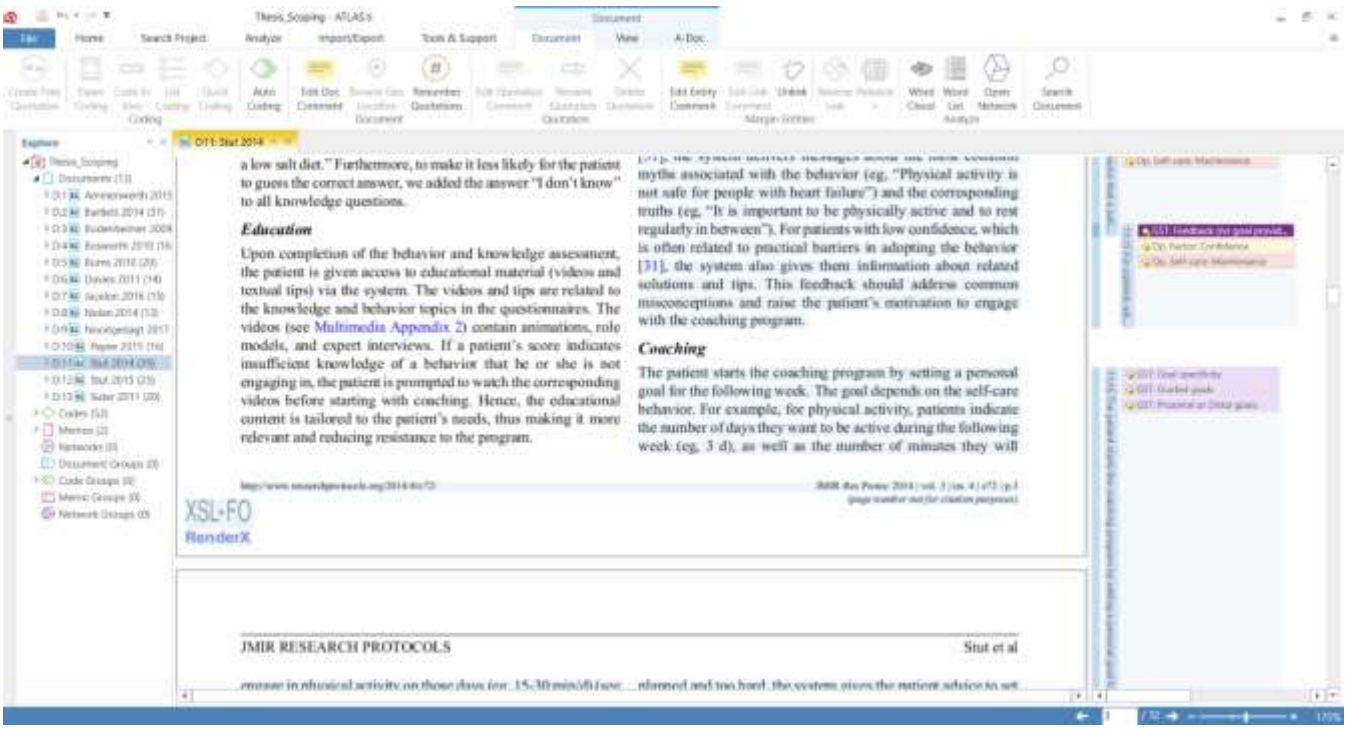
Description of studies	
Year of publication	
Study location	
Study design (*objective + method*)	
Study participants (*number [M/F] + mean age + targeted medical condition + comorbidities identified*)	

Description of eHealth technology	
System name	
System's objective(s) or aim	
Technical device(s)	
Main feature(s)	
Instructions / Recommendations of use	

Persuasive System Design principles							
Primary task support		Dialogue support		Credibility support		Social support	
• Self-monitoring		• Reminders		• Trustworthiness		• Social learning	
• Reduction		• Praise		• Real-world feel		• Social comparison	
• Personalization		• Suggestion		• Expertise		• Normative influence	
• Rehearsal		• Rewards		• Verifiability		• Social facilitation	
• Tunneling		• Similarity		• Authority		• Cooperation	
• Simulation		• Social role		• 3rd party endorsement		• Competition	
• Tailoring		• Liking		• Surface credibility		• Recognition	

Theory constructs		Goal setting as a BCT	
Feedback (where no goal is provided)		Aim (target as *behaviour* or *outcome*)	
External incentives (diff. to feedback without a goal provided or assigned goals)			
Goals (Extracted by constructs below)			
• Goal difficulty			
• Goal specificity			
• Personal / Self-set goals			
• Assigned goals			
• Participatory / Collaborative goals			
• Guided goals			
• Proximal or Distal goals		Operationalization (*self-care element(s) + factor(s) considered)*	
Directive function			
Energizing function			
Persistence			
Task-relevant knowledge and strategies			
Feedback (on progress towards a goal)			
Task complexity			
Commitment		Reported outcomes (*positive*, *negative* or *missing + description*)	
• Importance		Theory	BCT
• Self-efficacy			
Task performance (Extracted as BCT aim)			
Satisfaction			
Satisfaction paradox			

6.3. Coding Using the ATLAS.ti Software



6.4. Codebook: Goal Setting and PSD Model Principles

1. Goal Setting Theory constructs

Code	Description
Feedback (no goal provided)	Feedback acts as an **external incentive when no goal is provided**, in this case it has an effect on performance through the influence of "self-set goals" in response. (Code only when feedback on performance is given but NOT linked to an already existing goal) (e.g., shows summary of health measurements from previous week)
Ext. Incentives (Others)	**External incentives** can be provided, for example, by participation, money, or task design. (Code when not referring to *"feedback (no goal provided)"* or *"assigned goals"*, which can also function as incentives) (e.g., money is offered)
Personal / Self-set goals	Personal or **self-set** goals. (Code only when individuals are prompted or given the opportunity to set a goal for themselves; contrast with other goal sources)
Assigned goals	Goals that are set by **others**. According to the theory, assigned goals affect performance through their influence on self-set goals and self-efficacy. (Contrast with other goal sources)
Participatory / Collaborative goals	Goals set based on a **discussion** or **agreement** with others (e.g., clinician and patient). (Code only when another individual plays a role in goal setting)
Guided goals	When an individual chooses a goal from among a **preset list of options**. (Code against other types of goals)
Goal difficulty	Setting **difficult** goals or **addressing difficulty** in order to promote better performance. According to the theory they significantly increase performance compared to easy goals.
Goal specificity	Setting goals in a **specific** manner or **addressing the specificity** of a goal. According to the theory specific goals significantly increase performance as opposed to general goals such as 'do your best'.

Proximal or Distal goals	Setting proximal (**short term**) goals or **addressing the proximity** of a goal. According to the theory goals that seem achievable in the short term (can facilitate performance on complex or more distal tasks).
Directive function	**Mechanism:** Goals **direct attention** away from irrelevant behaviour and **direct effort(s)** towards goal-relevant activity. (Code when the content describes this function as part of the intervention or technology; or when such a mechanism can be sufficiently inferred)
Energizing function	**Mechanism:** Goals **energize and generate effort toward goal accomplishment**. High goals lead to **more effort** being invested in task performance than low goals. (Code when the content describes this function as part of the intervention or technology; or when such a mechanism can be sufficiently inferred)
Persistence	**Mechanism:** The **time spent to attain a goal**. Specific and difficult goals **prolong the effort** that people will put into goal attainment. (Code when the content describes this function as part of the intervention or technology; or when such a mechanism can be sufficiently inferred)
Task-relevant knowledge and strategies	**Mechanism:** Defined as the **ability** (e.g., knowledge and skill) to perform the task. Goals stimulate the **use** or **discovery** of task-relevant knowledge and strategies. (Code when the content describes this function as part of the intervention or technology; or when such a mechanism can be sufficiently inferred)
Feedback (on progress towards a goal)	**Moderator:** Knowledge of **results** or **progress** towards goal attainment. (Code only when linked to an already existing goal or when one is provided through *"participatory / collaborative goals", "assigned goals"* or any form of external suggestion to a goal is identified)
Task complexity	**Moderator:** The **complexity of the task** affects the goal-performance relationship, as with greater task complexity people may have to **develop** new **strategies** or **learn** new **skills** to perform the task. (Code when the content **addresses complexity** of a goal)
Commitment	**Moderator:** Refers to **one's attachment or determination to attain the goal**, regardless of its source (e.g., self-set vs. assigned goal). Commitment to the goal **strengthens** the goal-performance relationship. (Consider coding together with *"self-efficacy"* and / or *"importance"* if any applies)
Importance	The **perceived importance** of the goal and its expected outcomes. (Consider coding together with *"commitment"* if it applies)
Self-efficacy	A person's **belief** about whether they can attain the goal. The theory states that performance is affected not only by what one is trying to do (the goal) but also by how confident one is of being able to do it (self-efficacy). (Consider coding together with *"commitment"* if it applies)
Satisfaction	Goals serve as reference point for **satisfaction** or dissatisfaction, with satisfaction **increasing** the more a person exceeds a goal, and **decreasing** as the negative discrepancy between a set goal and achievement grows. (Code when the aim of a goal is different than a behaviour or outcome of behaviour; when **satisfaction or dissatisfaction is addressed or can be inferred from the content as an outcome of goal setting**)
Satisfaction paradox	A paradox exists: people **who have the best performance are the least satisfied**, because their reference point for satisfaction is much higher. This dissatisfaction motivates performance, explaining the positive effects of difficult goals upon performance. (Code if this paradox is described or if it can be sufficiently inferred from the content)

2. Aim and operationalization of goal setting as a BCT

Code	Description
Aim	
Focused on behaviour	Set or agree a goal defined in terms of the **behaviour to be achieved** (e.g., set a daily walking goal) (Code specific behaviour)
Focused on outcome	Set or agree a goal defined in terms of a **positive outcome of wanted behaviour** (e.g., set a weight loss goal as an outcome of changing eating patterns) (Code specific outcome)
Operationalization: Self-care element	
Self-care maintenance	Behaviours or activities to **reduce risk factors**, **improve health**, **and adhere to recommendations (**e.g., follow dietary restrictions, take medications as prescribed, exercise regularly)
Self-care monitoring	Routine daily **monitoring** / **vigilance** to **HF symptoms** and recognize a problem when it occurs (e.g., daily weights, checking for edema)
Self-care management	Evaluate a **change in symptoms**, determine what **action** is needed and / or evaluate the effectiveness of the action (e.g., do nothing, call a health care provider)
Operationalization: Factors that affect self-care	
Confidence	Aim to increase the **confidence** of the patients **to perform self-care**.
Cognitive status	Aim to address a **cognitive impairment** and / or **literacy level** in patients.
Emotional status	Aim to address **depression** / **anxiety** or **related psychological conditions** in patients.
Relationship with healthcare provider (HCP)	Aim to increase **trust**, **collaboration** and / or **respect** with **HCP**.
Learning environment	Aim to provide a **safe environment** to explore **real or a potential situation in which self-care is difficult**.
Teaching approach	Aim to **practice** or **learn** self-care skills over time.
Personalization of self-care symptom monitoring and management	Aim to **assist HCPs** in identifying individual patterns to aid **decision-making process** around self-care.
Social support	Aim to increase **social support** for patient self-care activities in the form of emotional, instrumental, informational, or appraisal.

3. Persuasive Design Model principles

Code	Description
Primary Task Support	
Reduction	A system that reduces complex behavior into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour. (Code when it specifically **divides the target behaviour into small, simple steps**)
Tunneling	Using the system to guide users through a process or experience provides opportunities to persuade along the way. (Code when it **delivers content in a step-by-step format with a predefined order**)

Tailoring	Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group. (Code when it provides **content that is adapted to factors relevant to a user group**, or when a counselor provides **feedback based on information filled out by a participant**, contrast with *personalization* where content or information is modifiable by one single user) (e.g., tailored by age group or after a self-assessment)
Personalization	A system that offers personalized content or services has a greater capability for persuasion. (Code when it provides **content that is adapted to one user**, contrast with *tailoring* where content or information is delivered based on a number of factors and could be applicable to anyone fulfilling these) (e.g., name of the user appears in the content)
Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals. (Code when it **provides the ability to track and view the user's behaviour, performance or status**)
Simulation	Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect. (Code when it **provides the ability to observe the cause-and-effect relationship of relevant behaviour**) (e.g., showing a calculation of how much adhering to self-care behaviours can reduce the risk of hospitalization)
Rehearsal	A system providing means with which to rehearse a behaviour can enable people to change their attitudes or behaviour in the real world. (Code when it **provides the ability and stimulation to rehearse a behavior or to rehearse the content of the intervention**) (e.g., an interactive animated simulation showing the right way to measure blood pressure)
Dialogue Support	
Praise	By offering praise, a system can make users more open to persuasion. (Code when it **offers praise to the participant on any occasion**) (e.g., system congratulates the user every time a goal is reached)
Rewards	Systems that reward target behaviours may have great persuasive powers. (Code when it **offers some kind of reward when the participant performs a target behaviour** relating to the use or goal of the intervention) (e.g., digital points)
Reminders	If a system reminds users of their target behavior, the users will more likely achieve their goals. (Code when it **provides reminders about the use of the intervention or the performance of target behaviour**)
Suggestion	Systems offering fitting suggestions will have greater persuasive powers. (Code when it **provides a suggestion to help the participants** reach the target behaviour)
Similarity	People are more readily persuaded through systems that remind them of themselves in some meaningful way. (Code when it **is designed to look familiar and designed especially for the participant**) (e.g., language slangs common in their context)
Liking	A system that is visually attractive for its users is likely to be more persuasive. (Code when it is **visually designed to be attractive to the participants**) (e.g., specific images or animations that are known to be appealing to the users)
Social role	If a system adopts a social role, users will more likely use it for persuasive purposes. (Code when it **acts as if it has a social role**) (e.g., system acts as a coach, instructor, or buddy)
System Credibility Support	
Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion. (Code when it **provides information in a way that remarks it to be truthful, fair and unbiased**) (e.g., a link to the website of developers involved)
Expertise	A system that is viewed as incorporating expertise will have increased powers of persuasion. (Code when it **provides information in a way that shows knowledge, experience and competence**) (e.g., updated information from core organization)
Surface credibility	People make initial assessments of the system credibility based on a firsthand inspection. (Code when it has a **competent look and feel**) (e.g., avoids ads, non-relevant information or features unrelated to main target of the system)

Real-world feel	A system that highlights people or organization behind its content or services will have more credibility. (Code when it **provides information on the organization or people behind the content and services**) (e.g., provides means to contact them)
Authority	A system that leverages roles of authority will have enhanced powers of persuasion. (Code when it **provides information or refers in its content to people in the role of authority**) (e.g., quotes an authority figure from a recognized organization)
Third-party endorsements	Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility. (Code when it **shows endorsements on respected external sources**) (e.g., logo regarding the protection of the data from a provider)
Verifiability	Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources. (Code when it **provides means to verify the accuracy of site content via outside sources**) (e.g., citing sources)
Social Support	
Social learning	A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behaviour. (Code when it **provides the opportunity and stimulates participants to see others using the intervention** or performing the target behaviour) (e.g., a feature to connect and give performance feedback to other users)
Social comparison	System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others. (Code when it **provides the opportunity for participants to compare their behaviour** to the target behavior of other participants and stimulates them to do this) (e.g., shows comparison chart of number of users fulfilling their goals in a certain week)
Normative influence	A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behaviour. (Code when it **provides normative information on the target behavior or the usage of the intervention**) (e.g., offers information on average amount of physical activity done by patients with high adherence to self-care behaviours)
Social facilitation	System users are more likely to perform target behavior if they discern via the system that others are performing the behaviour along with them. (Code when it **provides the opportunity to see whether there are other participants using the intervention**) (e.g., includes a discussion board)
Cooperation	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to cooperate. (Code when it **stimulates participants to cooperate** to achieve a target behaviour)
Competition	A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete. (Code when it **stimulates participants to compete** with each other to achieve a target behaviour)
Recognition	By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behaviour. (Code when it **prominently shows (former) participants who adopted the target behaviour**)

6.5. Trail of Evidence for the Development of Personas

Structure	Case	Quotes / Sources *(Examples)*	Content
Demographics	2	"Nou, wie ik ben, ik ben .., ik ben getrouwd, wij zijn al X jaar getrouwd, we hebben X kinderen, een zoon en X dochter, we hebben X kleinkinderen. En dat is allemaal bijzonder gezellig samen" "Want toen begon mijn hartfalen, 8 jaar terug. We hadden de koffers gepakt, om weg te gaan, maar dat feest ging niet door. Dat was natuurlijk heel erg vervelend. Ik ben gelukkig bij een hele goede arts terecht gekomen, dokter X"	Family woman, retired almost eight years ago. "Jet suffered a heart attack eight years ago, which led her to retire from her job".
Educational level or professional background	1	"Ja ik heet X, ik ben een vrouw, ik werk bij X in het magazijn. Ik werk halve dagen"	Recently retired, part time job. "Secretary for a big manufacturing company in the Netherlands".
Healthcare specifics	1	"Wanneer heeft u nou de diagnose hartfalen dan gekregen? Even kijken, in april, afgelopen april" "Ik kan moeilijk lopen, ik kan niet fietsen, traplopen is helemaal uit den boze, dr op wil nog wel maar d'r af dat is een ramp. Dus ik heb ook een stoeltjeslift. En ja je bent gewoon heel beperkt en nou met dat hartinfarct erbij natuurlijk helemaal"	Recently diagnosed. Limited mobility.
Technical ability in general (with technology)	2	"Nu zou ik graag wat meer willen weten over uw internetgebruik. Heeft u thuis een computer? Ja. Heeft u ook een tablet? Ik heb een iPad. Heeft u ook een telefoon waarmee u op internet kan? Nee. Ik heb wel een mobiele telefoon. Ik kan wel appen en al die dingen" "Hoe vaak gebruikt u nou internet, per dag of per week? Nou kijk iedere dag wel even ja. Naar emailtjes dan wel, of ik wat wil bestellen ofzo, of ja, daar heb ik internet voor ja. Bankrekening natuurlijk, kunnen bankieren"	Low use of technology, mostly functional.
iMediSense experience	2	[a] **Log data analysis: Higher interaction with history charts.** "Ik zie dat u regelmatig uw grafiekje bekijkt. De grafiek waarin u de gegevens echt terug kan zien. Niet elke dag, maar wel de helft van de dagen, zou ik zeggen. Waarom doet u dat? Om het verloop te zien. En ik heb het een keer laten zien aan mijn zoon. O ja. En aan mijn vrouw. Maar voor uzelf voor het overzicht dus? Ja, voor het overzicht meer. En kan u wat met de gegevens? Nee, het is meer informatie en verder niet. Ik doe er niets anders mee. Ik doe er verder niets mee nee"	Positive experience of measurements. Reason for extensive use of history chart.
Self-management (in general)	3	[a] **Log data analysis: Multiple measurements per day.** "Hield u daarvoor ook al meetwaardes van uzelf mee. Ja, ik ging iedere dag wegen. Je vergat het weleens, heel af en toe, maar over het algemeen iedere dag even op de weegschaal staan om te kijken of het allemaal goed is. En dan ben je het wel gewend. Is dat dan iets waar u voor uzelf naar kijkt? Schrijft u het ook op? Nee, dat doe ik gewoon voor mezelf. Dat er niet ineens een kilo bijkomt, dat je denkt: er is wat verkeerd of zo. Daarvoor doe je het eigenlijk. En dat advies kreeg ik ook bij hartfalen van 'houd het gewicht in de gaten"	High confidence and good adherence to self-care.
Latent need for self-care coaching (self-management through a goal setting module)	1	"En dat is het enigste waar ik moeite mee heb, met die vochtbeperking. Wat is daar dan moeilijk aan? Nou ja je mag maar 1,5 liter drinken. En als je alles er bij op telt. Fruit, koffie, thee. Dan zit je daar nog wel gauw een keer aan. Want mensen denken oh 1,5 liter dat haal ik nooit maar ja als je alles er bij op telt ook fruit en yoghurt en soep en dat soort dingen, dan zit je daar heel gauw aan. En ik vind anderhalf dus niet zo heel veel. En ik houd me er nu sinds een paar dagen wel weer aan. Maar vorige week of die week er voor met die suikerziekte dat ik zo'n dorst had dan zat ik d'r echt weer over heen. Maar nou houd ik me dr wel aan eigenlijk"	Low confidence in specific self-care behaviours.

[a] The results from the first log data analysis were usually considered as first in line to shape the content of the personas. For example, if the selected case showed a high interaction with the history chart, quotes that didn't match this kind of behaviour were dismissed.

6.6. Informed Consent Form

UNIVERSITEIT TWENTE.

RESEARCH INFORMATION & INFORMED CONSENT

Introduction

We would like to invite you to participate in a scientific research organized as part of a master's thesis project of the University of Twente. The study is aimed at enhancing the functionalities of the iMediSense telemonitoring and coaching technology. You're being invited because you've been identified as a valuable stakeholder of this technology. Your input is fundamental for the current stage of development. In this paper we explain to you what the project is, what we are investigating, and what we expect from you so you can make an informed decision about your participation.

What is the research about?

This research aims to develop the coaching functionalities (behavioural support and feedback) of the iMediSense technology by exploring goal setting as an evidence-based behavioural change technique and its underlying theory. Furthermore, it seeks to identify and deliver functional requirements (what should the system do?) with the support of key stakeholders so that our findings can be properly connected with the current state of the technology.

How is this research being conducted?

First, we have explored goal setting as an evidence-based technique and its theory through a scoping review of the literature and now have a set of preliminary findings about how a technology like the iMediSense system can support self-care of patients with congestive heart failure (CHF). Our next step is to make sense of these results in order to deliver feasible and relevant functional requirements for the development of this module, this means that we need to detail how this system should support its users to set and strive for personal goals related to the management of their disease. Given the importance of this step, it is fundamental that we involve the people that can affect or are affected by this technology, the stakeholders.

What do we ask from you?

If you decide to participate in the research, you will be invited to a focus group session where together with other stakeholders we will present to you our preliminary findings and then hold discussions about key topics relating to the potential self-care functionalities of the iMediSense technology. The focus group will take approximately 1.5 hours of your time and will be hosted in a location and time to be defined, which will be established in convenience with the group's availability. During this session you will be asked for your opinion regarding certain topics, no preparation will be required from you and the agenda for the session will be sent to you beforehand in case you have questions or comments about it. Furthermore, we also ask you to agree to the possibility of an individual interview with you at a different time than the focus group. If this is required for your case we will contact you about it to arrange the details, an individual interview will take no longer than 45 minutes and will have the same objective of the focus group. As researchers our intention is to learn from you, your area of expertise, and / or your role for the development, implementation, and evaluation of the iMediSense technology.

Benefits of your participation

As a stakeholder of the technology you will have the opportunity to influence the design of the coaching functionalities of the iMediSense technology. Your expertise or role will be considered in order to make sure that the proposed module fulfills your needs and harvests on your knowledge about each topic of discussion.

Voluntary participation

Your participation in the research is voluntary. If you decide to participate, you are asked to sign this consent form. You can stop your participation at any time without giving a reason and this will not affect you in any way.

Confidentiality of the data

The focus group session and, if applicable, the individual interview will be audio-recorded. The information collected this way will be treated strictly confidential in accordance with the applicable laws and regulations. The research results can be published but your identity will remain secret.

Researchers involved from the University of Twente

Supervisors: prof. dr. Lisette van Gemert-Pijnen & MSc. Floor Sieverink

Leader researcher: Roberto Cruz

Questions and comments

Please contact Roberto Cruz | r.r.cruzmartinez@student.utwente.nl | 0683186149

Authorization of consent

'I hereby declare that I have been informed in a manner which is clear to me about the nature and method of this research. I reserve the right to withdraw this consent without the need to give any reason and I am aware I may withdraw at any time. I have had the opportunity to ask questions about it and any questions I had have been answered to my satisfaction. I consent voluntarily to participate in this research.

_____	_____	_____
Full name of subject	Signature	Place and date of consent

'I have provided an explanation about the research. I declare myself willing to answer to the best of my ability any questions which may still arise about the research.'

_____	_____
Full name of researcher	Signature

6.7. Consultation Scripts and Sample of Materials

1. Expert-user (Cardiologist)

Individual Interview Script

Interviewee: Cardiologist. Cardiologists are not meant to be the most frequent users of the system, but are an expert user of the information and content on the platform.

Material: Voice Recorder, Informed Consent & Research Information.

Introduction

- Name, institution, main task (research)
- Objective of the interview
- Process of the interview
- Summary of mutual benefits
- Reminder of IC: Audio recorded

Topics & Questions

- General questions
  - **Briefly: What was your role in the 'Twente TEACH'-pilot?**
  - **How was your experience regarding the 'Twente TEACH'-pilot?**
  - **Expectations for iMediSense after the 'Twente TEACH'-pilot?**
- Self-management of HF patients using the iMediSense technology
  - **How far can self-management of HF go?**
  - **What do you know about goal setting as a BCT?**
  - **How important do you think it is for self-management?**
  - **Pros / Cons?**
- Now I would like to point out some of our preliminary results…
  - Exploration of goal setting for HF self-care (Scoping review)
  - Behaviour or outcome (e.g., walking or losing weight)
  - What existing technologies or prototypes already address…
    - Feedback (no goal provided) as incentive
    - **How do you usually motivate or prompt patients to change?**
    - Personal / Collaborative goals / Guided goals?
    - **Which option do you see fit for iMediSense?**
    - Feedback (on goal performance)
    - Self-efficacy
    - **How important is self-efficacy for HF?**
    - Goals for self-care maintenance
    - **Goals for self-care management or monitoring?**
    - **Would you recommend a patient to set goals to measure their symptoms X amount of times per week?**
    - **Would you recommend a patient to set goals to better understand his symptoms and improve the decision-making process?**
- 3 cases (Log data)
  - Not fully adherent
  - Fully adherent
  - Fully adherent + high self-monitoring
  - **Do you think these 3 cases match with what is commonly found among HF patients?**
  - **What are we missing? (e.g., possible cases, relevant factors)**
- Further steps
  - Personas
  - **How would you describe these patients based on these charts?**
  - **What other important characteristics do you find among HF patients?**
  - Integrate to technology (PSD and Agile Science)
  - **What would you recommend for the developers of the technology? Regarding improving the feedback and coaching of iMediSense**
- Closure
  - **Any additional topics you would like to discuss?**
  - Thank you for the interview

2. Potential end-user (Individual under an initial stage of CHF diagnosis)

Individual Interview Script

Interviewee: HF Patient. Potential end user of the system.

Material: Voice Recorder, Informed Consent & Research Information.

Introduction

- Name, institution, main task (research)
- Objective of the interview

- Process of the interview
- Summary of mutual benefits
- Reminder of IC: Audio recorded

Topics & Questions

General questions

- **How was your experience with the iMediSense system? *(if applicable)***
- **Expectations for improvement of the iMediSense system?**

Goal Setting for HF

- **Could you briefly describe an average day for you? Specifically in the aspects regarding your condition?**
- **Do you have any specific (daily, weekly) goals regarding your condition?**
- **What do you do to accomplish these goals?**
- **What are the difficulties to fulfill these goals?**

Now I would like to discuss more specific points…

- When you set a goal, it can be aimed at a behaviour or outcome
    - e.g., 30 minutes of exercise per day, daily fluid intake, medication intake, remove salt shaker from kitchen (*)
    - e.g., physical activity level, lose weight, low-salt diet (*)
    - **Can you think of any behavioural or outcome goal you've had? How did it go?**
- Now, I'll explain a few points to you and I would like your opinion…
    - Feedback (no goal provided) as incentive
        - **What motivates you the most to deal with your condition?**
    - Personal goals
    - Collaborative goals
        - **What kind of support to your goals would you expect from other people?**
    - Social support
        - **Which persons around you play a role? Why?**
    - Role in relationship with HCP
        - **What is your relationship with your HCP?**
        - **How does this relationship makes you feel? Why?**
    - Guided goals
        - **If you were suggested 5 goals to improve your health and were recommended to start with one of them. Would you find this useful?**
        - **On which basis would you choose?**
        - **What would you like to know about these options?**
    - Self-efficacy
        - **How confident do you usually feel to reach the goals related to your condition?**
    - Goals for self-care maintenance (e.g, increase physical activity)
        - **Would you accept this as a goal?**
    - Goals for self-care management (e.g., receive education to understand better your measurement values)
        - **Would you accept this as a goal?**
    - Goals for self-care monitoring (e.g., take daily measurements in the next two weeks)
        - **Would you accept this as a goal?**
    - Lo-fi prototype
        - Education
        - **What have you done in the past to stay informed or educated about your condition?**
        - **Would you find something like this useful?: "Tip of the day" prototype**
        - **What is your usual reaction when you come across 'unusual' or 'undesired' measurements?**
        - Coaching
        - **If the technology provided training for the first two weeks of use. Would you find this useful? (e.g., practicing measurements, exploring the application)**
        - Social support through message function
        - **If you could receive support messages (advice, recommendations) from your HCP regarding your goals. Would you find this useful?**
        - **If the technology itself could provide you support messages (advice, recommendations). Would you find this useful?**
        - Feedback on goals
        - **How would you like to see your goal performance?**
            - **A: Thumbs up**
            - **B: Number**
            - **C: Animation (e.g., flower with growing petals)**
            - **D: Chart**
    - Further steps
        - **Are you in contact with other HF patients?**
        - **In general, how do you compare yourself with them? (e.g., dealing with the condition, etc.)**
        - **What would you recommend for the developers of the technology?**
- Closure

- **Any additional topics you would like to discuss?**
- Thank you for the interview

3. Developers

Consultation Script

Stakeholders: Developers.
Material: Voice Recorder, Informed Consent & Research Information.

Overview

- Roberto Cruz; University of Twente; leading the research.
- Objective: Gather your insights and learn from you to enhance the usefulness of our results.
- Process:
  - Review IC, address questions, etc.
  - General questions
  - Consultation: Power point presentation & hand-outs
- Sign Informed Consent and address questions and comments

General questions (*start audio recording)*

- What is your function at ----? Can you describe your role in the development of the iMediSense technology?
- If applicable, what were your personal conclusions from pilot? Especially regarding the functionality of the app.
- What are your expectations for improvement of the iMediSense system? Same as before.

Consultation *(PP, slide number in brackets)*

Overview of research

- **[6]** Basically, this describes what we focused on, with an evidence-based approach that was feasible and useful
- **[8]** Any questions or comments so far?
- **[8]** The agile concept comes from software development. What does it mean to you? What is the added value?

Preliminary results

- **[9]** We're summarizing the description of these technologies (e.g., country, main features, etc.). Would this kind of information be useful to you? As if to include it in a design document.
- **[10-11]** Evidence-based is the keyword here, to raise effectiveness but 'innovation' is also applicable. Our first method presupposed and then confirmed that there is no technology with this kind of description yet.
- **[12-19]** Our goal here was to confirm a difference that we presupposed existed between these users. Please address any observations you have at any of these.
- **[19]** Would you like some time to review the table?
- **[19]** We're talking about different concepts, such as adherence, but that's coming from our end. From your perspective what are the evaluations that you consider important?
- **[19]** Do you have any analysis suggestions for further analysis? (Considering limitation on generalization)

Key topics

- **[21]** Some of these products will be in the thesis paper no matter what. However, we'd like to know which ones would be more relevant for you as developers and stakeholders in order to gather them in a single design document. We want to translate the knowledge we collected into useful input for practice.
- **[21-27]** From now on, I'd just like you to address the potential usefulness of these type of results for your practice and the development of the technology overall.
- **[26]** Regarding data flow-charts, if you'd consider this as useful I'd like to request some recommendations on the optimal way to do this. Given that this would be quite a stretch in terms of methodology for us.

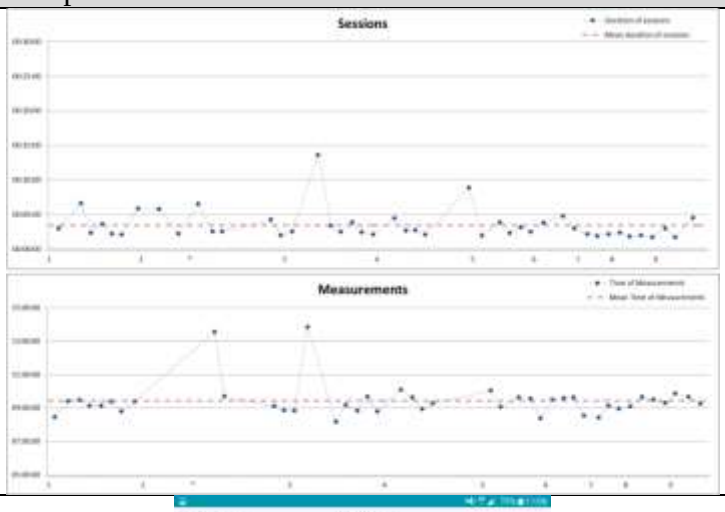
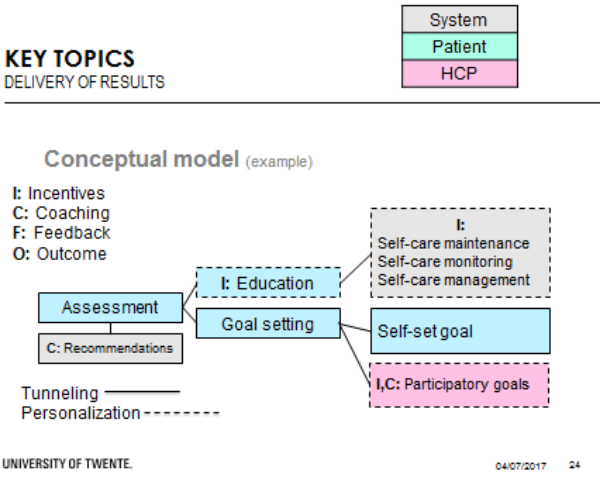
Design of coaching functionality: further steps

- Where are we at now?
- What are your current expectations of contributions to this project from the UT?
- Do you have any other ideas or proposals that you'd like to share?

Closure

- Anything else you'd like to discuss or add?
- Thank you for this meeting and your time

Sample of materials for each consultation

Stakeholder	Sample	Objective
Expert user		*Preliminary results of log data analysis:* To prompt the discussion of use of the system and characteristics of CHF patients
Potential end-user		*Feedback mock-ups:* Different interfaces selected from the review literature were shown to the interviewee to prompt discussion of persuasiveness
Developers		*Microsoft PowerPoint slides:* Support material for the consultation meeting. Was organized according to the script.

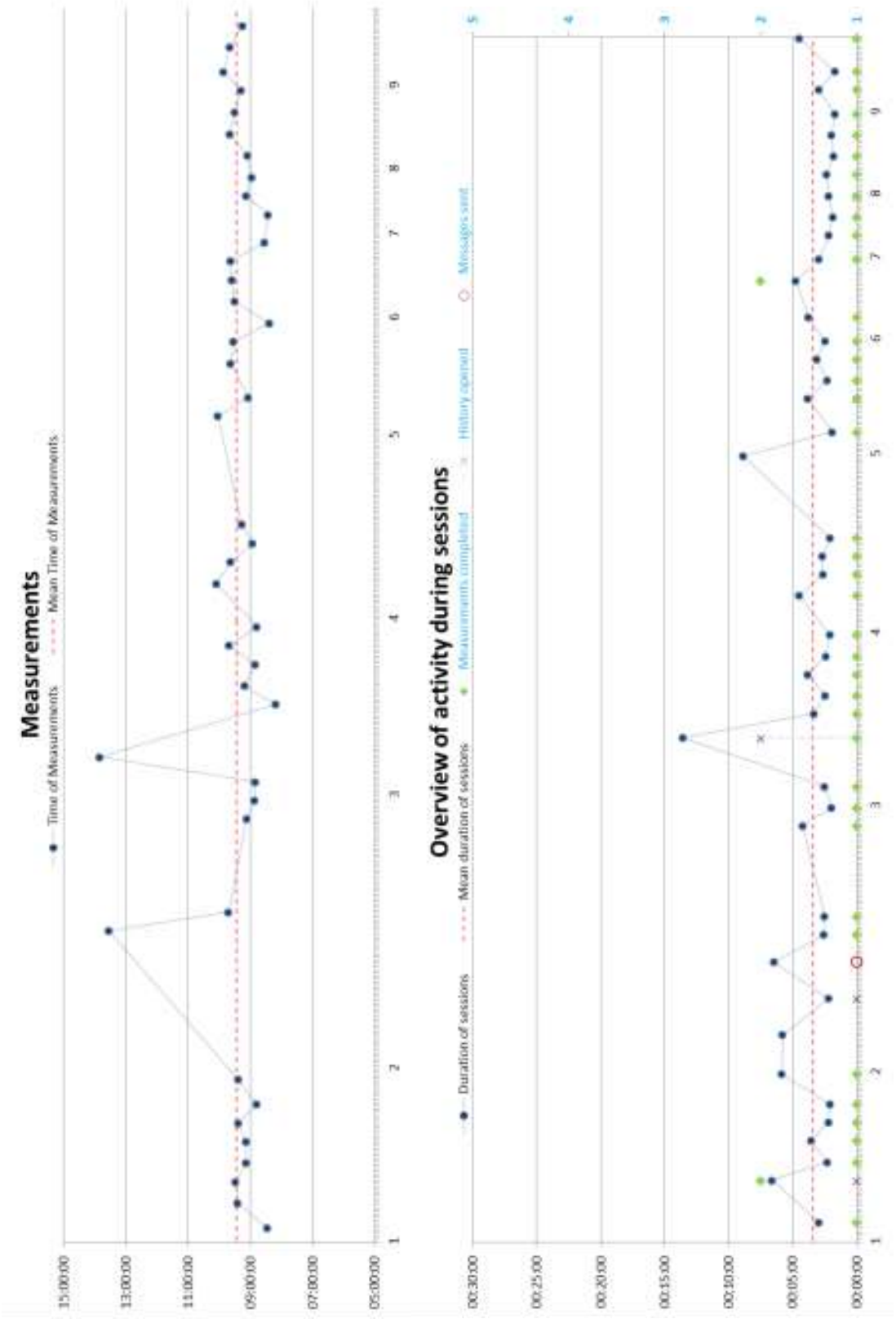
6.8. Codebook: Stakeholder Consultation

Consultation codebook for thematic analysis (*deductive coding*)

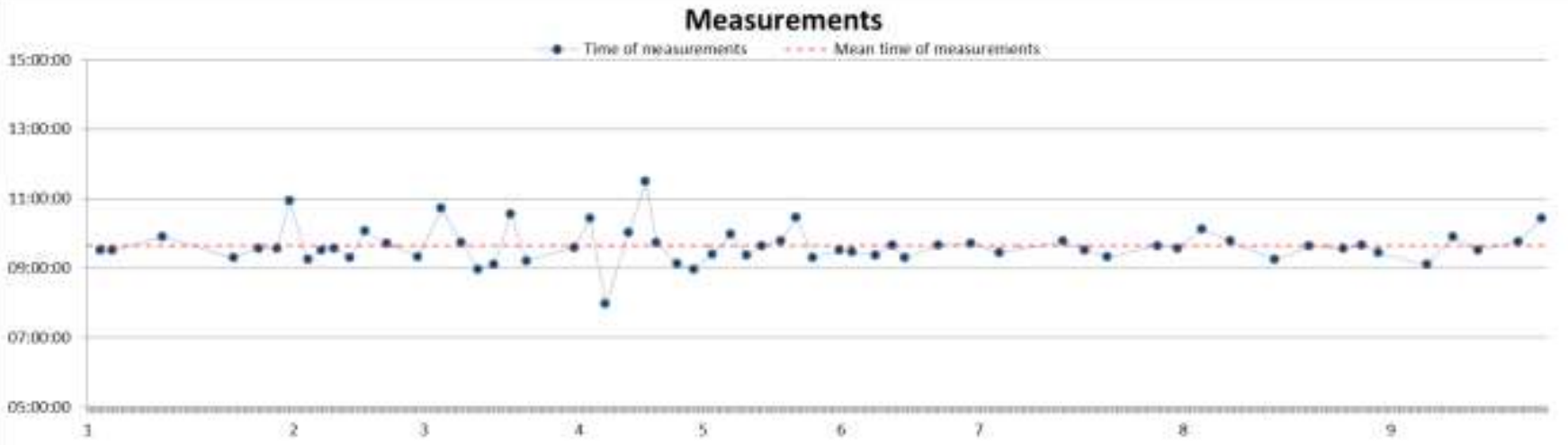
Code	Description
Self-care coaching for heart failure	
Enhancing self-care	Factors or elements of value to increase or support self-care coaching. (e.g., providing education)
Challenges in self-care of HF	Factors or elements that could hinder or diminish the effects of self-care coaching. (e.g., attitudes or motivation)
Self-care elements of HF	Statements regarding the three self-care elements as defined by Howlett et al. (2016): self-care maintenance, self-care monitoring, and self-care management. (e.g., relevance of setting goals to monitor health parameters)
Goal setting for heart failure	
Value of goal setting for HF	Potential benefits or relevance of goal setting for self-care coaching (e.g., keeps the patient motivated)
Challenges of goal setting HF	Factors or elements that could hinder or diminish the effects of goal setting for HF (e.g., could cause dissatisfaction)
Personal / Self-set goals	Statements regarding personal or self-set goals
Collaborative / Participatory goals	Statements regarding collaborative or participatory goals
Guided goals	Statements regarding guided goals
Confidence / Self-efficacy	Statements regarding confidence or self-efficacy (e.g., value for self-care)
Feedback	Statements regarding provision of feedback (e.g., how to deliver it)
Goal difficulty	Statements regarding difficulty of goals set (e.g., relevance)
Goal importance	Statements regarding importance of goals set
Social support	Statements regarding role of social support in goal setting
Implementation of coaching in iMediSense	
Challenges of implementation	Factors or elements that could hinder implementation of a coaching feature in the iMediSense technology (e.g., ineffective methods)
Functionalities	Potential or desired functionalities for a coaching feature in the iMediSense technology (e.g., feedback on goals)
Persuasiveness	Statements regarding factors or elements to consider for the persuasiveness of a potential coaching feature for the iMediSense technology (Based on PSD framework by Oinas-kukkonen & Harjumaa, 2009) (e.g., sending reminders)
Target group / End-users	Statements regarding factors or elements that could describe and profile the target group or end-users of the iMediSense technology (e.g., education level)
Development of iMediSense	
Project expectations	Statements regarding the expectations or recommendations for further development of the iMediSense technology
Research results (present study)	Statements regarding the (preliminary) research results of the present study (e.g., usefulness or recommendations for delivery)

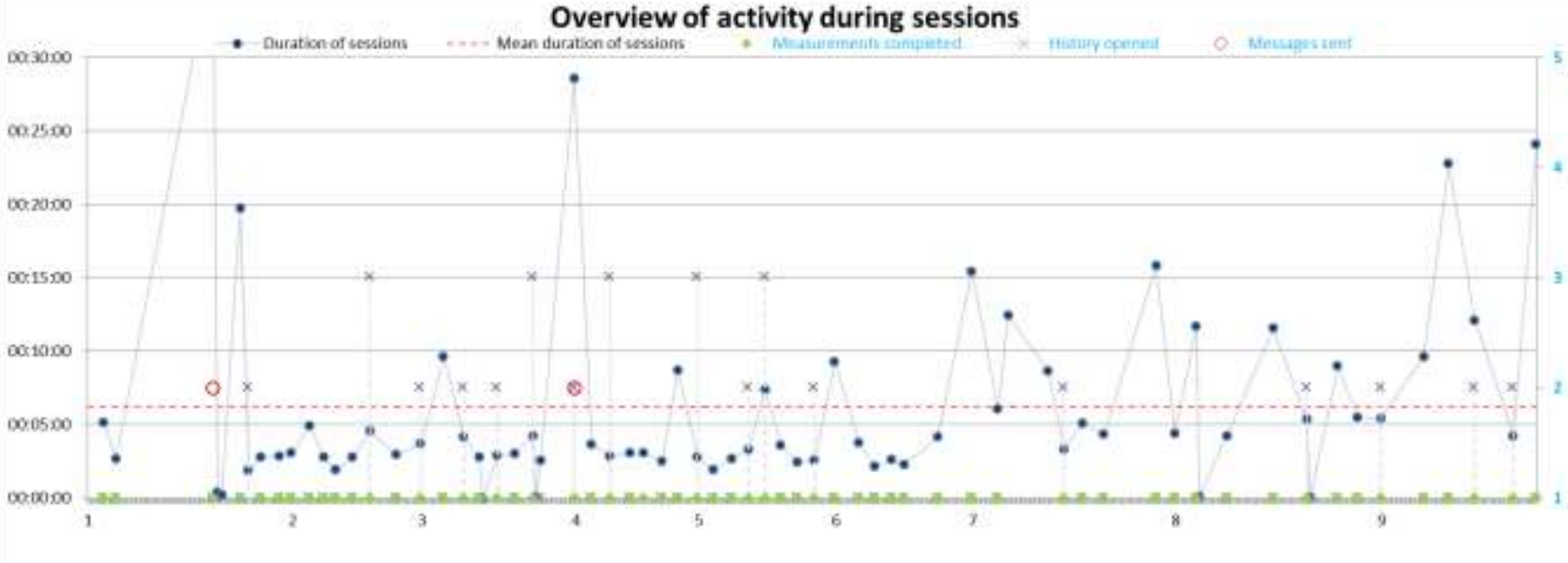
6.9. Descriptive Log Data Analysis: Results

Case 1 – Low adherence

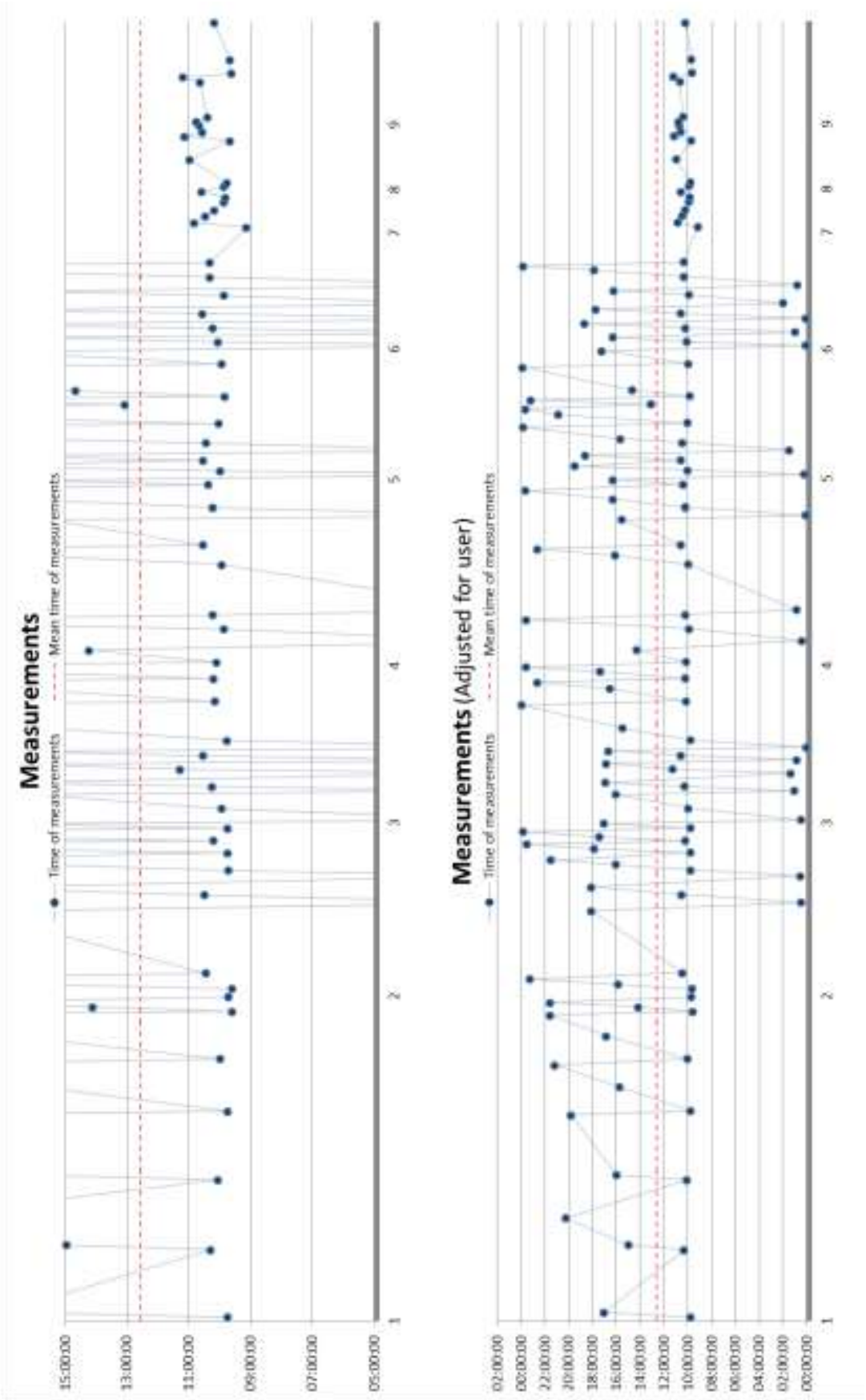


Case 2 – Adherence





Case 3 – Adherence and high self-monitoring



Case 3 – Adherence and high self-monitoring